



MRC GRAPHITE PTY LTD



MUNGLINUP GRAPHITE PROJECT

S38 & EPBC Referral: Supporting Information
Part B_c: Appendices

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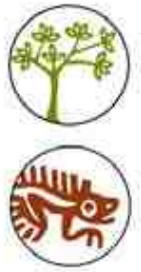
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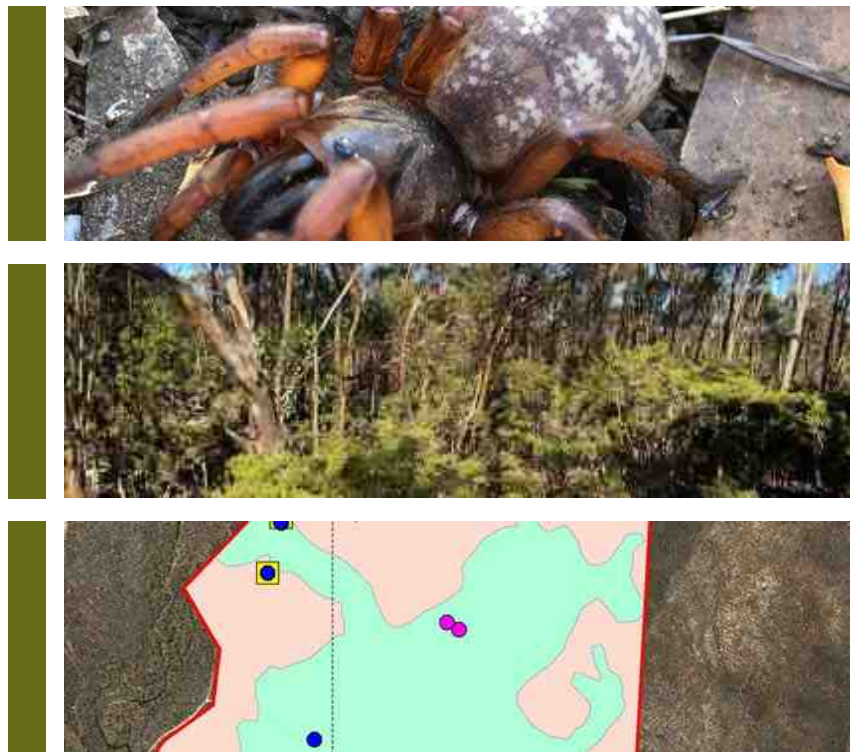
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Munglinup Graphite Project Terrestrial Short Range Endemic Fauna Pilot Study





© Biota Environmental Sciences Pty Ltd 2018
ABN 49 092 687 119
Level 1, 228 Carr Place
Leederville Western Australia 6007
Ph: (08) 9328 1900 Fax: (08) 9328 6138

Job No.: 1375

Prepared by: Dan Kamien

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Munglinup SRE Fauna Pilot Study

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DBCA Regulation 17 Permit

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1.0 Summary

MRC Graphite Pty Ltd (MRC) plans to develop a graphite project (M74/245) in the Munglinup region in the Great Southern of Western Australia, between Esperance and Ravensthorpe. The project tenure is situated approximately 4 km north of the town of Munglinup, with the tenement encompassing approximately 685 ha. Biota Environmental Sciences Pty Ltd (Biota) was commissioned by MRC to undertake a desktop assessment and pilot study to assess the Short Range Endemic (SRE) invertebrate fauna of the Munglinup study area.

The scope of this study was to:

- identify and describe terrestrial SRE fauna habitats occurring within the study area;
- determine the significance of relevant habitats present within the study area;
- conduct limited sampling using appropriate techniques at pilot study intensity;
- provide a risk assessment based on the study results, with general commentary on the potential impacts of graphite mining in the study area;
- collate existing SRE fauna records and information from previous sampling, involving a review of previous relevant surveys in the locality, publicly available consultant reports, and database searches;
- outline species conservation significance for any potential SRE taxa known from the study area locality; and
- summarise existing knowledge of the study area locality including fauna habitats, climate, geology, Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and subregions, and related mapping.

A literature review and database search was conducted, focusing on potential SRE species that have previously been recorded in the study area locality. Additionally, a single phase SRE fauna pilot survey was conducted. During the field component, 12 sites were targeted with a total of over 36 person hours of search effort.

Specific invertebrate groups pre-disposed to short-range endemism targeted during this survey included:

- mygalomorph (trapdoor) spiders (Mygalomorphae);
- millipedes (Diplopoda); and
- terrestrial snails (Pulmonata).

Based on database searches, there have been multiple collections of groups known to contain SRE species within the study area locality, with none listed as conservation significant. The consolidated data from the searches yielded a total of 25 species level taxa belonging to potential SRE groups. Only four taxa were considered likely to occur within the study area, of which three are not SREs. Of the remaining 21 species, 18 may potentially occur in the study area and three are considered unlikely to occur.

Two higher-order taxonomic groups with the potential to include SRE species were recorded within the study area during the pilot survey, mygalomorph spiders and land snails. Specifically, these comprised three putative mygalomorph spider taxa and one land snail species. However, none of the spiders recorded during the pilot study could be identified to species level based on morphology and therefore, their SRE status remains undetermined. Based on current data, only a risk-based assessment could be provided.

Seven different fauna habitats were identified within the study area, all of which also occur outside of the study area, with some being contiguous to the study area. Using habitat as a surrogate to infer wider distributions, it is unlikely that any of the taxa recorded are restricted solely to the study area, as there are no geomorphological or habitat attributes that suggest a high risk of species level distributions being restricted to the scale of the current study area. Despite this, it is important to recognise that the study area is located within remnant bushland and that remnant habitat patches are typical of the region. This landscape fragmentation in itself creates potential restrictions to dispersal and can promote localised distributions in taxa that already exhibit restricted distributions due to habitat preference or life history.

2.0 Introduction

2.1 Project Background

MRC Graphite Pty Ltd (MRC) plans to develop a graphite project (M74/245) in the Munglinup region in the Great Southern of Western Australia, between Esperance and Ravensthorpe. Specifically, the project tenure is situated approximately 4 km north of the town of Munglinup, with the tenement encompassing approximately 685 ha (Figure 2.1). It is currently undetermined if the project will be formally assessed under either State or Commonwealth legislation.

As the managing consultant, Integrate Sustainability Pty Ltd has identified the requirement for a terrestrial Short Range Endemic (SRE) fauna desktop review and pilot study. Neither MRC nor previous tenement holders have conducted previous work relating to terrestrial SREs in the locality of the study area.

2.2 Scope of Work and Objectives

The primary aim of this study is to provide an initial assessment of the occurrence and potential significance of terrestrial SRE fauna and habitats at Munglinup, in order to inform the prospective Environmental Impact Assessment (EIA). This review will also act as a preliminary risk assessment of potential project impacts on invertebrate fauna of potential conservation significance.

This report outlines the results of the desktop review, sampling effort and results of the pilot study terrestrial SRE fauna sampling completed within the study area.

2.2.1 Desktop Review

- collate existing SRE fauna records and information from previous sampling, involving a review of previous relevant surveys in the locality, publicly available consultant reports, and database searches;
- summarise species conservation significance for any potential SRE taxa known from the study area locality; and
- outline existing knowledge of the study area locality including fauna habitats, climate, geology, Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and subregions, and related mapping.

2.2.2 Pilot Study Fauna Sampling

- identify and describe terrestrial SRE fauna habitats occurring within the study area;
- determine the significance of relevant habitats present within the study area;
- conduct limited sampling using appropriate techniques at pilot study intensity; and
- provide a risk assessment based on the study results, with general commentary on the potential impacts of graphite mining in the study area.



Figure 2.1: Location of the Munglinup study area.

2.3 Short Range Endemic Fauna Overview

SRE fauna comprise taxa that display naturally small distributions (less than 10,000 km²) (Harvey 2002). These invertebrates often possess similar ecological and life-history characteristics and are in part characterised by low fecundity, slow growth and poor dispersal capabilities (Harvey 2002). Examples exist from a range of groups including freshwater snails (Ponder and Colgan 2002), land snails (Johnson et al. 2004), and mygalomorph spiders (Main et al. 2000).

In addition, SRE invertebrates are often confined to disjunct 'refugial' habitats, having persisted from a time when moist conditions were more evenly distributed throughout the Australian landscape (Harvey 2002). Given their predisposition to be restricted at small spatial scales, SRE fauna are more likely to be at risk of population extinctions than more widely distributed taxa (Harvey 2002). Given their elevated risk of change in conservation status, the potential presence of SRE taxa in development areas represents a relevant factor for proposals being assessed by the Environmental Protection Authority (EPA) (EPA 2016a).

In recognition of their small distributions and ongoing threatening processes, numerous SRE taxa are listed as Specially Protected fauna under the WA *Wildlife Conservation Act 1950*. On land, mygalomorph spiders, millipedes and land snail taxa dominate this listing (EPA 2016a). Additionally, the Department of Biodiversity Conservation and Attractions (DBCA) list some SRE taxa as Priority species.

The following processes are considered potential threats to SRE fauna (EPA 2016a):

- clearing of native vegetation;
- changes to fire regimes;
- introduction/spread of weeds and pathogens;
- habitat fragmentation; and
- changes to surface hydrology

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3.0 Methodology

3.1 Desktop Review

A desktop review was undertaken to identify relevant records of invertebrate fauna of conservation significance and habitats that may support them within the study area and wider locality (defined here as within 40 km of the study area). The desktop review considered publicly available information, previous fauna surveys in the locality, and the results of various database searches (see Section 3.1.2). A review of provided aerial imagery, geology and vegetation was also conducted (see Section 4.0) to inform site selection for the field survey component.

3.1.1 Review of Previous Relevant Surveys

A literature review was completed to identify any previous relevant surveys from the study area locality. This included searches of Biota's library database, GoogleScholar¹ and the EPA website².

3.1.2 Database Searches

Database searches were carried out in June/July 2018, using the Biota internal database, NatureMap database³, Atlas of Living Australia (ALA), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) Protected Matters Search Tool and the Western Australian (WAM) Arachnida and Myriapoda and Mollusca databases (see Table 3.1).

The Biota, NatureMap, ALA and EPBC Protected Matters databases were searched for a radius of 40 km from the approximate central point of the study area (301858 mE, 6273160 mN). The following co-ordinates bounded the WAM database searches: 261827 mE, 6313020 mN (northwest) and 342002 mE, 6233217 mN (southeast), encompassing a 40 km buffer from the study area boundary.

Table 3.1: Summary and dates of database searches completed for the study.

Database	Date	Search Target
Biota	08/06/2018	Arachnida, Myriapoda, and Mollusca
NatureMap	08/06/2018	Arachnida, Myriapoda, and Mollusca
ALA	29/06/2018	Arachnida, Myriapoda, and Mollusca
EPBC Protected Matters	02/07/2018	Arachnida, Myriapoda, and Mollusca
WAM	08/06/2018	Arachnida, Myriapoda, and Mollusca

3.1.3 Likelihood of Occurrence Terrestrial SREs

Results from the literature review and database searches were used to compile a list of potential terrestrial SRE fauna species that had previously been recorded from the study area locality using the rankings and criteria provided in Table 3.2. The likelihood that each taxon would occur in the study area was then assessed based on consideration of:

- the documented distribution of the species;
- the proximity of the study area to known populations; and
- preferred habitat.

¹ <https://scholar.google.co.uk>

² <http://www.epa.wa.gov.au>

³ <http://NatureMap.dec.wa.gov.au>: NatureMap is a joint project of DBCA and the WAM, and presents the most comprehensive source of information on the distribution of Western Australia's flora and fauna.

Table 3.2: Ranking system used to assign the likelihood that an SRE species occurs in the study area.

Rank	Example Criteria
Recorded	1. The species has been previously recorded in the study area.
Likely	1. There are existing records of the species in close proximity to the study area, or from the locality; and - the species is strongly linked to a specific habitat, which is present in the study area; or - the species has more general habitat preferences, and suitable habitat is present.
May potentially occur	1. There are existing records of the species from the locality, however - the species is strongly linked to a specific habitat, of which only a small amount is present in the study area; or - the species has more general habitat preferences, but only some suitable habitat is present. 2. There is suitable habitat in the study area, but the species is recorded infrequently in the region.
Unlikely	1. The species is linked to a specific habitat, which is absent from the study area; or 2. Suitable habitat is present, however there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; or 3. There is some suitable habitat in the study area, however the species is very infrequently recorded in the region.
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the study area; and/or 2. The species' range is very restricted and would not include the study area.

3.1.4 SRE Habitat Assessment

Habitat elements such as dominant vegetation, substrate characteristics and landform were described at each SRE search site. Habitat descriptions were subsequently validated based on aerial imagery, existing vegetation descriptions, vegetation mapping and previously identified fauna habitats within the study area (Ecologia 2015).

Assessment of broad fauna habitats corresponded to those documented by Ecologia (2015) and as a result existing habitat mapping (Ecologia 2015), provided by MRC was adopted in this study.

3.2 Pilot Study Fauna Sampling

The survey was completed under "Licence to Take Fauna for Scientific Purposes" No. 08-002146-1, issued to Dan Kamien (Appendix 1). The methodology and approach were undertaken under consideration of the following compliance and regulatory documents:

- Environmental Factor Guideline: Terrestrial Fauna (EPA 2016b); and
- Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna (EPA 2016a).

3.2.1 Survey Timing and Personnel

Dan Kamien and David Keirle of Biota conducted the survey between 14 and 18 May 2018. Taxonomic identification of mygalomorph spiders was conducted by Dr Mark Harvey of the WAM. All collected specimens were ultimately lodged at the WAM.

3.2.2 Terrestrial SREs

Specific invertebrate groups pre-disposed to short-range endemism targeted during this survey included:

- mygalomorph spiders (Mygalomorphae);
- millipedes (Diplopoda); and
- terrestrial snails (Pulmonata).

In total, over 36 person hours were dedicated to SRE fauna searches (Table 3.3). Search sites were located where SRE species most frequently occur (e.g. habitat with suitable soil profile, rock piles and drainage depressions). A total of 12 SRE sites were sampled (Table 3.3 and Figure 3.1).

Table 3.3: SRE site location and search effort.

Site	Easting (mE)	Northing (mN)	Personnel	Minutes Searched	Effort (minutes)
MUNSRE01	302227	6273985	2	110	220
MUNSRE02	302075	6273322	2	75	150
MUNSRE03	301548	6275134	2	78	156
MUNSRE04	301954	6271327	2	56	112
MUNSRE05	302065	6271377	2	60	120
MUNSRE06	301806	6271312	2	78	156
MUNSRE07	301784	6272368	2	82	164
MUNSRE08	301569	6272946	2	90	180
MUNSRE09	301406	6273712	2	170	340
MUNSRE10	301633	6273805	2	184	368
MUNSRE11	301354	6273491	2	40	80
MUNSRE12	301089	6274107	2	70	140
				Total Minutes	2,186

Mygalomorph spiders were targeted by visually locating burrows, and then excavating them with the aim of collecting individuals to be preserved in 70% ethanol for morphological description. Two legs were removed and placed in 100% ethanol for potential future molecular analysis, in accordance with WAM requirements.

Millipedes were searched for under leaf litter and logs. Aestivating land snails were targeted by locating dead snail shells and digging in drainage gullies and at the base of trees and shrubs.

3.2.2.1 Determining SRE Status

The SRE status of species is based on their geographic distributions, which are described by two summary statistics. The first is the 'maximum spanning distance', which is the maximum linear distance between two records. The second statistic is the 'minimum spanning area', which is the area of the smallest polygon that can be drawn around all of the records. The minimum spanning area can be used as a means for objectively establishing SRE status by comparison against the 10,000 km² criterion established by Harvey (2002).

Table 3.4 details the criteria used to determine the SRE status of putative species for the purposes of this report.

Table 3.4: Criteria used to determine SRE status.

SRE Status	Defining Criteria
Known SRE	- Species, morphotype or genetic type has a documented distribution of <10,000 km². - Species, morphotype or genetic type is well collected with numerous specimens typed and habitat preference understood.
Potential SRE	- Species, morphotype or genetic type has a documented distribution of <10,000 km² but is poorly sampled. - Specimen may not be formally described or assigned to a morphotype / genetic type. - Short-range endemism may be common in genus or family. - May have been collected from restricted, refugia or isolated habitats.
Unlikely to be an SRE	- Species, morphotype or genetic type has a documented distribution of <10,000 km² but is poorly sampled. - Specimen may not be formally described or assigned to a morphotype / genetic type. - Short-range endemism is not common in genus or family. - Taxon was not collected from restricted, refugia or isolated habitats. - Few other individuals of the taxon collected, but records are separated by long distances (>100 km).
Not an SRE	- Specimen formally described or assigned to a morphotype / genetic type. - Species, morphotype or genetic type has a documented distribution of >10,000 km².
Undetermined	Taxa where there is insufficient taxonomic framework available to provide any informed comment on the species-level distribution of the fauna or, therefore, the risk of small-scale spatial restrictions.

3.3 Limitations

There are a number of limitations that apply to the current study, many of which are common to SRE fauna sampling, rather than specific to this study. These include:

- Inconsistencies in identification methods used between projects identified in the desktop review. Many species, which have commonly been subject to molecular analysis over the past five years are difficult to compare with those identified solely on morphological characteristic. Some specialists have also maintained separate voucher collections and naming systems from that followed by the WAM. These inconsistencies may cause a single taxon to be incorrectly recognised as two or more species.
- Many taxa are difficult to sample adequately (e.g. mygalomorph spiders are difficult to locate, and morphological identification requires adult male specimens, which are often in low abundance). For female and juvenile mygalomorph specimens, species level identification requires molecular analysis.
- Not all sections of the study area were equally ground-truthed or sampled for fauna, as parts were inaccessible in the given timeframe. However, SRE fauna searches and sampling were conducted in habitats considered to be representative of the majority of units present within the study area.
- This pilot study represents a preliminary assessment rather than an EIA, and as a result, recommendations in regards to impact assessment and management are not provided.

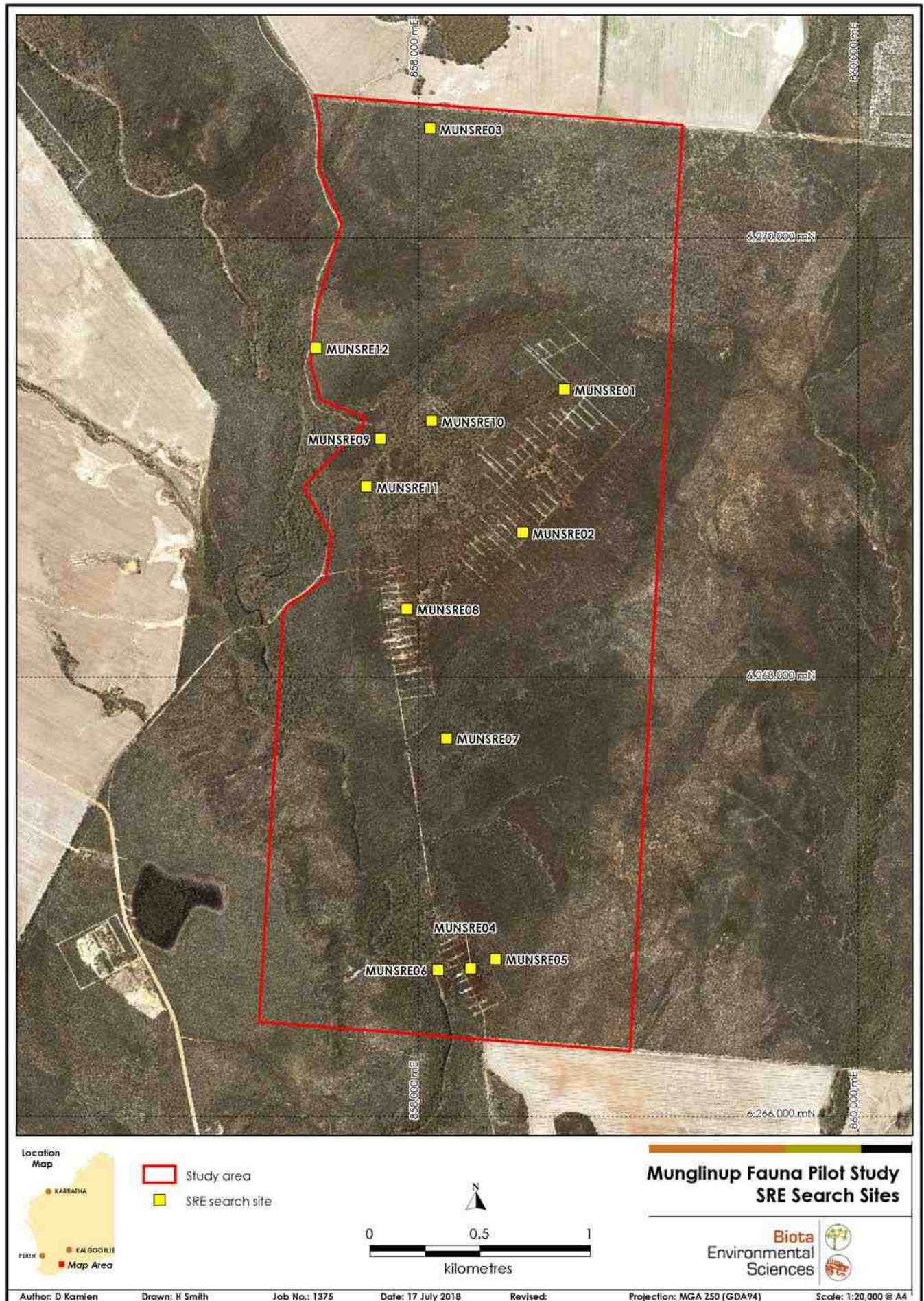


Figure 3.1: Location of SRE sites with the study area.

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4.0 Desktop Review

4.1 IBRA Bioregion and Subregion

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 89 bioregions and 419 subregions (DSEWPaC 2012). The study area is located within the Esperance Plains bioregion, which is divided into two subregions: Fitzgerald and Recherche. The study area lies entirely within the Recherche subregion, which is characterised as follows:

- **Recherche** (ESP2): “proteaceous scrub and mallee heaths on sandplain overlying Eocene sediments; rich in endemics. Herbfields and heaths (rich in endemics) on abrupt granite and quartzite ranges that rise from the plain. Eucalypt woodlands occur in gullies and alluvial foot-slopes. ESP2 Subregion has variable relief, comprising the Quaternary coastal sandplains and dunes overlying Proterozoic gneiss and granite as well as Eocene and more recent coastal limestones. Numerous granitic islands occur in the near shore area of this subregion. Vegetation comprises heath, coastal dune scrub, mallee, mallee-heath and granite heath. Vegetation types are diverse. The climate is Temperate Mediterranean, with 400-700 mm annual rainfall and total area is 1,606,517 ha.” (Comer et al. 2003)

4.2 Climate

To characterise the weather conditions leading up to the survey, monthly rainfall and temperature data were sourced from the closest reliable Bureau of Meteorology (BoM⁴) weather recording station, located at Munglinup West (station no. 012044), approximately 20 km northwest of the study area. The monthly rainfall totals were compared to the long-term monthly mean rainfall for the years 2007-2018 (Figure 4.1). Mean monthly minimum and maximum temperatures were also compared to the long-term mean monthly minimum and maximum temperatures for the years 2002-2018 (Figure 4.1).

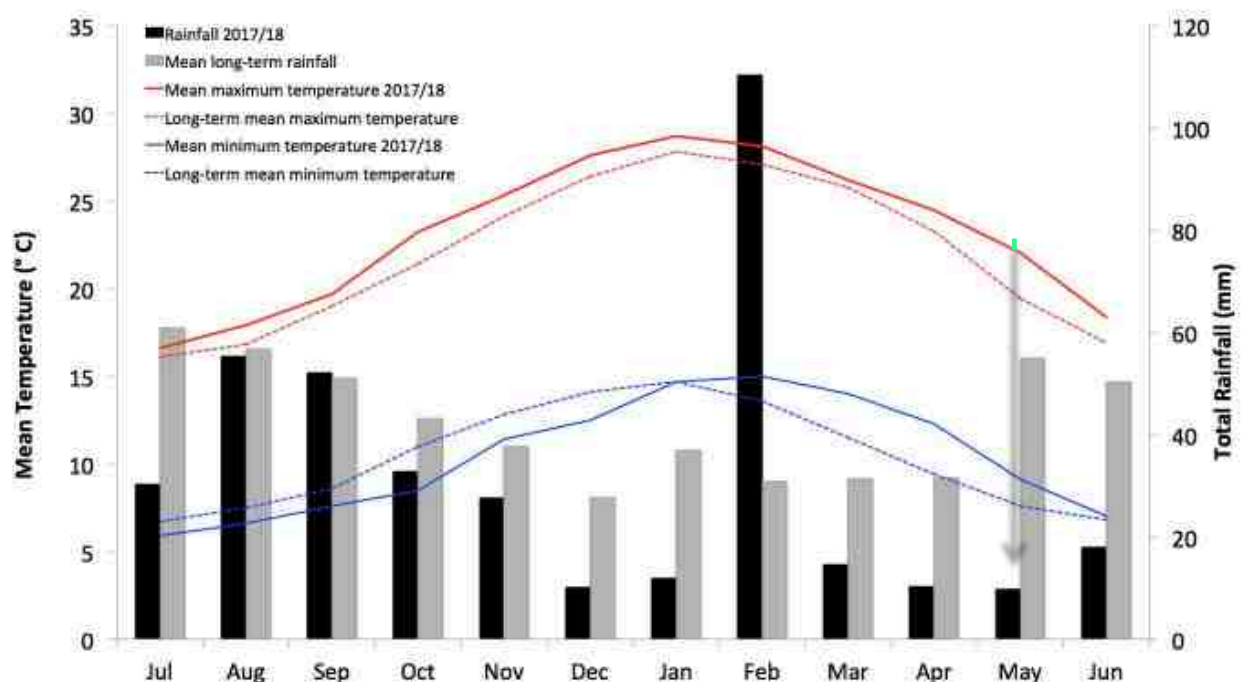


Figure 4.1: Climate and weather graph depicting long-term averages and 2017/2018 data at Munglinup West Station 012044. (Long-term data 2002-2018; arrow indicates survey timing.)

⁴ www.bom.gov.au

Lower than mean rainfall was recorded for most months preceding the survey. However an extreme rain event in February 2018 (72.2 mm) resulted in approximately three times the average rainfall for that month (Figure 4.1). This may have created optimal breeding conditions for taxa such as millipedes and snails.

4.3 Vegetation

The vegetation of the Esperance Plains bioregion was mapped by Beard (1973) at a scale of 1:1,000,000. The study area lies within Beard's South-West Botanical Province as defined by Beard, specifically within three vegetation associations (Beard 1973):

- Esperance 47 - *Shrublands; Tallerack (Eucalyptus pleurocarpa) Mallee-heath*;
- Esperance 516- *Shrublands; Mallee scrub, Black Marlock (Eucalyptus redunca)*; and
- Esperance 931- *Medium woodland; Yate (Eucalyptus cornuta)*.

A recent flora and vegetation survey (Ecologia 2015) identified four discrete vegetation units within the study area:

- EfAi: *Eucalyptus flocktoniae* and *E. uncinata* woodland, over *Acacia ingrata* and *Grevillea pectinata* mid sparse shrubland.
- EoAcNa: *Eucalyptus occidentalis* mid woodland, over *Acacia cyclops*, *Acacia saligna* subsp. *lindleyi*, and *Acacia sulcata* subsp. *platyphylla*, and *Thomasia angustifolia* mid sparse shrubland, over *Lepidosperma sanguinolentum* low sparse sedgeland.
- EplaAgMa: *Eucalyptus platypus* (or *E. dielsii*) low open forest, over *Acacia glaucoptera* and *Melaleuca acuminata* subsp. *acuminata* mid sparse shrubland, over *Lepidosperma* spp. or *Austrostipa* spp. low sparse sedgeland/grassland.
- EpleBaMt: *Eucalyptus pleurocarpa* mid open mallee woodland, over *Banksia armata* subsp. *armata* and *Calothamnus gracilis* mid sparse shrubland, over *Melaleuca tuberculata* var. *tuberculata*, *Leucopogon crassifolius*, and *Hibbertia gracilipes* low sparse shrubland.

4.4 Geology

4.4.1 Surface Geology

The study area lies within the Munglinup Gneiss, comprising Archean to Paleoproterozoic, metamorphosed granitic and other metamorphic rocks of the Albany–Fraser Orogen (AEMCO 2017). The study area is characterised by two main surface geological units (Table 4.1), (Geological Survey of Western Australia 1986).

Table 4.1: Surface geology of the study area.

Age	Code	Description	Area (ha)	% of Study Area
Cainozoic	Cze	Marine limestone marine and continental sandstone; lignite and spongolite on south coast	252	36.8
Archean	g2d	Granite (granitic gneiss)	433	63.2
Total			685	100

4.5 Previous Studies

The Esperance Plains bioregion has not been extensively surveyed for SRE fauna. Some relevant SRE fauna studies have been conducted in the bioregion (Biota 2004, 2005, 2014, Keighery et al. 2004, Harvey and Leng 2008). However, with the exception of Keighery et al. (2004), none have been conducted in the wider locality of the study area. A flora and fauna assessment has been conducted within the study area itself (Ecologia 2015), but this did not consider terrestrial SRE fauna.

Based on database searches, only four taxa are considered likely to occur within the study area, of which three are not considered to be SREs (Table 4.2 and Table 4.3). Of these, three are not SREs and occur well beyond the study area boundary. Of the remaining 21 species, 18 may potentially occur in the study area and three are considered unlikely to occur (Table 4.3).

Although there have been multiple collections of groups known to contain SRE species within the study area locality (Table 4.3), none listed as conservation significant. The consolidated data from the searches yielded a total of 25 species level taxa belonging to potential SRE groups, comprising:

- twenty-one previous Mygalomorphae (mygalomorph spider) records from the locality, representing up to six nominal species from three families;
- ten Pseudoscorpiones (pseudoscorpion) records from the locality, representing five nominal species from five different families;
- one Opiliones (harvestmen) record from the locality;
- six Diplopoda (millipede) records from the locality, representing three nominal species from two different families; and
- thirty-two Pulmonata (land snail) records from the locality, representing ten nominal species from three different families.

Table 4.2: Taxa likely to occur within the study area.

SRE Group	Family	Species	SRE Status	Recorded Distance to Study Area	Habitat Recorded
Mygalomorph Spider	Idiopidae	<i>Gaius hueyi</i>	Known SRE	400 m	Mallee Shrubland; <i>Eucalyptus</i> open mallee shrubland
	Nemesiidae	<i>Aname mainae</i>	Not an SRE	2.8 km	Eucalyptus Woodland
Millipede	Julidae	<i>Ommatoiulus moreleti</i> *	Not an SRE	16 km	<i>Eucalyptus</i> open mallee shrubland
Land Snail	Bothriembryontidae	<i>Bothriembryon dux</i>	Not an SRE	5.5 km	<i>Eucalyptus</i> woodland and <i>Eucalyptus</i> open mallee shrubland.

Table 4.3: Database search results indicating likelihood of occurrence in the study area.

	Class	Source of Record				SRE Status	Distribution and Habitat in Search Locality	Habitat Available in Study Area?	Likelihood of Occurrence in Study Area
Family	Common Name / Species Name	NatureMap	EPBC Act	ALA	WAM				
Mygalomorph Spiders									
Barychelidae	<i>Synothele rastelloides</i>	–	–	–	✓	Potential SRE	Known from three records located in bushland 50 km SW of study area. Distributed from Munglinup to Denmark in coastal and remnant bushland.	Undetermined	May potentially occur
Idiopidae	<i>Blakistonia`sp. indet.`</i>	–	–	–	✓	Undetermined	40 km NNE of study area: Single record on cultivated land.	x	Unlikely to occur
	<i>Bungulla fusca</i>	–	–	–	✓	Known SRE	20 km SE of study area. Two specimens recorded in <i>Eucalyptus</i> open mallee shrubland in the study area locality.	✓	May potentially occur
	<i>Eucanippe bifida</i>	–	–	–	✓	Known SRE	32 km NNE of study area. Two specimens recorded in <i>Eucalyptus</i> open mallee shrubland in the study area locality.	✓	May potentially occur
	<i>Gaius hueyi</i>	–	–	–	✓	Known SRE	<i>Eucalyptus</i> mixed open mallee shrubland and <i>Eucalyptus</i> open mallee shrubland. Recorded on four occasions within 40 km of the study area. One specimen recorded only 400 m outside of the study area in contiguous bushland to the study area.	✓	Likely to occur
Nemesiidae	<i>Aname mainae</i>	–	–	–	✓	Not an SRE	Recorded 2.8 km NW of study area in <i>Eucalyptus</i> woodland, contiguous with the study area.	✓	Likely to occur
Harvestmen									
Triaenonychidae	<i>Nunciella`sp. indet.`</i>	–	–	–	✓	Undetermined	Located 30 km SE of study area in coastal bushland	x	Unlikely to occur
Pseudoscorpions									
Atemnidae	<i>Oratemnus`sp. indet.`</i>	–	–	–	–	Undetermined	Recorded on five occasions within 40 km of the study area in a variety of habitat types.	Undetermined	May potentially occur
Chernetidae	<i>Nesidiochernes`sp. indet.`</i>	–	–	–	–	Undetermined	Recorded in estuarine and coastal vegetation within 40 km of the study area	x	Unlikely to occur
Chthoniidae	<i>Lagynochthonius australicus</i>	–	–	–	–	Not an SRE	Distributed coastally from Perth to Munglinup. <i>Eucalyptus</i> open mallee shrubland	✓	May potentially occur
Garypidae	<i>Synsphyronus callus</i>	–	–	–	–	Not an SRE	Distributed through much of the south coast, but also recorded in Perth and near Cape Range. <i>Eucalyptus</i> mixed open mallee shrubland	✓	May potentially occur
Tridenchthoniidae	<i>Dithella`sp. indet.`</i>	–	–	–	–	Undetermined	Recorded 40 km west of study area in remnant vegetation.	Undetermined	May potentially occur
Millipedes									
Julidae	<i>Ommatoiulus moreleti*</i>	–	–	–	–	Not an SRE	Introduced species distributed throughout much of SW Western Australia in <i>Eucalyptus</i> open mallee shrubland. Recorded 16 km NW of study area.	✓	Likely to occur
Paradoxosomatidae	<i>Antichiropus`sp. indet. (female)`</i>	–	–	–	–	Undetermined	One record located 40 km north of study area in <i>Eucalyptus</i> open mallee shrubland	✓	May potentially occur
	<i>Antichiropus rex</i>	–	–	–	–	Potential SRE	Recorded 32 km NNE of study area and in Lake King vicinity 125 km NE of study area. <i>Eucalyptus</i> open mallee shrubland	✓	May potentially occur
Land Snails									
Bothriembryontidae	<i>Bothriembryon aff. praecelsus</i>	–	–	–	–	Undetermined	Recorded 11 km NE of study area in remnant <i>Eucalyptus</i> open mallee shrubland.	✓	May potentially occur
	<i>Bothriembryon balteolus</i>	–	–	–	–	Potential SRE	Recorded 29 km SE of study area. Also located in vicinity of Salmon Gums, approximately 100 km NE of study area. <i>Eucalyptus</i> open mallee shrubland	✓	May potentially occur
	<i>Bothriembryon bradshawi</i>					Unlikely to be an SRE	Recorded 8 km NW of study area and also in the vicinity of Stirling Ranges approximately 250 km SW	✓	May potentially occur

	Class	Source of Record				SRE Status	Distribution and Habitat in Search Locality	Habitat Available in Study Area?	Likelihood of Occurrence in Study Area
Family	Common Name / Species Name	NatureMap	EPBC Act	ALA	WAM				
							of study area. <i>Eucalyptus</i> open mallee shrubland		
	<i>Bothriembryon</i> cf. <i>rhodostomus</i>					Undetermined	Recorded 40 km SE of study area in coastal <i>Melalueca</i> woodland/shrubland.	✓	May potentially occur
	<i>Bothriembryon</i> <i>dux</i>					Not an SRE	Recorded in study area. Occurring from Albany in the west to the South Australian border in the east (approximately 1,000 km straight-line distance). <i>Eucalyptus</i> woodland and <i>Eucalyptus</i> open mallee shrubland. Recorded 5.5 km NW of study area.	✓	Likely to occur
	<i>Bothriembryon</i> <i>melo</i>					Unlikely to be an SRE	Recorded approximately 50 km SW of the study area. Also recorded from numerous records from Bremer Bay to Albany. <i>Eucalyptus</i> open mallee shrubland	✓	May potentially occur
	<i>Bothriembryon</i> sp.					Undetermined	Recorded 7 km NE of study area in river flat upstream of the Munglinup River. Also recorded in coastal vegetation 50 km SW of the study area.	✓	May potentially occur
Pupillidae	<i>Gastrocopta</i> cf. <i>margaretae</i>					Undetermined	Recorded 40 km SE of study area in coastal <i>Melalueca</i> woodland/shrubland.	✓	May potentially occur
Succineidae	<i>Succinea</i> <i>scalarina</i>					Not an SRE	Recorded 40 km SE of study area. Distributed from Cape Arid National Park to Walpole (approximately 600 km straight line distance). Prefers damp habitat marshes and rivers. <i>Melalueca</i> woodland/shrubland.	✓	May potentially occur
	<i>Succinea</i> sp.					Undetermined	Recorded 40 km SE of study area in <i>Melalueca</i> woodland/shrubland.	✓	May potentially occur

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5.0 Pilot Survey Results

5.1 SRE Habitats

Based on a combination of recent vegetation mapping (Ecologia 2015) and on-ground assessment during the pilot survey, seven fauna habitats were identified in the study area. These were in accordance with those already documented in (Ecologia 2015): 1) Mallee Shrubland, 2) *Eucalyptus* Woodland, 3) Proteaceous Shrubland, 4) Major Drainage Line, 5) *Eucalyptus Pleurocarpa* Low Woodland, 6) Low *Melaleuca* Shrubland, and 7) *Allocasuarina* Woodland.

1. Mallee Shrubland

This habitat accounted for 300 ha of the study area (43.9%) and comprised *Eucalyptus flocktoniae* and *E. uncinata* low mallee over mixed *Acacia* and *Melaleuca* closed shrubland (Plate 5.1 (Ecologia 2015). Soils varied from clay loam to sandy loam, often with stones interspersed. Sites MUNSRE01, MUNSRE05, MUNSRE10 and MUNSRE11 were located in this habitat (see Section 5.2).



Plate 5.1: Mallee Shrubland

2. *Eucalyptus* Woodland

This habitat accounted for 208 ha of the study area (30.4%) and comprised *Eucalyptus platypus* and *E. dielsii* closed woodland, over *Acacia* and *Melaleuca* open shrubland (Plate 5.2 and (Ecologia 2015). Clay loam soils were dominant in this vegetation type. Sites MUNSRE02, MUNSRE04, MUNSRE08 and MUNSRE09 were located in this habitat (see Section 2.2.2).



Plate 5.2: *Eucalyptus* Woodland.

3. Proteaceous Shrubland

This habitat accounted for 114 ha of the study area (16.7%) and comprised *Eucalyptus* spp. open mallee shrubland, over *Acacia* spp., *Melaleuca* spp. and *Micromyrtus elobata* mixed shrubland (Plate 5.3 and Ecologia 2015), on loamy sand soils.

This habitat also consists of isolated patches in the locality. However, it is contiguous to an area east of the study area. Therefore it is likely that potential SRE fauna occurring in this habitat are found both inside and outside the study area. Sites MUNSRE03 and MUNSRE12 were located in this habitat (see Section 2.2.2).



Plate 5.3: Proteaceous Shrubland.

4. Major Drainage Line

This habitat accounted for 36 ha of the study area (5.3%) and comprised *Eucalyptus occidentalis* and *Allocasuarina huegeliana* woodland, over mixed *Acacia* spp. and *Allocasuarina* spp., over low shrubs, sedges and halophytes (Plate 5.4 and Ecologia 2015), on sandy clay loam soils.

The major Drainage Line intersected the southwest section of the study area and is contiguous with areas outside of the study area. As a result, it is likely that potential SRE fauna occurring in this habitat are found both inside and outside the study area. Site MUNSRE06 was located in this habitat (see Section 2.2.2).



Plate 5.4: Major Drainage Line.

5. *Eucalyptus Pleurocarpa* Low Woodland

This habitat accounted for 13 ha of the study area (1.9%) and comprises low *Eucalyptus pleurocarpa* low woodland over mixed low shrubs and sedges (Plate 5.5 and Ecologia 2015), on sandy loam soils.

This habitat intersects the southwest section of the study area and is contiguous with areas outside of the study area. As a result, it is likely that potential SRE fauna occurring in this habitat are found both inside and outside the study area. This habitat was not sampled during the survey.



Plate 5.5: *Eucalyptus Pleurocarpa* Low Woodland.

6. Low *Melaleuca* Shrubland

This habitat accounted for 12 ha of the study area (1.8%) and comprised *Eucalyptus* sp. scattered trees (dead), over *Melaleuca* sp. closed shrubland, (Plate 5.6 and (Ecologia 2015), on clay or loam soil.

This habitat type occurs in a single isolated patch within the study area, adjacent to Mallee Shrubland habitat and *Eucalyptus* Woodland habitat. Site MUNSRE07 was located in this habitat (see Section 2.2.2).



Plate 5.6: Low *Melaleuca* Shrubland.

7. *Allocasuarina* Woodland

This habitat accounted for only 1 ha of the study area (0.2%) and comprised *Allocasuarina huegeliana*, *Eucalyptus occidentalis* and *E. pileata* dense woodland (Plate 5.7 and Ecologia 2015). The substrate was typically loam or clay-loam with granite rocks (Ecologia 2015).

This habitat type occurs in a single isolated patch within the study area, associated with granite (Ecologia 2015). It lies adjacent to Mallee Shrubland habitat and the Major Drainage Line habitat. This habitat was not sampled during the survey.



Plate 5.7: *Allocasuarina* Woodland
(Sourced from Ecologia (2015)).

5.2 Survey Results

Two higher-order taxonomic groups with the potential to include SRE species were recorded within the study area, mygalomorph spiders and land snails. Sections 5.2.1.1 to 5.2.1.4 provide accounts of each group and detail the SRE status of each putative taxon. Table 5.1 summarises the records by sites and fauna habitats, while collection locations are provided in Figure 5.1.

Table 5.1: Summary of potential SRE invertebrate fauna recorded from the study area.

Invertebrate Group Family	Taxon	No. of Specimens	Habitat	Sites Recorded	SRE Status
Mygalomorph Spiders					
Nemesiidae	<i>Aname</i> sp. indet.	5	<i>Eucalyptus</i> Woodland; Mallee Shrubland; Proteaceous Shrubland.	MUNSRE02 MUNSRE10 MUNSRE12	Indeterminate
Nemesiidae	<i>Proshermacha</i> sp. indet.	8	<i>Eucalyptus</i> Woodland; Mallee Shrubland; Proteaceous Shrubland.	MUNSRE01 MUNSRE08 MUNSRE09 MUNSRE10 MUNSRE11 MUNSRE12	Indeterminate
Idiopidae	Idiopidae. sp. indet.	1	Major Drainage Line	MUNSRE06	Indeterminate
Land Snails					
Placostylidae	<i>Bothriembryon</i> <i>dux</i>	7	<i>Eucalyptus</i> Woodland; Mallee Shrubland.	MUNSRE01 MUNSRE09 MUNSRE11	Not an SRE

5.2.1.1 *Aname* sp. indet.

A total of five specimens of the genus *Aname* were recorded within the study area at three different locations representing three different habitat types (*Eucalyptus* Woodland, Mallee Shrubland and Proteaceous Shrubland).

These specimens could not be morphologically identified to species level as only juveniles and females were collected. Although it cannot be confirmed without molecular analysis, it is possible that they are all *Aname mainae*, a species that is known not to be an SRE (ALA database) and has non-specific habitat requirements, given there are records of this species from similar habitat in close proximity to the study area (see Section 4.5).



Plate 5.8: *Aname* sp. indet..

5.2.1.2 *Proshermacha* sp. indet.

A total of eight specimens of the genus *Proshermacha* were recorded within the study area at six different locations in three different habitat types (*Eucalyptus* Woodland, Mallee Shrubland and Proteaceous Shrubland).

These specimens could also not be morphologically identified to species level as only juveniles and females were collected. Spiders of the genus *Proshermacha* have not previously been recorded within the study area locality. However, the habitats from which these specimens were recorded also occur outside of the study area, and as a result, it is likely that the species represented by *Proshermacha* sp. indet. also occurs beyond the study area.



Plate 5.9: *Proshermacha* sp. indet.



Plate 5.10: *Proshermacha* sp. indet. live specimen.

5.2.1.3 *Idiopidae* sp. indet.

A single specimen of the family Idiopidae was recorded in a single location within *Eucalyptus* Woodland habitat (but at the edge of the Major Drainage Line). This specimen was a juvenile and could not be identified to the genus or species level based on morphology. Four idiopid taxa have previously been recorded in the study area locality, three of which are known SREs (Dr Mark Harvey pers. comm., 2018). It is possible that the taxon recorded within the study area represents one of these.



Plate 5.11: *Idiopidae* sp. indet.

5.2.1.4 *Bothriembryon dux*

A total of seven *Bothriembryon dux* land snails were collected from three sites within the study area, within both *Eucalyptus* Woodland and Mallee Shrubland habitat (Table 5.1).

Bothriembryon dux occurs predominantly in mallee woodland with a distribution extending from Albany in the west to the South Australian border in the east (approximately 1,000 km straight-line distance (ALA database)). As a result, it is not considered to be an SRE.



Plate 5.12: *Bothriembryon dux*.

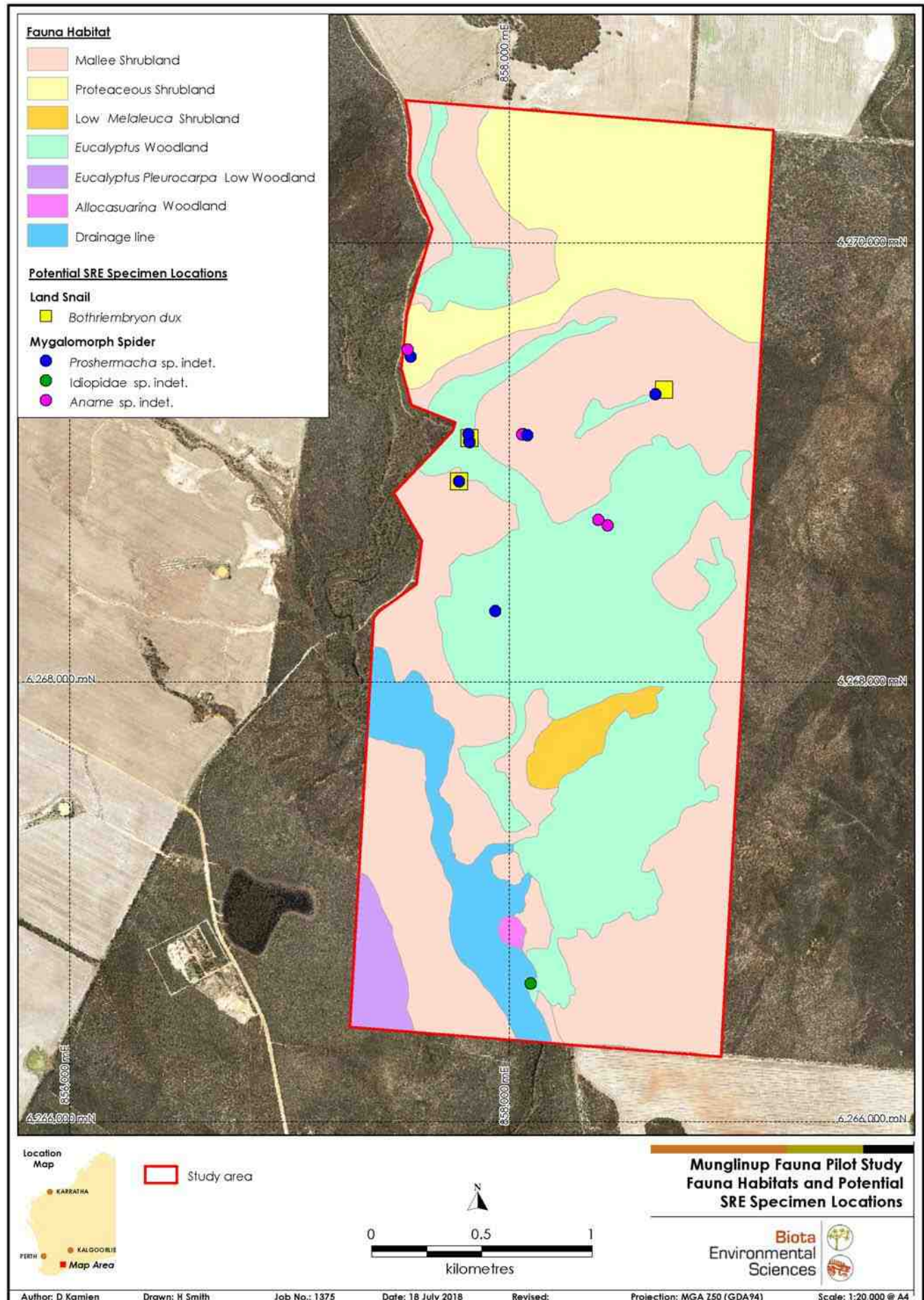


Figure 5.1: Potential SRE taxa and location by habitat type recorded.

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6.0 Discussion

Of the 25 described and nominal taxa identified in the desktop review only four are considered likely to occur within the study area. Of these, three are not SREs (i.e. they have a distribution greater than 10,000 km²) and occur well beyond the study area boundary. As a result, these taxa would not be meaningfully impacted by mine development within the study area. Only the mygalomorph spider *Gaius hueyi* is a known SRE, with documented records occurring within 40 km of the study area. It appears that there is a low risk that a high number of SRE taxa occur within the study area. However, as SRE taxa are often difficult to sample due to their cryptic nature and distinctive life history characteristics, some additional SRE taxa may potentially occur within the study area.

The land snail *Bothriembryon dux*, which was identified in the desktop review, was also recorded from the study area during the pilot survey. As this species also occurs outside of the study area and is not an SRE, it is not considered further. Mygalomorph spiders represent the other three taxa recorded during the pilot survey, of which none could be identified to species level based on morphology, and therefore, their SRE status remains undetermined. Based on current data, only a risk-based assessment can be provided.

Both *Aname* sp. Indet. and *Proshermacha* sp. indet. specimens were located in *Eucalyptus* Woodland, Mallee Shrubland and Proteaceous Shrubland habitats. Assuming that all records assigned to these putative taxa are represented by just two species then it is clear that they are not habitat specific and demonstrate some flexibility in habitat requirements. On this basis alone, it is unlikely that *Aname* sp. indet. and *Proshermacha* sp. indet. (as putative taxa) are restricted solely to the study area. Although it cannot be confirmed without molecular analysis, it is also possible that *Aname* sp. Indet. is analogous to *Aname mainae*, a species that is considered likely to occur within the study area and is known not to be an SRE (ALA database).

As only a single specimen of Idiopidae sp. indet. was recorded, conclusions on the habitat specificity of this taxon cannot be reached. However, all habitats present in the study area also occur outside of the study area, so it is probable that taxa recorded from the study area also occur outside of the study area. Additionally, Mallee Shrubland and Proteaceous Shrubland in the study area are contiguous with areas beyond the study area, making the above assumption even more likely for species that occur in those habitats. *Eucalyptus* Woodland habitat is not naturally restricted, but due to historical land clearing it consists of isolated patches in the locality, of which only a small section is contiguous with that located within the study area. As a result, it may be slightly more likely to support a unique SRE assemblage within the study area than Mallee Shrubland.

Using habitat as a surrogate to infer potentially wider distributions, it is unlikely that any of the taxa recorded during the survey are restricted solely to the study area, as there are no geomorphological or habitat attributes that suggest a high risk of species-level distributions being restricted to the scale of the current study area. Despite this, it is important to recognise that the study area is located within remnant bushland and that habitat remnants are prevalent in the region. This landscape fragmentation in itself creates potential restrictions to dispersal and can promote localised distributions in taxa that already exhibit restricted distributions due to habitat preference or life history.

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7.0 Glossary

ALA	Atlas of Living Australia
Biota	Biota Environmental Sciences Pty Ltd
DBCA	Department of Biodiversity Conservation and Attractions
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority of Western Australia
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act</i> 1999
IBRA	Interim Biogeographic Regionalisation for Australia
NatureMap	Database developed in collaboration between DBCA and the WAM. Represents the most comprehensive source of information on the distribution of Western Australia's fauna
Taxon (plural: taxa)	A taxonomic entity, typically at species level or below
Taxonomy	Theory and practice of biological classification
sp. (plural: spp.)	Abbreviation of "species"
sp. indet.	Indeterminate species
SRE	Short-range endemic
Short Range Endemic (SRE)	A species that has a naturally small distribution and is often characterized by having poor dispersal capabilities, confinement to disjunct habitats and low fecundity
WAM	Western Australian Museum

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Appendix 1

DBCA Regulation 17 Permit





Wildlife Conservation Act 1950

REGULATION 17

Regulation 17 – Licence to take fauna for scientific purposes (Regulation 17 - Standard)

The undermentioned person may take fauna for research or other scientific purposes and where authorised, keep it in captivity, subject to the following and attached conditions, which may be added to, suspended or otherwise varied as considered fit.

Director General

Conditions

- 1 The licensee must comply with the provisions of the Wildlife Conservation Act 1950, Wildlife Conservation Regulations 1970 and any Notices in force under this legislation.
- 2 The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.
- 3 Unless specifically authorised in the conditions of this Licence or otherwise in writing by the Director General, species of fauna declared as likely to become extinct, rare or otherwise in need of special protection shall not be taken.
- 4 Any by-catch of fauna, which is declared to be rare, likely to become extinct, or otherwise in need of special protection shall be released immediately at the point of capture. Where such fauna taken under this licence is injured or deceased, the licensee shall contact the Department's Wildlife Licensing Section for advice on disposal. Records must be kept of any such fauna so captured and details are to be included in the report required under further condition below.
- 5 Any interaction involving Gazetted Threatened Fauna that may be harmful to the fauna and/or invasive may require approval from the Commonwealth Department of the Environment ph 02 6274 1111. Interaction with such species is controlled by the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the Wildlife Conservation Act 1950 and Wildlife Conservation Regulations 1970.
- 6 No fauna shall be taken in areas where it would impinge on pre-existing scientific research programs.
- 7 Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers used, and signs and structures erected by the licensee shall be removed and the environment returned to its original condition.
- 8 Not more than ten specimens of any one protected species of fauna shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.
- 9 The licensee shall not release any fauna or their progeny in any area where it does not naturally occur, nor hand such fauna over to any other person or authority unless approved by the Director General, nor dispose of the remains of such fauna in any manner likely to confuse the natural or present day distribution of the species.
- 10 Bioprospecting involving the removal of sample aquatic and terrestrial organisms for chemical extraction and bioactivity screening shall not be conducted without specific written approval by the Director General.
- 11 No fauna is to be taken from any CALM land, as defined in the Conservation and Land Management Regulations 2002, without prior written approval of the Director General. No fauna is to be taken from any public land without the prior written approval of the Government Authority managing that land.
- 12 The licensee must not enter upon any private property or pastoral lease for the purposes of this licence, nor take any fauna from any private land or pastoral lease without the prior consent in writing of the owner or occupier. Similarly, in the case of Aboriginal lands, the licensee must not enter upon or take fauna from such lands without the written approval of the Department of Aboriginal Affairs and/or the relevant native title holders or applicants.
- 13 Copies of this licence and any written approval or consent required by conditions of this licence must be carried by the licensee and any person/s authorised under the licence at all times when conducting activities relevant to the licence

DEPARTMENT OF PARKS AND WILDLIFE



Department of
Parks and Wildlife



Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: <https://wildlifelicensing.dpaw.wa.gov.au>
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

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and must be presented to an authorised officer of the Department upon request.

- 14 All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range shall upon request be donated to the Western Australian Museum.
- 15 To prevent any unnecessary collecting in this State, all specimens and material taken and retained under the authority of this license shall, upon request, be loaned to the Western Australian Museum. Any unused portion or portions of any specimen collected under the authority of this license shall be offered to the Western Australian Museum for inclusion in its collection or made available to other scientific workers if so required.
- 16 Within one month of the expiration of this licence, the holder shall submit an electronic return into the department's Wildlife Licensing System, detailing the locality, site, geocode, date and number of each species of fauna captured, sighted or vouchered during the currency of the licence. A copy of any paper, report or thesis resulting from the research shall upon completion be lodged with the Director General.

Purpose

SRE invertebrate survey by hand foraging, raking, sieving, excavation and Subterranean (troglifaunal & stygofauna) survey using PVC colonisation traps and scraping inside bore column with plankton net in accordance with EPA guidance statement 2016 for Mineral Commodities Ltd Munglinup Graphite Project.

Locations

Munglinup region in the Great Southern, between Esperance and Ravensthorpe.

Authorised Person

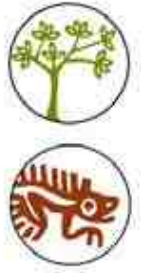
Surname	Given name(s)
Keirle	David
Schmidt	Sylvie
Humphreys	Garth

Date of Issue 27/04/2018
Valid From 11/05/2018
Date of Expiry 11/08/2018

Licensee: Mr Daniel Kamien
Address Biota Environmental Sciences Pty Ltd
PO Box 155
Leederville WA 6903
Australia

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APPENDIX C-13: Biota - Munglinup Graphite Project Subterranean Fauna Pilot Study



Munglinup Graphite Project Subterranean Fauna Pilot Study





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ABN 49 092 687 119
Level 1, 228 Carr Place
Leederville Western Australia 6007
Ph: (08) 9328 1900 Fax: (08) 9328 6138

Job No.: 1375

Prepared by: Dan Kamien

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Munglinup Subterranean Fauna Pilot Study

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1.0 Summary

MRC Graphite Pty Ltd (MRC) plans to develop a graphite project (M74/245) in the Munglinup region in the Great Southern of Western Australia, between Esperance and Ravensthorpe. The project tenure is situated approximately 4 km north of the town of Munglinup, with the tenement encompassing approximately 686 ha. Biota Environmental Sciences Pty Ltd (Biota) was commissioned by MRC to undertake a desktop assessment and pilot study to assess the subterranean fauna of the study area.

The scope of this study was to:

- collate existing subterranean fauna records and information from previous sampling, involving a review of previous relevant surveys in the locality, publicly available consultant reports and database searches;
- summarise species conservation significance for any subterranean fauna taxa known from the locality;
- outline existing knowledge of the study area locality including geology, hydrogeology, Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and subregions and related mapping;
- identify and describe subterranean fauna habitats occurring within the study area;
- conduct limited sampling using appropriate techniques at pilot study intensity;
- determine the significance of subterranean habitats present within the study area; and
- provide a risk assessment based on the study results, with general commentary on the potential impacts of graphite mining in the study area.

A literature review and database search was conducted, focusing on previous subterranean fauna records and surveys conducted in the study area locality. Additionally, a single-phase troglofauna and stygofauna study was conducted. During the field component, a total of seven sites were sampled for stygofauna using modified plankton haul nets. Eleven sites were sampled for troglofauna using baited colonisation traps and drill hole scraping.

The desktop review did not return any troglofauna or stygofauna records, or previous subterranean fauna surveys within the locality of the study area. Additionally, no subterranean fauna were recorded from the study area. Furthermore, the geology and drill cores indicate a scarcity of vugs, fractures or cavities that represent structural features typically present in subterranean fauna habitat. On this basis, it appears that the subsurface geology within the study area does not constitute suitable subterranean fauna habitat resulting in a low likelihood of subterranean fauna occurrence.

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2.0 Introduction

2.1 Project Background

MRC Graphite Pty Ltd (MRC) plans to develop a graphite project (M74/245) in the Great Southern region of Western Australia, near the town of Munglinup, located between Esperance and Ravensthorpe. Specifically, the project tenure is situated approximately 4 km north of the town of Munglinup, with the tenement encompassing approximately 686 ha (Figure 2.1). It is currently undetermined if the project will be formally assessed under either State or Commonwealth legislation.

As the managing consultant, Integrate Sustainability Pty Ltd has identified the requirement for a subterranean fauna (stygo fauna and troglota fauna) desktop review and pilot study for this project. Neither MRC nor previous tenement holders have conducted previous work relating to subterranean fauna in the study area locality.

2.2 Scope of Work and Objectives

The primary aim of the desktop review component of this study is to assess the likelihood of occurrence and potential significance of subterranean fauna and habitat at Munglinup, in order to inform the pilot study and prospective Environmental Impact Assessment (EIA). The study will also act as a preliminary risk assessment of potential project impacts on subterranean fauna of potential conservation significance.

This report outlines the results of the desktop review, sampling effort and results of pilot study subterranean fauna sampling completed within the study area. Specific scope components are summarised in Section 2.2.1 and Section 2.2.2.

2.2.1 Desktop Review

- collate existing subterranean fauna records and information from previous sampling, involving a review of previous relevant surveys in the locality, publicly available consultant reports and database searches;
- summarise species conservation significance for any subterranean fauna taxa known from the locality; and
- outline existing knowledge of the study area locality including geology, hydrogeology, Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and subregions and related mapping.

2.2.2 Pilot Study Fauna Sampling

- identify and describe subterranean fauna habitats occurring within the study area;
- conduct limited sampling using appropriate techniques at pilot study intensity;
- determine the significance of subterranean habitats present within the study area; and
- provide a risk assessment based on the study results, with general commentary on the potential impacts of graphite mining in the study area.

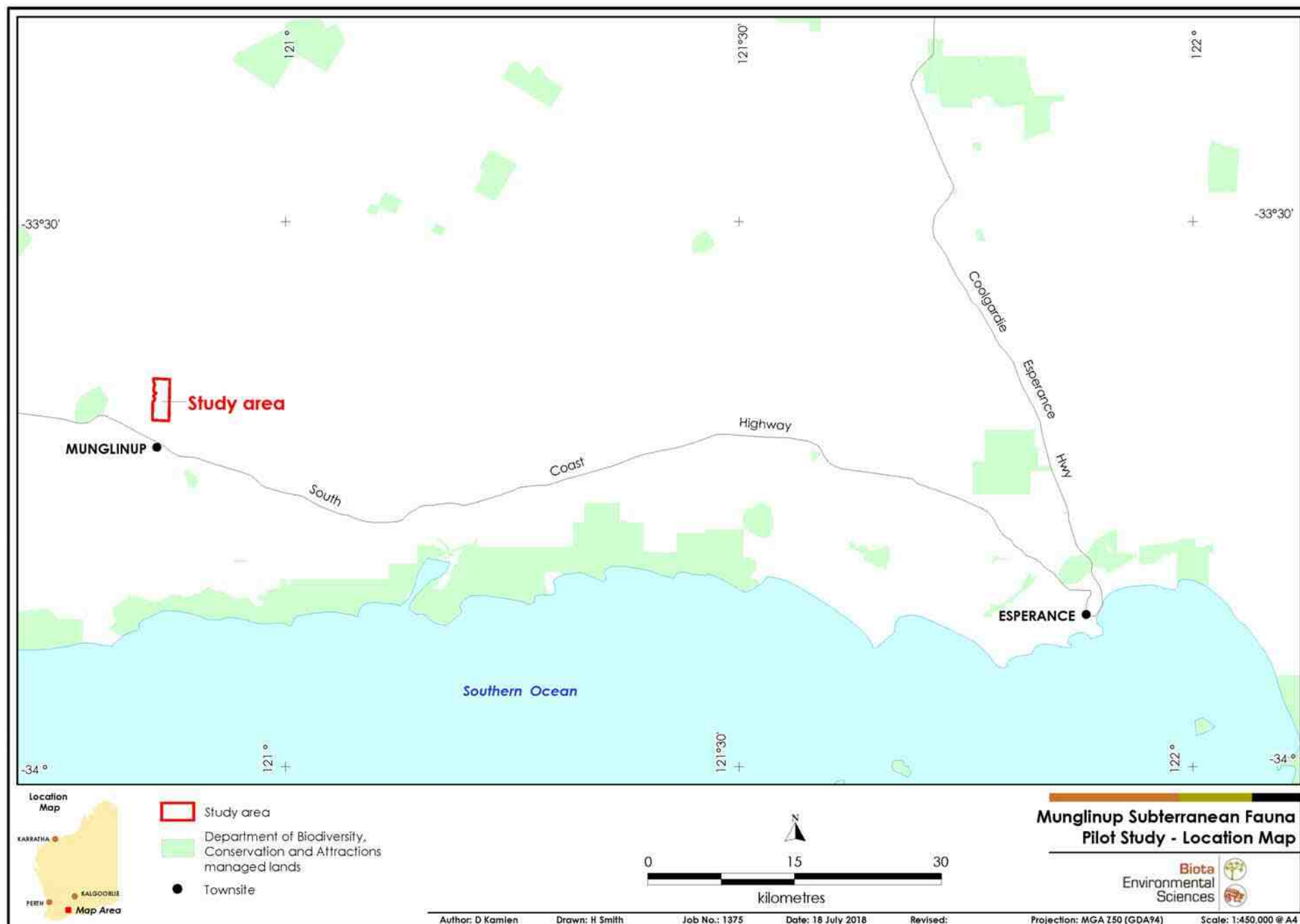


Figure 2.1: Location of the Munglinup study area.

2.3 Subterranean Fauna Overview

Australia was historically thought to lack habitat suitable for subterranean fauna, however studies in recent decades (mostly with an emphasis on environmental impact assessment), have revealed Australia to be highly diverse in subterranean fauna with numerous areas of interest throughout the continent (Guzik et al. 2010). In Western Australia these zones of subterranean biodiversity can be found at Cape Range, Barrow Island, the Pilbara bioregion, the Yilgarn and the Nullarbor (Humphreys 2001a, Page et al. 2008, Guzik et al. 2010).

Subterranean fauna habitats are characterised by shared physical parameters that include a lack of light, stable temperature, limited nutrient infiltration from surface environments and a constant humidity (Juberthie 2000, Romero 2009). These habitat characteristics have resulted in convergence in body morphology evolution amongst many subterranean fauna. Morphological characteristics common to most subterranean fauna include reduced or lack of pigmentation, reduced or lack of eyes, and elongate body morphology and appendages adapted for sensory movement (Culver and Pipan 2009, Romero 2009).

Subterranean fauna are characterised as obligatory subterranean habitat dwellers, and while they may occur close to surface environments, they are strongly adapted to subterranean environments. They can be categorised into two distinct ecological groups based on habitat: troglofauna and stygofauna. Troglofauna are a suite of fauna that survive only in air-filled cavities and interstices between the surface and the water table. Stygofauna comprise aquatic taxa occurring in groundwater aquifers and subterranean water bodies. A range of similarly adapted fauna occurs that opportunistically use subterranean habitats but are able to survive outside these stable environments, specifically troglaphiles, troglloxenes and edaphobites. However, these are not similarly restricted in range and therefore unlikely to be impacted by small-scale developments.

For both stygofauna and troglofauna, the suitability of geological formations is primarily a function of available habitat space, rather than a specific rock type (Marmonier et al. 1993, Humphreys 1999, Biota 2006). Core habitat for subterranean fauna encompass geologies that are conducive to fractures, caverns, vugs, or interstices sufficient in size to physically accommodate them. Where these spaces exist, stygofauna and troglofauna assemblages have potential to occur, unless there is strong evidence that these spaces are anoxic, or contain groundwater of salinity greater than 60 milliSiemens/cm (fresh water lying above a hypersaline lens may still support stygofauna) (EPA 2016a).

Dispersal and distribution of troglofauna and stygofauna species tends to remain limited to individual blocks of inter-connected habitat, leading to long periods of population isolation and speciation. Troglofauna and stygofauna species are considered to be of conservation significance given species often display extreme short-range endemism and species may therefore be affected by relatively small-scale developments such as mining and construction. This often results in such fauna being deemed vulnerable (EPA 2016a), which has lead to an increasing number of subterranean fauna species being listed for protection under the *Wildlife Conservation Act 1950* and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Some invertebrate groups with troglobitic representatives include the Arachnida (e.g. Schizomida (Plate 2.1), Pseudoscorpiones (Plate 2.2) and Araneae), Chilopoda (e.g. Scolopendrida), Diplopoda (e.g. Polydesmida and Haplodesmida (Plate 2.3)), and Insecta (e.g. Diplura, Zygentoma, Coleoptera (Plate 2.4) and Blattodea). A single troglobitic vertebrate species of blind snake (*Anilius longissimus*) is known from Australia, collected from Barrow Island (Aplin 1998, Humphreys et al. 2013).



Plate 2.1: Troglobitic Schizomida recorded from the Pilbara region, Western Australia.



Plate 2.2: Troglobitic Pseudoscorpiones recorded from the Pilbara region, Western Australia.



Plate 2.3: Troglobitic diplopoda recorded from the Pilbara region, Western Australia.



Plate 2.4: Troglobitic Coleoptera recorded from the Pilbara region, Western Australia.

Stygol communities in Western Australia are predominantly Crustacean (e.g. Amphipoda (Plate 2.5), Isopoda (Plate 2.6), Decapoda, Syncarida, Ostracoda and Copepoda), however Annelida (e.g. Oligochaeta), Arachnida (e.g. Hydracarina) and Platyhelminthes are also commonly collected.

Three species of stygal vertebrates have been recorded from Australia. This includes two species of blind gudgeon (*Milyeringa veritas* and *M. justitia*) as well as a blind cave eel, *Ophisternon candidum* (Humphreys 2001b, DSEWPaC 2008, Foster and Humphreys 2011, Larson et al. 2013).



Plate 2.5: Stygobitic Amphipod recorded from the Pilbara region, Western Australia.



Plate 2.6: Stygobitic isopod recorded from the Pilbara region, Western Australia.

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3.0 Methodology

3.1 Desktop Review

A desktop review was undertaken to identify relevant records of subterranean fauna and habitats that may support them within the study area and wider locality (defined here as within 40 km of the study area). The desktop review considered publicly available information, previous fauna surveys in the locality and the results of various database searches. A review of geology and hydrogeology was also conducted (see Section 4.0).

3.1.1 Review of Previous Relevant Surveys

A literature review was completed to identify relevant previous surveys from within the study area. This included searches of Biota's library database, GoogleScholar¹ and the Environmental Protection Authority (EPA) website².

3.1.2 Database Searches

Database searches were carried out in June/July 2018, using the Biota internal database, NatureMap database³, Atlas of Living Australia (ALA), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) Protected Matters Search Tool and the Western Australian Museum (WAM) Arachnida and Myriapoda, Mollusca and Crustacea databases in June/July 2018. Completed database search details are outlined in Table 3.1.

The Biota, NatureMap, ALA and EPBC Protected Matters databases were searched for a radius of 40 km from the approximate central point of the study area (301858 mE, 6273160 mN). The following co-ordinates bounded the WAM database searches: 261827 mE, 6313020 mN (northwest) and 342002 mE, 6233217 mN (southeast), encompassing a 40 km buffer from the study area boundary.

Table 3.1: Summary and dates of database searches completed for the study.

Database	Date	Search Target
Biota	08/06/2018	Arachnida, Myriapoda, Mollusca and Crustacea
NatureMap	08/06/2018	Arachnida, Myriapoda, Mollusca and Crustacea
ALA	29/06/2018	Arachnida, Myriapoda, Mollusca and Crustacea
EPBC Protected Matters	02/07/2018	Arachnida, Myriapoda, Mollusca and Crustacea
WAM	08/6/2018	Arachnida, Myriapoda, Mollusca and Crustacea

3.1.3 Drill Logs and Core Samples

Although little geological interpretation has been completed by MRC for the current study, a total of 194 drill logs were made available for review as part of the desktop review. These were located throughout all of the study area deposits. Additionally, 33 diamond drill core photograph sets were made available for inspection, 30 of these being obtained from an area approximately 500 m wide, within the Halbert's Main Zone deposit located centrally within the study area. The remaining three photograph sets were obtained from the Halbert's South deposit located at the southern end of the study area.

3.1.4 Likelihood of Occurrence Subterranean Fauna

At desktop level, the likelihood of stygofauna and troglodfauna occurring in the study area was assessed using a combination of regional information and site-specific habitat data. Where available, inputs considered in this process included:

¹ <https://scholar.google.co.uk>

² <http://www.epa.wa.gov.au>

³ <http://NatureMap.dec.wa.gov.au>: NatureMap is a joint project of DBCA and the WAM, and presents the most comprehensive source of information on the distribution of Western Australia's flora and fauna.

1. regional surface geology mapping;
2. hydrogeological information;
3. logging, diamond drill core photographs, and other information from drill holes in the study area;
4. previous sampling effort in the locality and results of published and unpublished studies on subterranean fauna from the region; and
5. locations of past subterranean fauna records in the study area locality.

Based on the outcomes of this process, the study area was assigned a likelihood to support stygofauna and troglofauna of 'Low', 'Moderate' or 'High/Definite', consistent with the categories defined in Table 3.2.

Table 3.2: Ranking system used to assign the likelihood of occurrence in the study area.

Rank	Example Criteria
Low	No records of subterranean fauna from within 20 km radius (giving consideration to sampling effort), and affected geological units unlikely to represent core subterranean fauna habitat.
Moderate	Records of subterranean fauna from within 5 km radius (giving consideration to sampling effort), and/or affected geological units likely to represent core subterranean fauna habitat.
High/Definite	Known records of subterranean fauna from within 1 km radius (giving consideration to sampling effort), and/or affected geological units likely to represent core subterranean fauna habitat.

3.2 Pilot Study Fauna Sampling

The pilot study sampling was completed under "Licence to Take Fauna for Scientific Purposes" No. 08-002146-1, issued to Dan Kamien (Appendix 1). The methodology and approach were undertaken with consideration to the following compliance and regulatory documents:

- Environmental Factor Guideline: Subterranean Fauna (EPA 2016b); and
- Technical Guidance: sampling Methods for Subterranean Fauna (EPA 2016a).

3.2.1 Survey Timing and Personnel

Dan Kamien and David Keirle of Biota conducted the survey between 14 and 18 May 2018, with troglofauna traps recovered 2 July 2018. Preliminary sorting of collected specimens was completed by David Keirle of Biota.

3.2.2 Stygofauna

Stygofauna were sampled using modified plankton haul nets, constructed from 70 μ m plankton mesh, with 50 mm or 100 mm apertures attached to a stainless steel catch cylinder (Plate 3.1). Nets were lowered to the bottom of water bores and drill holes before being slowly hauled through the water column to the surface where the contents of the cylinder were flushed into a uniquely labelled container. Each site was sampled in this way a total of four times. On the final haul the net was agitated gently to stir the benthos layer and mobilise any fauna present for more effective specimen collecting. Specimens were stored in a shaded esky in order to keep the sample cool prior to sorting and identification.



Plate 3.1: Plankton haul nets (50mm and 100mm diameter)

Following sampling of each site, the nets were thoroughly rinsed with water, inspected, and where possible, left to dry before using on another site. This prevented cross-contamination between sampling sites.

A total of seven sites were sampled for stygofauna and groundwater salinity profile was measured at four sites (Table 3.3 and Figure 3.1).

Table 3.3: Sites sampled for stygofauna and groundwater.

Site Name	Easting (mE)	Northing (mN)	Number of hauls	Salinity	Hole Total Depth (m)	Depth to Water (m)
HDRC01	301638	6271787	4	Yes	40	3
HDRC02	301869	6271283	4	Yes	69	8
HDRC03	301609	6272436	4	Yes	65	7
HDRC04	301353	6273502	4	Yes	67	10
GDH003	301659	6272843	4	No	50	12
GDH004	301854	6271362	4	No	41	12
GAMA033	301850	6273207	4	No	40	20



Figure 3.1: Location of stygofauna sites and salinity profiling.

3.2.2.1 Salinity Profiling

Salinity of the groundwater (as measured by electrical conductivity (milliSiemens/cm)) was recorded using an EC Dipper Pro. Records were taken at four water bores at 1 m intervals through the water column. Groundwater profiling was completed prior to haul net sampling to avoid disturbance to any haloclines that may have been present. On analysis of groundwater profiles, the final, deepest recordings (up to four recordings) were discarded as sediment in the bottom of the sample hole may cause spurious results.

3.2.3 Troglofauna

A total of 11 sites were sampled for troglofauna during the survey (Table 3.4 and Figure 3.2). Sampling was conducted using two methods; baited colonisation traps and scraping.

Table 3.4: Summary of troglofauna sites and sampling effort.

Site	Easting (mE)	Northing (mN)	Traps Installed	Depth of trap (m)			
				Trap 1	Trap 2	Trap 3	Trap 4
GDH003	301654	6272846	2	5	10	-	-
GDH004	301855	6271367	2	5	10	-	-
GDH005	301909	6271362	1	7	-	-	-
MRCG004	302094	6274135	4	10	20	30	40
MRCG016	302321	6273596	3	7	14	21	-
MRCG026	301935	6273231	3	10	15	20	-
GAMA008	301613	6272712	2	7	14	-	-
GAMA033	301850	6273207	3	7	14	19	-
GAMA090	301907	6273563	3	7	14	21	-
GAMA103	302054	6273651	3	7	14	21	-
GAMA147	301616	6273851	3	10	20	30	-
Total:			29				

3.2.3.1 Colonisation Trapping

Custom-built leaf litter colonisation traps were suspended at intervals within drill holes located within the study area (Plate 3.2). Traps were constructed from 60 mm internal diameter PVC irrigation pipe cut to a length of 180 mm. Each trap had a series of 20 mm holes drilled into the side, and traps remained open at the upper end. Up to four traps were installed such that they were in contact with the interior of the sampled drill hole, facilitating fauna entry into the trap.



Plate 3.2: colonisation trap

Leaf litter was gathered locally from the ground surface in the study area. The collected litter was soaked in water and irradiated in a microwave oven for two minutes on maximum power setting. The microwave acted to kill any surface invertebrates present and assisted in the breaking down of organic matter. Wet litter was added to the traps, which were kept in sealed containers until immediately prior to insertion into the drill holes to avoid desiccation of leaf litter. After the installation of traps, the opening of each drill hole was sealed to maintain humidity and to avoid entry of surface fauna.

Traps were recovered after seven weeks and stored in labelled zip lock bags in order to maintain humidity and prevent desiccation of potential troglofauna specimens during transportation to Perth.

Fauna specimens were recovered from the traps using specially designed Tullgren funnel units (Plate 3.3). Leaf litter from each trap was placed in a sieve under an aluminium lamp containing a 25-watt globe. This created a temperature of approximately 30°C at the surface of the leaf litter. A funnel situated below the leaf litter collected the fauna as they migrated away from the lamp and fell, directing them into an attached vial of 100% ethanol. Leaf litter was left in the Tullgren funnels for a period of 24 hours, or until dry, after which time the bulked invertebrate sample was removed.



Plate 3.3: Tullgren funnels.

3.2.3.2 Troglofauna Scraping

Troglofauna were also sampled by using a custom designed PVC funnel attached to a weighted catch jar. Sampling took place by lowering the scraper to the bottom of the drill hole before slowly hauling it to the surface whilst scraping the edge. This was aimed to dislodge any fauna on the vertical surface of the drill hole interior. Each site was scraped a minimum of four times. The contents of the scraper, which included dry soil and root matter, were emptied into a uniquely labelled container. The scraped material was examined for the presence of troglofauna on the same day it was sampled, using dissecting microscopes (Olympus SZ61, magnification up to 40x).

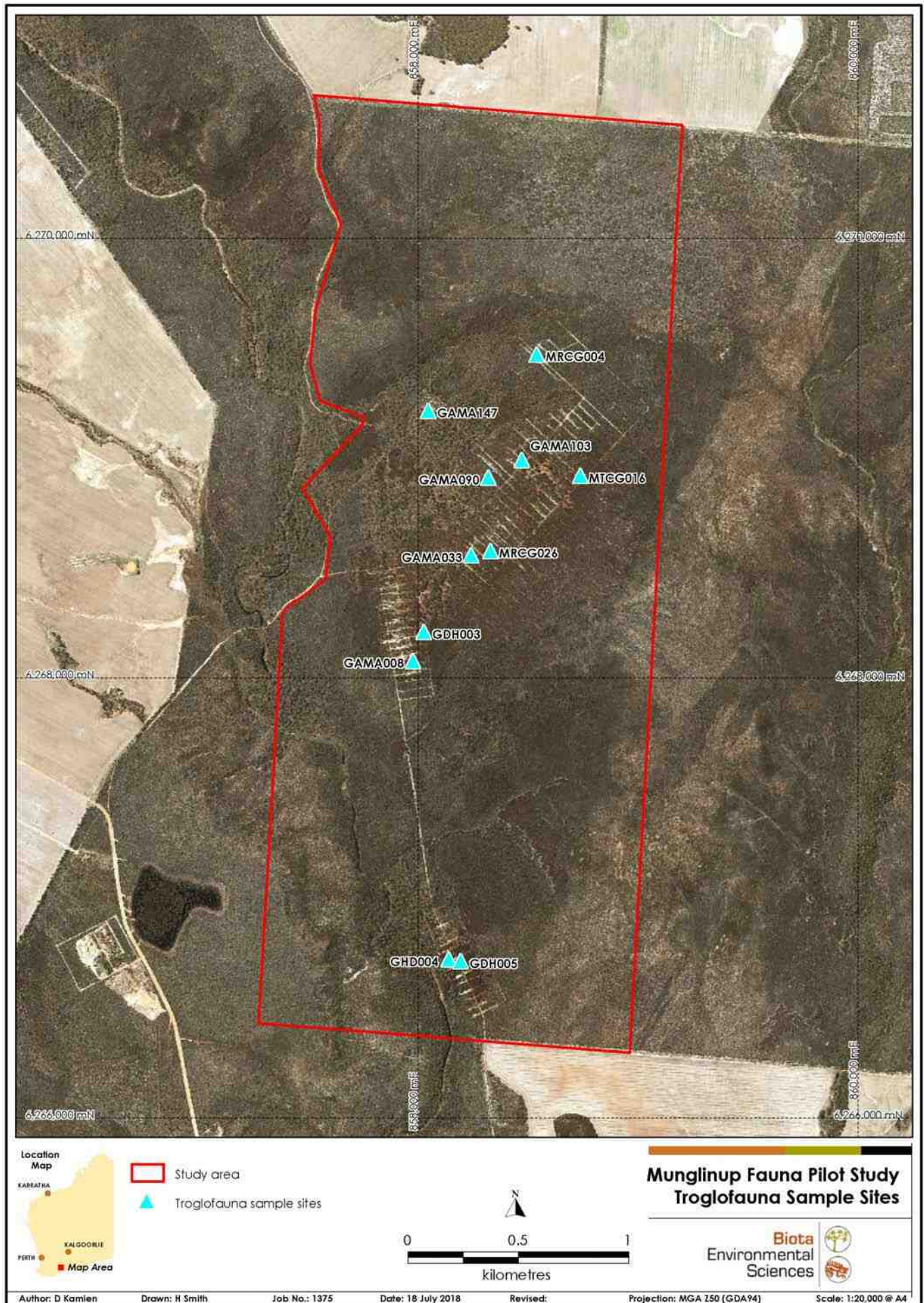


Figure 3.2: Location of troglofauna sampling sites.

3.3 Limitations

3.3.1 Subterranean Fauna

There are a number of limitations that apply to the current study, many of which are common to subterranean fauna sampling, rather than specific to this study. These include:

- The spatial extent of the subterranean fauna sampling was limited by the availability of viable drill holes and water bores, which may have resulted in habitat and/or geology sampling biases.
- Many of the drill holes planned for sampling were no longer present on-site or could not be located due to ill-positioned markers and some drill holes that were located were blocked. This resulted in successful sampling of fewer than expected drill holes.
- There is a lack of sampling history in the subsurface geology types present in the study area and in the study area locality, in general.

4.0 Desktop Review

4.1 IBRA Bioregion and Subregion

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 89 bioregions and 419 subregions (DSEWPac 2012). The study area is located within the Esperance Plains bioregion, which is divided into two subregions: Fitzgerald and Recherche. The study area lies entirely within the Recherche subregion, which is characterised as follows:

- **Recherche** (ESP2): “proteaceous scrub and mallee heaths on sandplain overlying Eocene sediments; rich in endemics. Herbfelds and heaths (rich in endemics) on abrupt granite and quartzite ranges that rise from the plain. Eucalypt woodlands occur in gullies and alluvial foot-slopes. ESP2 Subregion has variable relief, comprising the Quaternary coastal sandplains and dunes overlying Proterozoic gneiss and granite as well as Eocene and more recent coastal limestones. Numerous granitic islands occur in the near shore area of this subregion. Vegetation comprises heath, coastal dune scrub, mallee, mallee-heath and granite heath. Vegetation types are diverse. The climate is Temperate Mediterranean, with 400-700 mm annual rainfall and total area is 1,606,517 ha.” (Comer et al. 2003)

4.2 Geology

4.2.1 Surface Geology

The study area lies within the Munglinup Gneiss, comprising Archean to Paleoproterozoic, metamorphosed granitic and other metamorphic rocks of the Albany–Fraser Orogen (AEMCO 2017). The study area is characterised by three surface geological units (Table 4.1 and Figure 4.1), (Geological Survey of Western Australia 1974).

Table 4.1: Surface geology of the study area.

Age	Code	Description	Area (ha)	% of Study Area
Quaternary	Qrg	Colluvium and deeply eroded surfaces; contains rock fragments and minor outcrops.	546.0	79.6
	Czc	Sandplain- mostly loam or clay, with some ironstone pebbles and limonite nodules.	25	3.6
Proterozoic	Pmm	Migmatite with layered structure.	115	16.8
Total			686	100

4.2.2 Lithology

The Munglinup graphite deposits consist of a succession of tightly folded metasedimentary rocks, specifically graphitic schists and gneisses (Amphibolite and altered Amphibolite) together with jaspilite (ironstone), and clastic rocks that have been weathered to kaolinite, quartz, graphite, and goethite, with the graphitic horizons having been subjected to a high degree of weathering (AEMCO 2017, 2018a). The margins of the graphitic schist and gneissic zones comprise numerous narrow jaspilite zones that may extend to a depth of at least 45 m. A rich iron cap rock typically occurs close to the surface, mostly between altered amphibolite and graphite rich zone (AEMCO 2018a). Figure 4.2 shows a typical cross section of the graphite deposits (AEMCO 2017).

Based on drill log data, the subsurface geology throughout the study area is relatively consistent. The subsurface geology is not conducive to the presence of vugs, fractures and cavities required to support subterranean fauna (see Section 4.5).

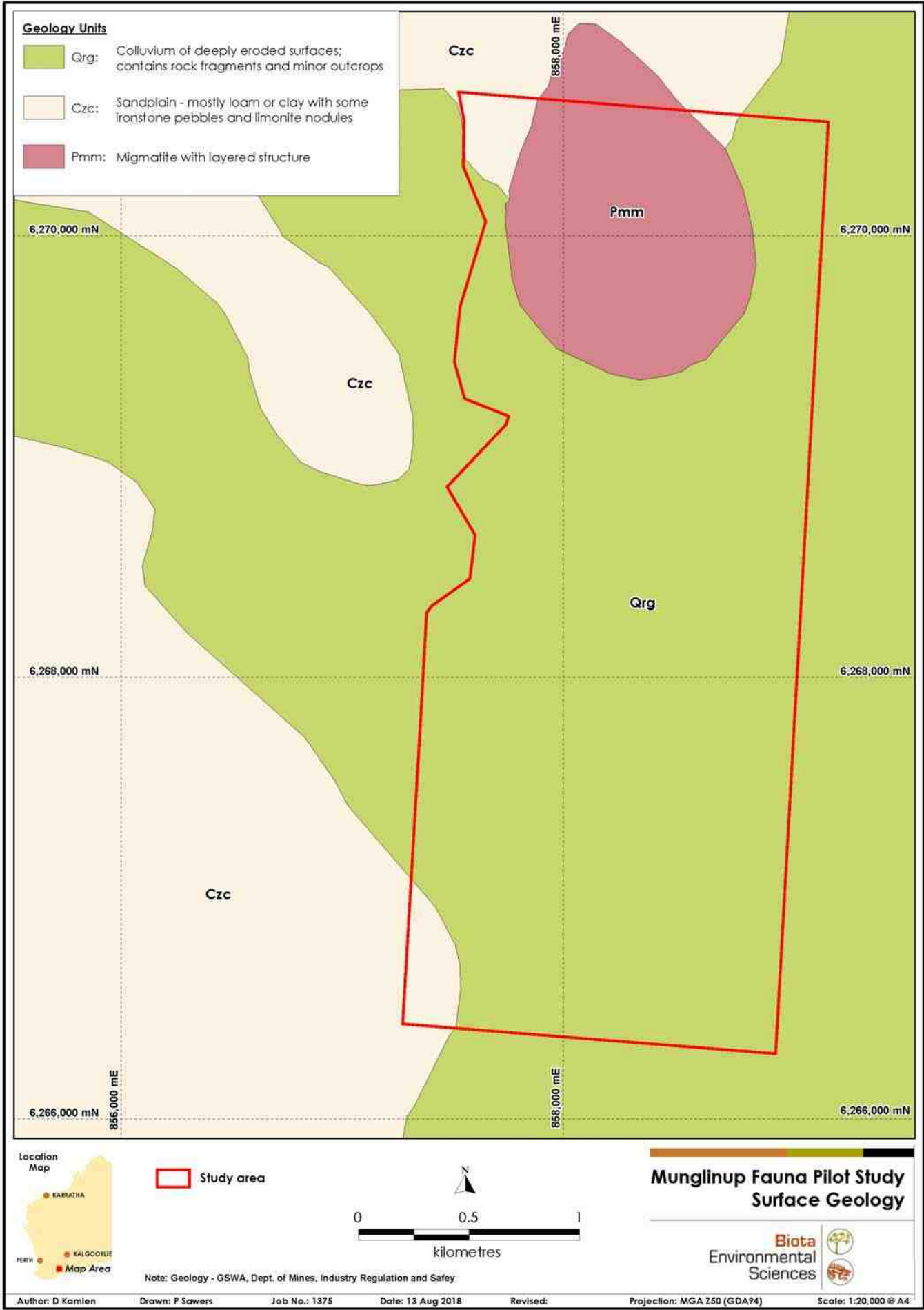


Figure 4.1: Surface geology of the study area.

4.3 Hydrogeology

The study area lies within the Munglinup River catchment. The river and groundwater flow south towards the coast. Hydrogeological assessment (AEMCO 2017) has revealed that the aquifer is not extensive, but occurs in a zone of high water recharge. Any stygofauna occurring in the study area is likely to be confined to the aquifer and if so, their distributions would also be limited.

Assessments of the hydrogeology of the study area are at a preliminary stage and most observations on aquifer properties have been inferred from resource drilling (AEMCO 2017, 2018b). Drilling results show that most of the ore formation within the graphite rich zone is fully saturated and has a very high hydraulic conductivity resulting in a high aquifer transmissivity. Within this zone there is a shallow perched surficial aquifer on top of the clay rich material that is not well developed, representing young meteoric water (derived from precipitation). The rest of the aquifer is unconfined to semi-confined within clay rich alteration zones (AEMCO 2018b).

Unlike the graphite rich zones, the surrounding host rock is not fully saturated and is fractured in places. In these locations the fractured aquifer was found to be sub-artesian (AEMCO 2018b). Figure 4.2 depicts the stratigraphic arrangement of the graphite deposits and host rock.

4.4 Previous Studies

Based on the literature review and database searches, no previous subterranean fauna surveys have been conducted in the wider locality of the study area. Moreover, the literature review did not return any subterranean fauna surveys in the Esperance Plains bioregion. A flora and fauna assessment has been conducted within the study area itself (Ecologia 2015), but this did not consider subterranean fauna.

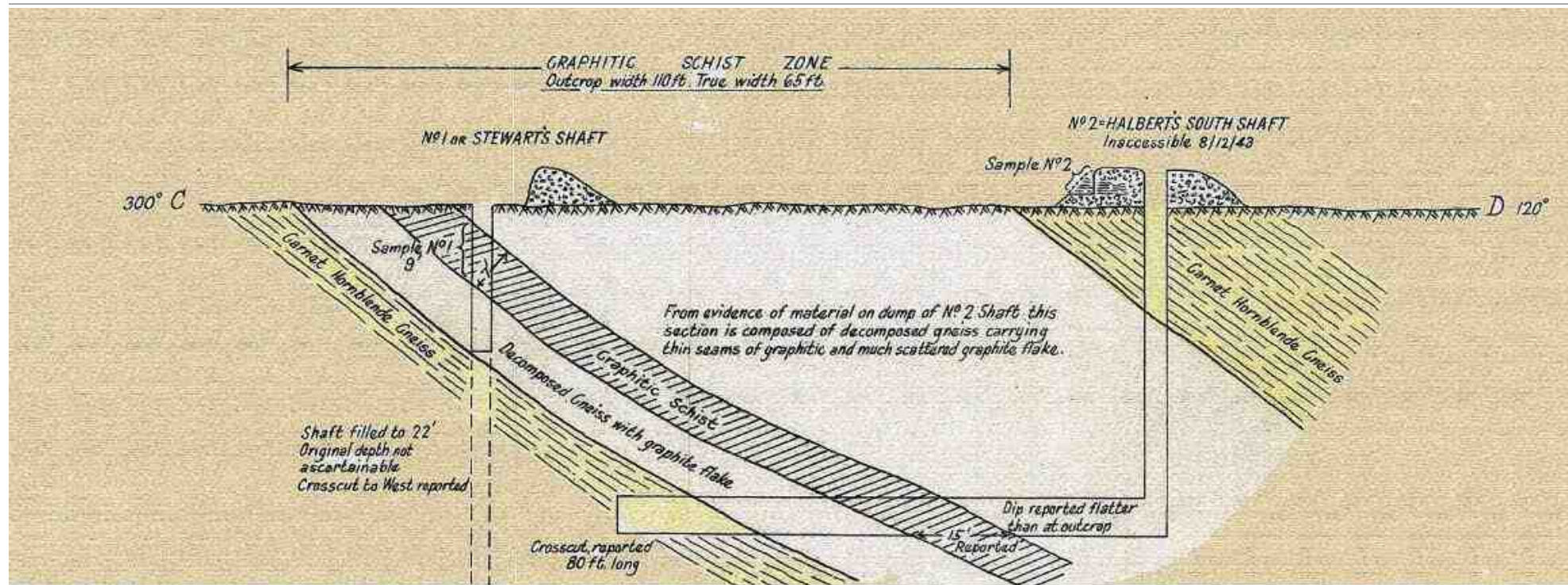


Figure 4.2: Typical cross section showing the stratigraphic arrangement of the graphite deposits and host rock.
(source: MRC 2018).

4.5 Habitats

The likelihood that the geology of a study area will provide suitable habitat to support subterranean fauna can be determined by considering the following characteristics:

1. physical attributes of the unit; especially the occurrence of vugs, fractures and cavities;
2. results of subterranean fauna sampling from equivalent geological units during previous studies; and
3. the level of transmissivity and hydrological connectivity of the geological unit (for stygofauna only).

No subterranean fauna have been recorded in similar geology types in the region. Drill logs and drill cores largely indicate the absence of vugs, fractures or cavities in the stratigraphy (Plate 4.2 to Plate 4.4). Drill logs and core photos for three of the drill holes sampled during the study are presented in Appendix 3. Additionally, the presence of soft clay around the ore body and in the form of clay rich altered amphibolites, indicates low water permeability and connectivity in such zones (AEMCO 2017). Despite this, in areas where rock vein quartz and breccia was noted (including quartz in contact with graphite) some faults and fractures were evident (AEMCO 2017), with these having potential to be considered subterranean fauna habitat. Additionally, the graphite rich zones have high aquifer transmissivity (AEMCO 2017), indicating permeability of water.

For the drill holes and water bores sampled, depth to water ranged from 3 m to 20 m below ground level (Table 3.3). Troglofauna are unlikely to inhabit areas where there is a very shallow water table, but they have potential to exist where the water table is consistently deeper and above-water table strata contain suitable habitat space. Although available drill logs do not consistently provide depth to water data, it appears that the northern deposits typically have a deeper water table than the southern deposits. This is consistent with a higher elevation in the north of the study area compared to the south (AEMCO 2017).



Plate 4.1: Example drill core through amphibolite geology.



Plate 4.2: Example drill core through altered amphibolite geology.



Plate 4.3: Example drill core through graphite schist geology.



Plate 4.4: Example drill core through magnesite geology.

5.0 Survey Results

5.1 Stygofauna

No stygofauna were recorded from the water bores and drill holes sampled during the survey.

5.2 Groundwater Profiling

The ground water sampled during the survey is brackish (22.20-36.85 milliSiemens/cm) (Table 5.1), and is within the range documented for habitats where stygofauna have been recorded (EPA 2016c).

Table 5.1: Overview of groundwater salinity data.

	Conductivity (milliSiemens/cm)			
	HDRC01	HDRC02	HDRC03	HDRC04
Mean	28.57	35.14	31.37	36.05
Standard Error	0.04	0.03	0.79	0.08
Minimum	28.08	34.68	22.21	34.52
Maximum	28.94	35.85	36.85	36.60

Groundwater salinity profiles are presented for the four water bores sampled (Figure 5.1). Each site displayed different salinity levels, though all were brackish (Figure 5.1). Two of the sites sampled exhibited an initial increase in conductivity with depth, which then plateaued, indicating the presence of a comparatively fresh water layer over a more brackish deeper layer (sites HDRC03 and HDRC04). This halocline was most pronounced at site HDRC03 (Figure 5.1). Where haloclines occur there is potential for different stygofauna species to inhabit the different groundwater habitats, when fauna are present (Juame et al. 2001).

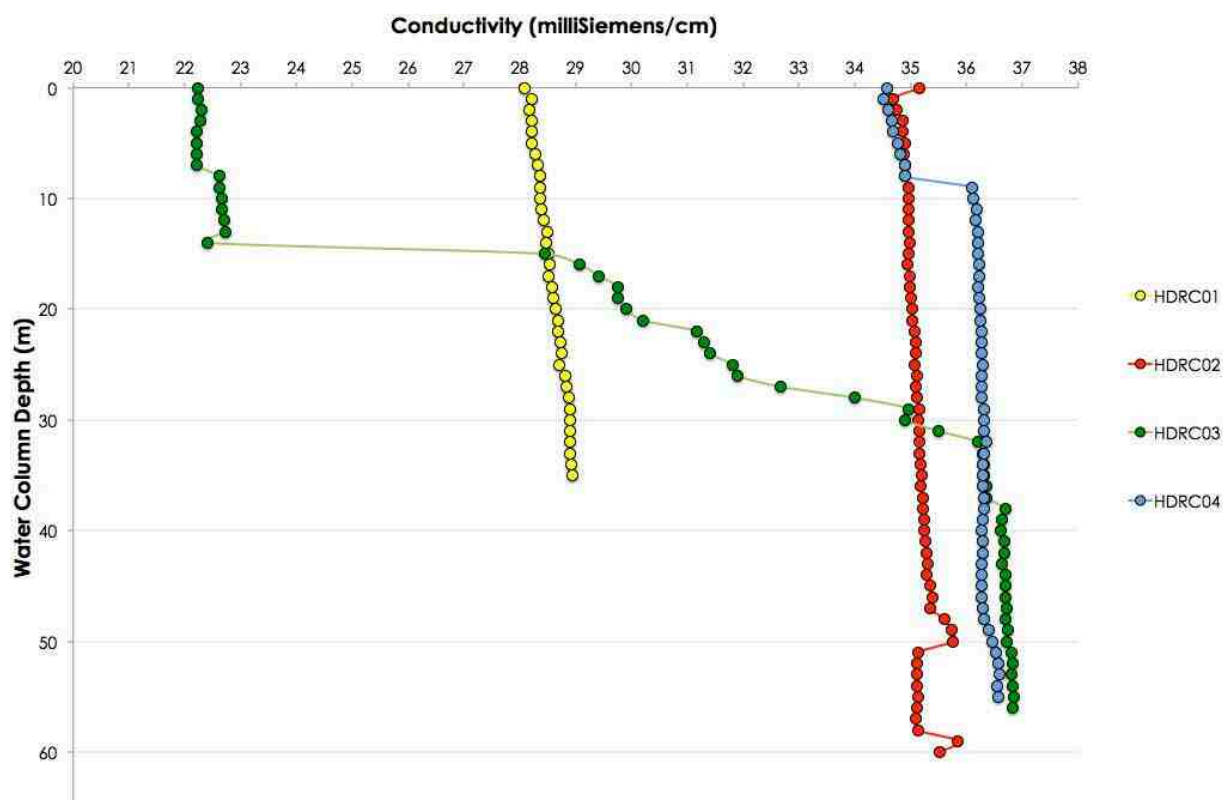


Figure 5.1: Groundwater conductivity profiles with depth within the study area.

5.3 Troglafauna

A total of 1,249 invertebrate specimens were collected via habitat colonisation traps. However, none of these specimens were troglobitic. These specimens represent by-catch and all were surface animals or edaphobites that do not have life histories conducive to short-range endemism (i.e. they are capable of dispersing widely). This was determined by examination of morphological characteristics as outlined in Section 2.3, in addition to previous molecular analysis of key taxonomic groups recorded elsewhere in Western Australia (Berry 2005).

A summary of fauna recorded is presented in Table 5.2 with full details by site presented in Appendix 2.

Table 5.2: Summary of fauna by-catch recorded during troglafauna sampling.

Taxon (order)	Number Collected	Number of Sites
Acarina	496	9
Coleoptera	5	2
Collembola	717	9
Diptera	11	3
Hymenoptera	16	5
Isopoda	4	1

6.0 Discussion

Although a total of six invertebrate orders were recorded from the study area during troglotauna sampling, none of these represent troglobitic fauna. Similarly, no stygofauna were recorded in the study area.

Based on drill log data, it is apparent that the subsurface geology is relatively consistent within and between the different graphite deposits within the study area. The geology and drill cores indicate a scarcity of vugs, fractures or cavities, which are structural features typically present in subterranean fauna habitat. As a result, it is unlikely that the rock types present in the study area represent habitat for troglotauna or stygofauna. For troglotauna, the shallow depth to water in the southern parts of the study area further limits the likelihood of inhabitable strata being present.

On this basis then, it appears that the subsurface geology within the study area does not constitute suitable subterranean fauna habitat resulting in a low likelihood of subterranean fauna occurrence (see Table 3.2). Pilot study sampling results were consistent with this.

As this pilot study represents a preliminary assessment rather than an EIA, conclusions regarding impact assessment and any related management recommendations are not provided. The pilot study was conducted in accordance with current technical guidance (EPA 2016a), and the objectives have been satisfied in that it determines the subterranean faunal values in the context of a desktop review and preliminary survey.

As no subterranean fauna were recorded, and the available information suggests that there is a low likelihood of their occurrence, it is unlikely that further subterranean fauna work is warranted. Further work would only appear to be required on subterranean fauna in the event that the EPA formally assesses the proposed development and determines that subterranean fauna represents a preliminary key environmental factor for the proposal.

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7.0 Glossary

Benthos	Area of sedimentation at the bottom of a stygofauna sampling site, which often has a stygal community distinct from that of the water column.
Biota	Biota Environmental Sciences.
DBCA	Department of Biodiversity Conservation and Attractions
Edaphobite	Soil dwelling fauna that can often display troglomorphic characteristics. Edaphobites are unlikely to have limited distributions and therefore unlikely to be classified as short-range endemics.
EIA	Environmental Impact Assessment
Endemic	Native to or confined to a certain region.
EPA	Environmental Protection Authority.
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
IBRA	Interim Biogeographic Regionalisation for Australia
NatureMap	Database developed in collaboration between DBCA and the WAM. Represents the most comprehensive source of information on the distribution of Western Australia's fauna
Stygobite/ Stygofauna	Species living obligatorily in the underground water environment.
Troglobite / Troglfauna	Species living obligatorily in caves; also blind, depigmented and often having an elongate body morphology.
Troglomorphic	Pertaining to morphological, behavioural and physiological characters that are convergent in subterranean populations (Christiansen 1962).
Troglophile/ Troglophilic	Species able to live and reproduce underground as well as in the epigean (surface) environment (Wilkins et al. 2000).
Trogloxene	An organism that habitually enters caves but must return periodically to the outside for certain of its living requirements, usually food (e.g. bats) (Romero 2009).
Vug	A minor cavity in rock formations.
WAM	Western Australian Museum

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Appendix 1

DBCA Regulation 17 Permit





Wildlife Conservation Act 1950

REGULATION 17

Regulation 17 – Licence to take fauna for scientific purposes (Regulation 17 - Standard)

The undermentioned person may take fauna for research or other scientific purposes and where authorised, keep it in captivity, subject to the following and attached conditions, which may be added to, suspended or otherwise varied as considered fit.

Director General

Conditions

- 1 The licensee must comply with the provisions of the Wildlife Conservation Act 1950, Wildlife Conservation Regulations 1970 and any Notices in force under this legislation.
- 2 The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.
- 3 Unless specifically authorised in the conditions of this Licence or otherwise in writing by the Director General, species of fauna declared as likely to become extinct, rare or otherwise in need of special protection shall not be taken.
- 4 Any by-catch of fauna, which is declared to be rare, likely to become extinct, or otherwise in need of special protection shall be released immediately at the point of capture. Where such fauna taken under this licence is injured or deceased, the licensee shall contact the Department's Wildlife Licensing Section for advice on disposal. Records must be kept of any such fauna so captured and details are to be included in the report required under further condition below.
- 5 Any interaction involving Gazetted Threatened Fauna that may be harmful to the fauna and/or invasive may require approval from the Commonwealth Department of the Environment ph 02 6274 1111. Interaction with such species is controlled by the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the Wildlife Conservation Act 1950 and Wildlife Conservation Regulations 1970.
- 6 No fauna shall be taken in areas where it would impinge on pre-existing scientific research programs.
- 7 Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers used, and signs and structures erected by the licensee shall be removed and the environment returned to its original condition.
- 8 Not more than ten specimens of any one protected species of fauna shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.
- 9 The licensee shall not release any fauna or their progeny in any area where it does not naturally occur, nor hand such fauna over to any other person or authority unless approved by the Director General, nor dispose of the remains of such fauna in any manner likely to confuse the natural or present day distribution of the species.
- 10 Bioprospecting involving the removal of sample aquatic and terrestrial organisms for chemical extraction and bioactivity screening shall not be conducted without specific written approval by the Director General.
- 11 No fauna is to be taken from any CALM land, as defined in the Conservation and Land Management Regulations 2002, without prior written approval of the Director General. No fauna is to be taken from any public land without the prior written approval of the Government Authority managing that land.
- 12 The licensee must not enter upon any private property or pastoral lease for the purposes of this licence, nor take any fauna from any private land or pastoral lease without the prior consent in writing of the owner or occupier. Similarly, in the case of Aboriginal lands, the licensee must not enter upon or take fauna from such lands without the written approval of the Department of Aboriginal Affairs and/or the relevant native title holders or applicants.
- 13 Copies of this licence and any written approval or consent required by conditions of this licence must be carried by the licensee and any person/s authorised under the licence at all times when conducting activities relevant to the licence

DEPARTMENT OF PARKS AND WILDLIFE



Department of
Parks and Wildlife



Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9219 9000
Facsimile: 08 9219 8242
Web Site: <https://wildlifelicensing.dpaw.wa.gov.au>
Correspondance: **Locked Bag 30**
Bentley Delivery Centre WA 6983

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and must be presented to an authorised officer of the Department upon request.

- 14 All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range shall upon request be donated to the Western Australian Museum.
- 15 To prevent any unnecessary collecting in this State, all specimens and material taken and retained under the authority of this license shall, upon request, be loaned to the Western Australian Museum. Any unused portion or portions of any specimen collected under the authority of this license shall be offered to the Western Australian Museum for inclusion in its collection or made available to other scientific workers if so required.
- 16 Within one month of the expiration of this licence, the holder shall submit an electronic return into the department's Wildlife Licensing System, detailing the locality, site, geocode, date and number of each species of fauna captured, sighted or vouchered during the currency of the licence. A copy of any paper, report or thesis resulting from the research shall upon completion be lodged with the Director General.

Purpose

SRE invertebrate survey by hand foraging, raking, sieving, excavation and Subterranean (troglifaunal & stygofauna) survey using PVC colonisation traps and scraping inside bore column with plankton net in accordance with EPA guidance statement 2016 for Mineral Commodities Ltd Munglinup Graphite Project.

Locations

Munglinup region in the Great Southern, between Esperance and Ravensthorpe.

Authorised Person

Surname	Given name(s)
Keirle	David
Schmidt	Sylvie
Humphreys	Garth

Date of Issue 27/04/2018
Valid From 11/05/2018
Date of Expiry 11/08/2018

Licensee: Mr Daniel Kamien
Address Biota Environmental Sciences Pty Ltd
PO Box 155
Leederville WA 6903
Australia

Issued by a Wildlife Licensing Officer of the Department of Parks and Wildlife under delegation from the Minister for Environment pursuant to section 133(1) of the Conservation and Land Management Act 1984.

Appendix 2

Non-troglobitic Fauna Recorded During Troglofauna Sampling



Date Collected	Drill hole ID	Batch No.	Taxon (Order)	No. Specimens	Identifier
2/07/18	GAMA103	GAMA103.20180702.T1	Collembola	~200	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T1	Isopoda	1	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T2	Collembola	~100	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T2	Coleoptera	2	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T2	Acarina	5	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T2	Isopoda	3	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T3	Diptera	1	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T3	Collembola	~50	David Keirle
2/07/18	GAMA103	GAMA103.20180702.T3	Hymenoptera	2	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T1	Acarina	4	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T1	Collembola	5	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T1	Coleoptera	2	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T2	Collembola	~10	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T3	Collembola	~20	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T3	Coleoptera	1	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T4	Collembola	~10	David Keirle
2/07/18	MRCG004	MRCG004.20180702.T4	Diptera (larvae)	1	David Keirle
2/07/18	GAMA008	GAMA008.20180702.T1	Acarina	~200	David Keirle
2/07/18	GAMA008	GAMA008.20180702.T1	Hymenoptera	2	David Keirle
2/07/18	GAMA008	GAMA008.20180702.T2	Acarina	~200	David Keirle
2/07/18	GDH005	GDH005.20180702.T1	Collembola	10	David Keirle
2/07/18	GDH005	GDH005.20180702.T1	Hymenoptera	1	David Keirle
2/07/18	GDH003	GDH003.20180702.T1	Collembola	10	David Keirle
2/07/18	GDH003	GDH003.20180702.T1	Acarina	2	David Keirle
2/07/18	GDH003	GDH003.20180702.T1	Hymenoptera	3	David Keirle
2/07/18	GDH003	GDH003.20180702.T2	Collembola	5	David Keirle
2/07/18	GDH003	GDH003.20180702.T2	Hymenoptera	2	David Keirle
2/07/18	GDH004	GDH004.20180702.T1	Acarina	3	David Keirle
2/07/18	GDH004	GDH004.20180702.T1	Collembola	~10	David Keirle
2/07/18	GDH004	GDH004.20180702.T2	Acarina	2	David Keirle
2/07/18	MRCG026	MRCG026.20180702.T1	Nil	0	David Keirle
2/07/18	MRCG026	MRCG026.20180702.T2	Acarina	2	David Keirle
2/07/18	MRCG026	MRCG026.20180702.T3	Nil	0	David Keirle
2/07/18	GAMA033	GAMA033.20180702.T1	Acarina	5	David Keirle
2/07/18	GAMA033	GAMA033.20180702.T2	Acarina	~10	David Keirle
2/07/18	GAMA033	GAMA033.20180702.T3	Acarina	~10	David Keirle
2/07/18	GAMA033	GAMA033.20180702.T3	Collembola	2	David Keirle
2/07/18	MTCG016	MTCG016.20180702.T1	Collembola	15	David Keirle
2/07/18	MTCG016	MTCG016.20180702.T1	Hymenoptera	6	David Keirle
2/07/18	MTCG016	MTCG016.20180702.T2	Collembola	10	David Keirle
2/07/18	MTCG016	MTCG016.20180702.T3	Collembola	5	David Keirle
2/07/18	GAMA090	GAMA090.20180702.T1	Collembola	5	David Keirle
2/07/18	GAMA090	GAMA090.20180702.T1	Acarina	5	David Keirle
2/07/18	GAMA090	GAMA090.20180702.T2	Acarina	3	David Keirle
2/07/18	GAMA090	GAMA090.20180702.T3	Acarina	5	David Keirle
2/07/18	GAMA090	GAMA090.20180702.T3	Collembola	~10	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T1	Acarina	~20	David Keirle

Date Collected	Drill hole ID	Batch No.	Taxon (Order)	No. Specimens	Identifier
2/07/18	GAMA147	GAMA147.20180702.T1	Collembola	~100	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T2	Diptera larvae	6	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T2	Acarina	~10	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T2	Collembola	~40	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T3	Diptera (larvae)	3	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T3	Acarina	~10	David Keirle
2/07/18	GAMA147	GAMA147.20180702.T3	Collembola	~100	David Keirle

Appendix 3

Drill Logs and Core Photos for a Sub-set of Drill Holes Sampled During the Pilot Study



GDH003 Core photos in order of descending depth

Core Photos	Depth (m)	Lithology
	0-5	Soil (Zs) Altered Amphibolite (Alt Amp)
	5- 11	Altered Amphibolite (Alt Amp)
	11-14	Altered Amphibolite (Alt Amp)
	14-18	Clay (cy) Quartzite (sq) Altered Amphibolite (Alt Amp)

	18-22	Quartzite (sqt)
	22-27	Quartzite (sqt) Clay (cy)
	27-30	Quartzite (sqt)
	30-34	Amphibolite (Amp) Altered Amphibolite (Alt Amp)

	34-38	Altered Amphibolite (Alt Amp)
	38-43	Drill Log not provided
	43-47	Drill Log not provided
	47-50	Drill Log not provided

GDH004 Core photos in order of descending depth

Core Photos	Depth (m)	Lithology
	0-4	Soil (Zs) Graphite gneiss (Sgp) Graphite gneiss (Sgp)- magnesite (mg)
	4-6	Graphite gneiss (Sgp)
	6-9	Graphite gneiss (Sgp)
	9-12	Graphite gneiss (Sgp)

	12-16	Graphite gneiss (Sgp)
	16-20	Graphite gneiss (Sgp)
	20-22	Graphite gneiss (Sgp) Altered Amphibolite (Alt Amp)
	22-26	Altered Amphibolite (Alt Amp) Sandy

	26-30	Altered Amphibolite (Alt Amp)
	30-34	Drill Log not provided
	34-36	Drill Log not provided
	36-39	Drill Log not provided

	39-41	Drill Log not provided

GDH005 Core photos in order of descending depth

Core Photos	Depth (m)	Lithology
	0-3	Soil (Zs)/Clay (cy)
	3-6	Clay (cy)-Iron (Fe)
	6-8	Clay (cy)- Iron (Fe)
	8-11	Clay (cy)- Iron (Fe)

	11-13	Altered Amphibolite (Alt Amp)
	13-16	Altered Amphibolite (Alt Amp)
	16-19	Altered Amphibolite (Alt Amp)
	19-21	Amphibolite (Amp)

	21-23	Amphibolite (Amp)
	23-26	Amphibolite (Amp)
	26-28	Amphibolite (Amp)
	28-31	Amphibolite (Amp)

	31-34	Amphibolite (Amp)
	34-37	Amphibolite (Amp) Altered Amphibolite (Alt Amp)
	37-40	Amphibolite (Amp)
	40-43	Amphibolite (Amp)

	Drill Log not provided

APPENDIX C-14: WRM - Munglinup River Water Quality & Aquatic Fauna Survey



Munglinup Graphite Project Munglinup River

Baseline Water Quality & Aquatic Fauna Survey
April 2018
Final Report



Munglinup Graphite Project Munglinup River

Baseline Water Quality & Aquatic Fauna Survey April 2018

Prepared for:

MRC Graphite Pty Ltd (MRC)

39-43 Murray Road North, Welshpool WA 6106

by:

Wetland Research and Management

16 Claude Street, Burswood, WA 6100

Ph +61 8 9361 4325

e-mail: admin@wetlandresearch.com.au

Final Report
August 2018

Study Team

Project Management: Adam Harman

Report: Adam Harman & Fintan Angel

Internal Review: Andrew Storey

Field Work: Andrew Storey and Fintan Angel

Macroinvertebrate Identification: Kim Nguyen and Bonita Clark

Macroinvertebrate QA/QC: Chris Hofmeester

Map compilation: Emma Thillainath

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1 INTRODUCTION

1.1 Project Background

MRC Graphite Pty Ltd (“MRC”) is proposing to develop the Munglinup Graphite Project (“The Project”), situated 105km west of Esperance and 4km north of the town of Munglinup, in Western Australia. The project lies entirely within M74/245, a mining lease in the Esperance Region granted on 26th August 2010 for a term of 21 years and expiring on 25th August 2031. The surrounding land use is primarily farmland (MRC Scoping Study 2017). Mine development requires the potential provision for emergency discharge of surplus project water into the Munglinup River, a seasonally flowing tributary of the Oldfield River. Though the quality of water to be discharged into the Munglinup River is unknown, discharge and disturbance of creeklines poses potential risk to the health of adjacent and downstream aquatic ecosystems, which needs to be appropriately assessed.

Wetland Research & Management (WRM) were contracted to undertake a baseline survey of the water quality and aquatic fauna of the Munglinup River in order to determine the conservation significance of the ecological values of pools in the vicinity of the Project area, and the local/regional distribution of these values to support environmental approvals, as required. The baseline survey follows a desktop review of the Project area by WRM, to document known (i.e. publicly available) water quality and aquatic fauna values of the Munglinup River.

1.2 Legislative framework

At a State level, native aquatic fauna are protected under the Biodiversity Conservation Act 2016 (BC Act¹) and their environment is protected under the *Environmental Protection Act 1986 (EP Act)*. This includes freshwater turtles, frogs, fish, zooplankton and macroinvertebrates.

The *BC 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 km²) defined as short range endemics (SREs; Harvey 2002, EPA 2009). Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) uses the International Union for Conservation of Nature (IUCN) Red List criteria for assigning species and communities to threat categories under the *WC Act*. Not all Western Australian species listed by the IUCN are also listed by the DBCA.

The Environmental Protection Authority (EPA) released the new Environmental Factor Guideline: Inland Waters on 27 June 2018. The purpose of this guideline is to communicate how the factor Inland Waters is considered by the EPA in the environmental impact assessment (EIA) process. The guideline replaces the following documents:

- Environmental Protection Authority 2016, Environmental Factor Guideline: Hydrological Processes, EPA, Western Australia.
- Environmental Protection Authority 2016, Environmental Factor Guideline: Inland Waters Environmental Quality, EPA, Western Australia

Where Inland Waters has been identified as a preliminary key environmental factor during the EIA process the EPA may require the proponent to provide information or studies, including but not

¹ Several parts of the new Biodiversity Conservation Act 2016 (BC Act) were proclaimed by the State Governor on 3 December 2016. The remaining provisions of the BC Act will come into full effect on 1 January 2019 and will replace the Wildlife Conservation Act 1950 (WC Act).

limited to the characterisation of surface water quality and description of the environmental values of surface or groundwater systems.

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*. Aquatic invertebrates in particular have historically been under-studied. Lack of knowledge of their distributions often precludes aquatic invertebrates for listing as threatened or endangered. The Environmental Protection Authority (EPA) has stated that listing under legislation should therefore not be the only conservation consideration in environmental impact assessment.

1.3 Regional setting

The Project is located within the South West Botanical Province of Western Australia, which is recognised globally as one of the “biodiversity hotspots” of the world due to a combination of high species diversity, high numbers of endemic plants, and high levels of threat to biodiversity in the region (Gole 2006). This area extends from Shark Bay in the North, to Israelite Bay towards the south east of the State and follows the 350 mm rainfall isohyet. The South Coast bioregion, where the Project area is located, occupies the south eastern part of the South West Botanical Province, contributing significantly to the overall biodiversity of the area (Danks 2004).

The South Coast bioregion contains around 107 rivers and major tributaries, which are perennial or ephemeral in nature (Cook *et al.* 2008). Broadly, two separate aquatic bioregions are recognised within the South Coast region; the Western South Coast bioregion, consisting of rivers from Gardner River in the west to Bluff River, and the Eastern South Coast bioregion, consisting of rivers lying between the Pallinup River and the Thomas River in the east (Cook *et al.* 2008, Stewart *et al.* 2009).

The Munglinup River, with a catchment area of approximately 32,300 ha, falls within the Eastern South Coast bioregion (Gee and Simons 1997). The river originates on the sandplain north of the South Coast Highway and only flows for short periods in winter. The corridor in which the river flows is well vegetated, with land surrounding the corridor being cleared for agricultural uses including cropping and grazing. The Munglinup River is a major tributary of the Oldfield River, which has a catchment area of approximately 217, 200 ha (Gee and Simons 1997). The two systems join approximately 13 km southwest of the town of Munglinup.

1.4 Climate

The climate of the area is Mediterranean, typified by cool, wet winters (June - August) and hot, dry summers (December - February). The weather is determined by eastward moving high and low-pressure systems. The average monthly minimum and maximum temperatures for Munglinup (Munglinup West 012044) range from 12.6 to 28.9 °C during summer months and from 6.6 to 18.0 °C during winter months (Figure 1.). The average annual rainfall is 473.4 mm at Munglinup West (station 012044, 2002-2018), 508.5 mm at Munglinup Melaleuca (station 012281, 1975-2013), and 430.7 mm at Ravensthorpe (station 010633, 1901-2018). Recent rainfall data show above average rainfall at Munglinup West station for February 2018 (110.4 mm, Figure 2). Anecdotal evidence suggest the Munglinup River was in flood prior to the current study, with connected surface flows from the township of Munglinup to the Oldfield River. Average annual evaporation is greatest during the summer months and is approximately 1750 mm (Hodgkin, 1997).

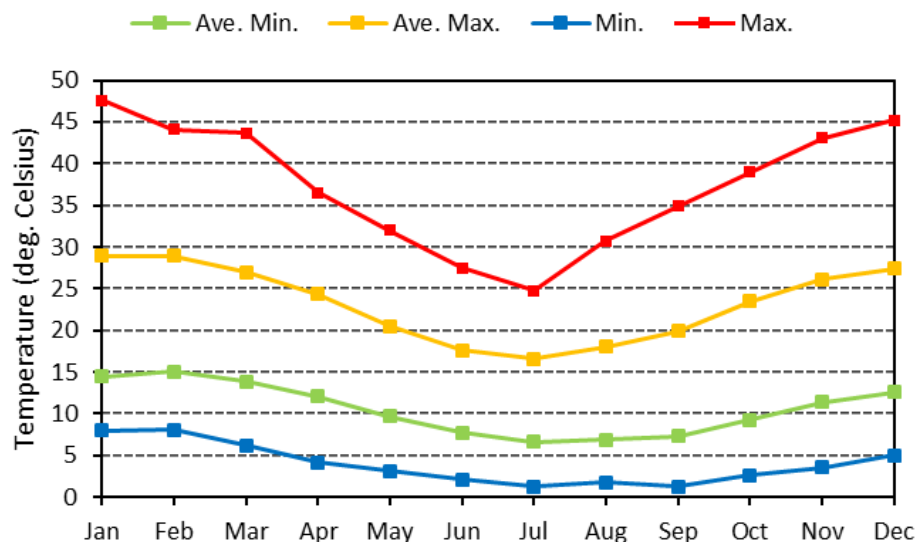


Figure 1. Maximum and minimum monthly temperature for Munglinup West together with average maxima and minima for the period 2002 – 2018 (data supplied by Climate Services, BOM, Perth).

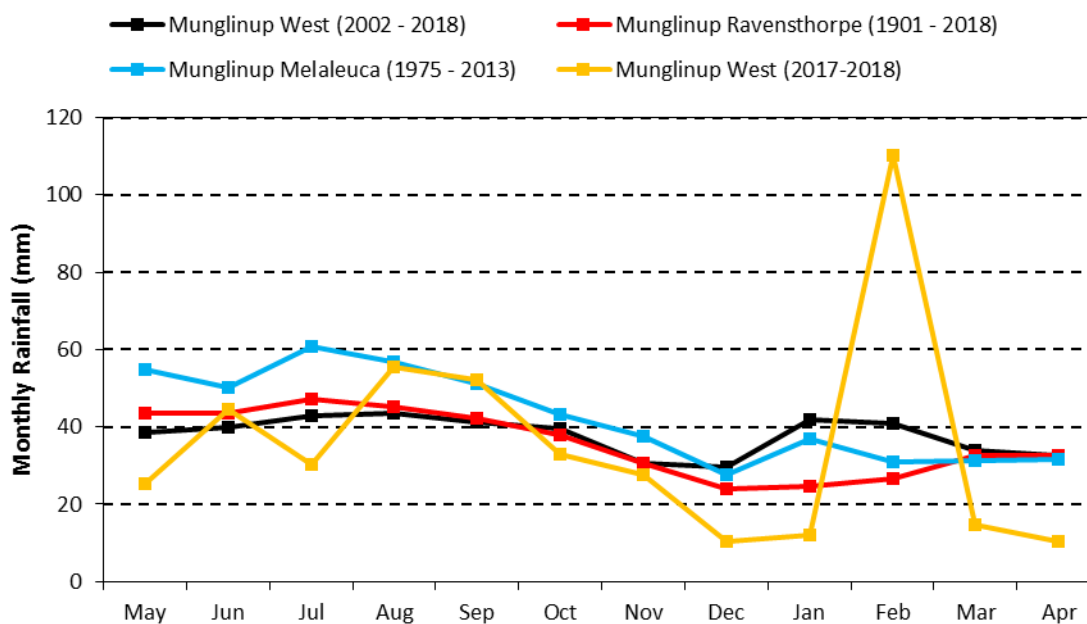


Figure 2. Average monthly rainfall for Munglinup West (2002 – 2018), Munglinup Melaleuca (1975 – 2013) and Munglinup Ravensthorpe (1901 – 2018) and Munglinup West (Last 12 months) (data supplied by Climate Services, BOM, Perth).

1.5 Desktop review

Few studies have been undertaken on the water quality and aquatic fauna of the Eastern South Coast bioregion, and few within the Munglinup River itself. As such, knowledge of the water quality and aquatic fauna in the immediate vicinity of the Project area is limited.

A summary of publicly available water quality and aquatic fauna technical reports and published scientific papers consulted in the review include:

- Danks (2004) provides a broad overview of biodiversity values, including aquatic fauna, and threats in the South Coast Region.
- The Water Corporation (2011) and the Department of Water and Environmental Regulation (1998-2000) provide a summary of water quality data collected from the Munglinup River.
- Morgan et al. 2006 provide a summary of the fish fauna of the south coast of Western Australia including the Munglinup and Oldfield River catchment.
- Cook et al. 2008 undertook a comprehensive water quality, macroinvertebrate and fish study in 33 waterways across the South Coast bioregion between 2006 and 2008. Results from this study are also presented in Stewart et al. 2009.

The desktop review suggests the Munglinup River can be considered of low-moderate regional conservation value, largely due to past anthropogenic disturbances, including catchment clearing and agricultural land use practices. Salinity, and to a lesser degree nutrient enrichment, are the main factors influencing the diversity and composition of aquatic fauna in rivers of the Eastern South Coast bioregion. Subsequently, macroinvertebrate richness is typically more depauperate in rivers within this bioregion, compared with those further to the west. In addition, the majority of fauna listed under federal and state conservation legislation do not have distributions which extend into the Eastern South Coast bioregion. Only two species listed under the BC Act are considered likely or possible to occur in the Munglinup River; the rakali (water rat) and south-western snake necked turtle. No species listed under the EPBC Act were considered likely or possible to occur in the Munglinup River. Endemic species of fish, crayfish and frogs which occur, or have potential to occur in the Munglinup River have a documented wider distribution across the South Coast region.

The desktop review is provided in full in the Appendix 5.

1.6 Scope of works

The scope of work to **Establish Ecological Values of the Munglinup River in the Project Area** includes:

- I. Description of survey methodologies (timing, duration, effort) used to sample aquatic fauna and water quality, any limitations and nomenclature used;
- II. Sampling, analysis/identification and reporting to be undertaken with the following considerations:
 - a. Systematic sampling of water quality (*in situ*, ions, nutrients, dissolved metals, turbidity) and aquatic fauna (macroinvertebrates, fish, crayfish, water rats, and observations of other vertebrate fauna, if present) at each selected site/pool in April 2018;
 - b. Identification of specimens to species-level, where possible;
 - c. Analysis of all data to assess spatial variability, with consideration of species occurrence amongst potentially exposed sites, and versus upstream reference sites;

- d. Assessment of conservation status of aquatic fauna recorded, with focus on species that occur in potential impact sites, and significance of potential impact in a local and regional context;
 - e. Reporting of water quality data against ANZECC/ARMCANZ (2000) water quality guidelines for protection of aquatic ecosystems, and assessment of spatial variability in results.
- III. A technical report which details identified ecological values of the Munglinup River in the Project area will be submitted in July 2018.
- IV. Recommendations for management and/or any further surveys/monitoring required.

2 METHODS

2.1 Sites and Sampling Design

A total of six sites (i.e. pool habitats) were selected for sampling throughout the project area during April 2018 (Table 1, Figure 3). Sites were selected on the basis of having attributes including a deep pool (likely to hold water all year round), a diversity of habitats (i.e. riffles, backwaters, fringing riparian vegetation, benthos), and accessibility. The sampling design was separated into two groups (i.e. reaches); sites upstream of the project area (i.e. mining tenement) which serve as the 'reference' and the potentially impacted (or exposed) sites downstream of the project area. This design will characterise any spatial differences in water quality and aquatic fauna assemblages along Munglinup River, relative to the project area. It also establishes a baseline dataset which allows statistical testing for significant change from baseline condition (should it occur), and separation of mine-related response from stochastic variation (e.g. climate change). Sites within each reach of the Munglinup River include:

- Munglinup River Upstream (MRU) – three reference sites along a 4km reach of the Munglinup River upstream of the project area.
- Munglinup River Downstream (MRD) – three potential exposed sites along a 3.5km reach of the Munglinup River downstream of the project area.

Table 1. GPS coordinates for aquatic fauna and water quality sampling sites in the Munglinup River. Treatment type codes include R = reference, and PE = potential exposed sites.

Reach	Site Code	Date sampled	Treatment	Zone	Eastings	Northings
Munglinup River Upstream	MRU2	10/04/2018	R	51 H	301029	6273678
	MRU3	10/04/2018	R	51 H	300792	6274254
	MRU5	10/04/2018	R	51 H	299009	6277057
Munglinup River Downstream	MRD3	12/04/2018	PE	51 H	302266	6268683
	MRD4	11/04/2018	PE	51 H	302057	6269525
	MRD5	11/04/2018	PE	51 H	301853	6270782

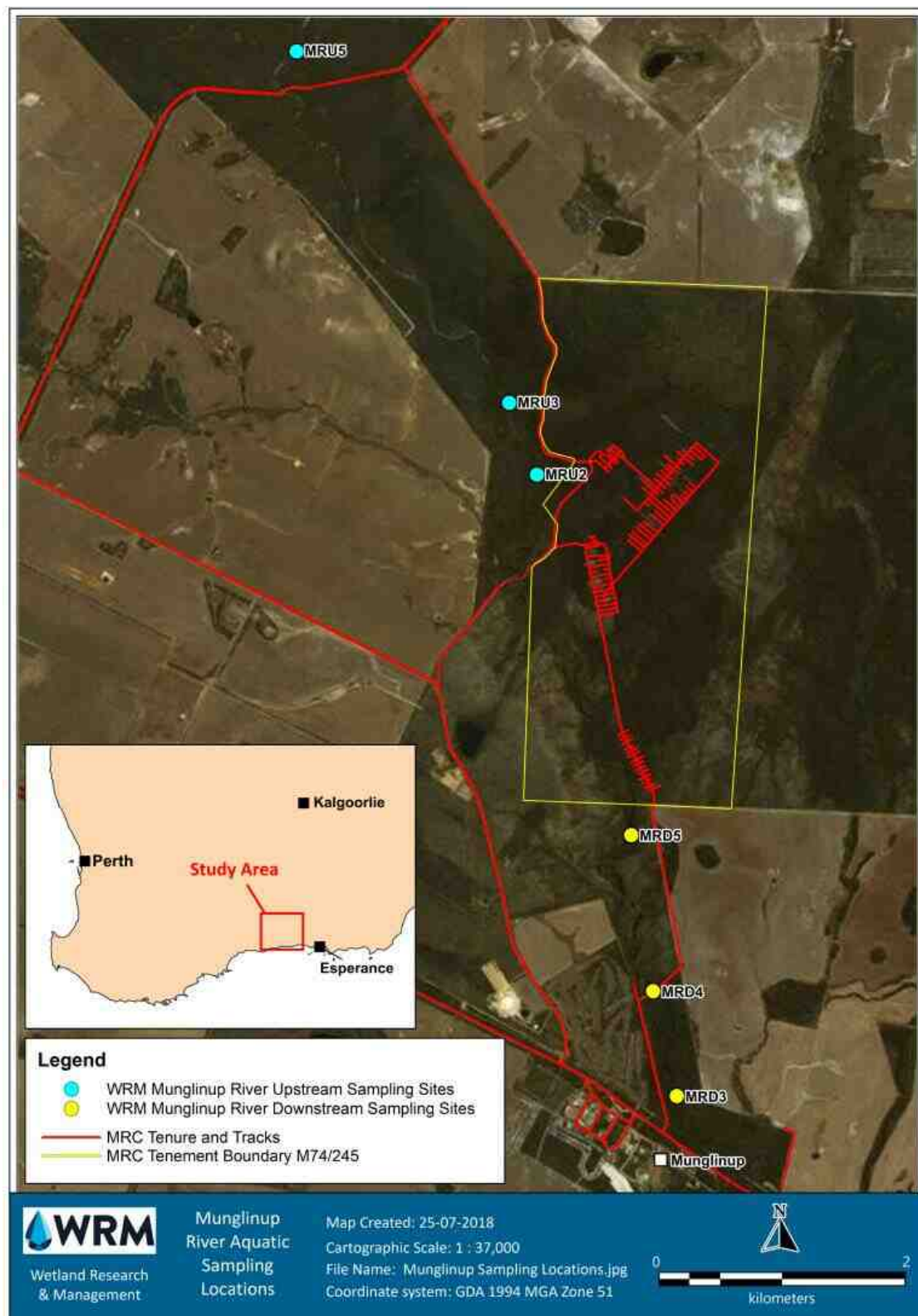


Figure 3. Location of aquatic fauna sampling sites on Munglinup River sampled during the April 2018 survey.

2.2 Field sampling

Baseline field surveys employ sampling design, methods and general approaches consistent with the following:

- EPA Technical Guidance, Terrestrial Fauna Surveys 2016
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000); and,
- EPA Technical Guidance, Sampling of short range endemic invertebrate fauna 2016
- Environmental Protection Authority 2018, Environmental Factor Guideline: Inland Waters EPA, Western Australia.

Aquatic fauna and water quality sampling by WRM is consistent with methodology used by government and Universities for similar surveys, including the Pilbara Biological Survey (i.e. Pinder *et al.* 2010), National Monitoring River Health Initiative (Halse *et al.* 2002) and the Department of Water and Environmental Regulation (DWER, White & Storer 2012).

Detailed methodologies for individual pool habitat ecological values are outlined below. Photographs of select methods are shown in Plate 1 and Plate 2.

2.2.1 Water quality

At each site a number of water quality variables were recorded *in situ* using portable Wissenschaftlich-Technische-Werkstätten (WTW) field meters, including electrical conductivity (EC, $\mu\text{S}/\text{cm}$), pH, dissolved oxygen (% and mg/L), and water temperature ($^{\circ}\text{C}$) (see Plate 1). Turbidity (NTU) could not be measured *in situ* due to technical issues with the Turbiquant 1100 IR portable turbidity meter, therefore, water samples were collected *in situ* for analysis of total suspended solids (TSS), as a measure of water clarity.

Water samples were collected for laboratory analyses of ionic composition, alkalinity, nutrients, and dissolved metals. Water samples for nutrients were filtered through 0.45 μm Millipore nitrocellulose filters, kept cool in an esky while in the field, and then frozen. Water samples for dissolved metals were taken using polyethylene gloves and filtered through nitric-acid washed 0.45 μm Millipore nitrocellulose filters and stored in acid washed Nalgene sample bottles to reduce incidental contamination. All water samples were delivered to the ChemCentre WA (a NATA accredited laboratory), upon return to Perth for laboratory analyses, whereby the limit of detection (LOD) was sufficiently low to allow comparison against the ANZECC/ARMCANZ (2000) water quality guidelines. Water quality variables measured are summarised in Table 2.



Plate 1. Field Sampling of *in situ* water quality using WTW meters.

Table 2. Water quality parameters measured and analysed from samples collected at each site.

Parameter	Unit	Parameter	Unit
pH	pH units	Aluminium (Al)	mg/L
Electrical conductivity	µS/cm	Arsenic (As)	mg/L
Dissolved oxygen	% saturation	Barium (Ba)	mg/L
Dissolved oxygen	mg/L	Boron (B)	mg/L
Redox potential	mV	Cadmium (Cd)	mg/L
Water temp	°C	Cobalt (Co)	mg/L
Maximum water depth	m	Chromium (Cr)	mg/L
Calcium (Ca)	mg/L	Copper (Cu)	mg/L
Chloride (Cl)	mg/L	Iron (Fe)	mg/L
Carbonate (CO ₃)	mg/L	Manganese (Mn)	mg/L
Hydrogen carbonate (HCO ₃)	mg/L	Nickel (Ni)	mg/L
Potassium (K)	mg/L	Lead (Pb)	mg/L
Magnesium (Mg)	mg/L	Selenium (Se)	mg/L
Sulphate (SO ₄)	mg/L	Uranium (U)	mg/L
Sodium (Na)	mg/L	Vanadium (V)	mg/L
Ammonia (NH ₄)	mg/L	Zinc (Zn)	mg/L
Nitrate (NO ₃)	mg/L	Total suspended solids	mg/L
Total nitrogen	mg/L		
Total phosphorus	mg/L		

2.2.2 Habitat characteristics

Qualitative visual observations of submerged mineral substrate composition and in-stream habitat were recorded from each site. Habitat assessments are based on AusRivAS protocol, a standardised rapid method for the collection of geomorphological, physical habitat and riparian data (Parsons *et al.* 2002, Parsons *et al.* 2004). WRM has specific worksheets for this task to ensure habitat recordings are as comparable as possible between sites and over time. Habitat characteristics recorded included proportional (%) cover by inorganic sediment, submerged macrophyte, floating macrophyte, emergent macrophyte, benthic algae, large woody debris, detritus, roots and trailing vegetation. Details of substrate composition recorded included percent cover by bedrock, boulders, cobbles, pebbles, gravel, sand, silt and clay.

2.2.3 Macroinvertebrates

Macroinvertebrates (*i.e.* fauna retained by a 250 µm aperture mesh) 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 for 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).

Sampling was conducted with a 250µm mesh Freshwater Biological Association (FBA) d-frame pond net to selectively collect the macroinvertebrate fauna. All meso-habitats were sampled at each site (*i.e.* fringing riparian vegetation, benthos, large woody debris, open water etc.) with the aim of maximising the number of invertebrate species recorded. Each sample was washed through a 250µm sieve to remove fine sediment. Leaf litter and other debris were carefully washed to remove attached animals, and then discarded, and all retained fauna were 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 possible level (generally genus or species level) and enumerated to log₁₀ scale abundance classes (i.e. 1 = 1 individual, 2 = 2 – 10 individuals, 3 = 11 – 100 individuals, 4 = 101–1000 individuals, 5 = >1000, and so on). In-house expertise was used to identify invertebrate taxa using available published keys and through reference to the established voucher collections held by WRM.

2.2.4 Fish and crayfish

Fish and crayfish were collected using a number of integrated sampling methods to effectively collect as many species/individuals as possible. Sampling methods included use of a beach seine, gill nets, fyke nets and box traps. Sampling methods were employed throughout the main body of each pool, including deep open water and shallow bank margins.

Two fyke nets comprising a double 10m wing and a 5m hooped net were set overnight at each site.



Plate 2. Two fyke nets set back to back to capture fish moving upstream and downstream at site MRU5.

The fyke nets were deployed in such a way as to create a barrier for fish travelling upstream or downstream and funnel them into the net, where possible (Plate 2).

Light-weight fine-mesh gill nets (10 m net, with a 2 m drop, using 10 mm, 13 mm, 19 mm and 25 mm stretched mesh) were used and set in deeper water for the duration of sampling at each site (approx. 20 mins).

Smaller species and juveniles were sampled by beach seine (10 m net, with a 2 m drop and 6 mm mesh) in shallow areas where there was little vegetation or

large woody debris. The net was deployed by walking one end out from the bank and then dragging the seine for approximately 10 m through shallow areas where there was little vegetation or large woody debris. Generally, two seines were conducted at each site (where habitat allowed) to maximise the number of individuals/species caught.

Two large mesh box traps baited with a mixture of cat food and chicken pellets were deployed overnight (12hr set) at each site for crayfish.

All fish were identified in the field to species-level where possible, measured (standard length mm) and released alive. Fish nomenclature followed that of Allen *et al.* (2002). Fish measurements were recorded to provide information on the size structure, breeding and recruitment of populations.

2.2.5 Rakali (water rat)

The rakali (or water rat) *Hydromys chrysogaster* is the only semi-aquatic mammal to occur in the south west of Western Australia. Due to the species' localised decline in Western Australia (particularly in the southwest), rakali have been included on the State Priority Fauna list and are, therefore, considered a species at risk and in need of monitoring (i.e. Priority 4 species; DBCA).

Motion sensor trail cameras were used in combination with an attractant (bait) to document presence of the Rakali at riverine pools. One motion sensor trail camera was deployed overnight (12-hr set) at each site during the survey. An active system was applied using a standard mammal mix of bait to entice animals in front of the camera trap to obtain a series of pictures. Cameras were set on high sensitivity and set to take a burst of three images with no delay period. Visual surveys were conducted along the shoreline of each pool, with cameras set at locations where high animal traffic or possible feeding middens were observed. Visual surveys conducted at each study site noted any indirect evidence of *H. chrysogaster* presence (i.e. feeding middens, footprints etc.).

2.2.6 Other vertebrate fauna

Other vertebrates such as frogs (and tadpoles depending on stage of development), water birds and turtles were also recorded during sampling, though were not specifically targeted as part of the scope of this survey. Water birds were noted from opportunistic sightings and detected on the motion sensitive trail cameras, with identifications referenced using *The Field Guide to the Birds of Australia* (9th edition Pizzey and Knight 2012).

Opportunistic surveys of adult frogs were conducted by comparing any calls heard on the day of sampling with audio files for south-west species. Frog calling is generally restricted to the breeding season (winter/spring) and when conditions (temperature, recent rainfall) are conducive to calling.

2.3 Data analysis

2.3.1 Assessment of conservation significance of fauna

The conservation significance of all aquatic fauna recorded was assessed using established lists of conservation fauna. For invertebrates, reference was made to the IUCN Redlist of Threatened Species (IUCN 2016) and DBCA Threatened and Priority Fauna List (DBCA 2015). Fish species were compared against the IUCN Redlist of Threatened Species (IUCN 2016), DBCA Threatened and Priority Fauna Rankings (DCBA 2015), and Australian Society for Fish Biology Conservation List (ASFB 2001). Reference was also made to other South Coast aquatic fauna studies, as well as databases such as The Australian Faunal Directory, The Australian National Insect Collection Database and in-house WRM database for distribution and occurrence information for all aquatic species.

2.3.2 Comparison to ANZECC/ARMCANZ trigger values

The ANZECC/ARMCANZ (2000) default guidelines provide conservative trigger values (TVs) for comparison with water quality measurements in order to identify potential hazards to aquatic ecosystems and minimize the overall environmental risk. The guidelines use a reference database of physio-chemical readings sampled from sites across a range of geographical and environmental habitats for the whole of Australia.

Historical water quality data available for the Munglinup River indicates the system is naturally salinised (i.e. groundwater inputs), with land-use practice in the headwater catchment likely resulting in secondary salinisation as well (WRM 2018). Subsequently, application of the ANZECC/ARMCANZ (2000) default guidelines for south-west Australia is problematic, as the majority of rivers and creeklines in the region are considered fresh. Therefore, default guidelines for the south-central Australia were also applied for comparison of reference water quality condition.

In cases such as the Munglinup River, which demonstrate a high degree of variability in physical and chemical stressors (i.e. EC, nitrogen nutrients) relative to the default guidelines it is recommended long term ongoing water quality monitoring is undertaken to provide a more robust baseline for the system and to develop site specific (i.e. local) trigger values (SSTVs).

2.3.3 Univariate analysis

Water quality, invertebrate and fish taxa richness and abundance data measured in April 2018 were plotted as histograms to investigate patterns at pool habitats within and between reach. Water quality data were compared to default ANZECC/ARMCANZ (2000) guidelines. For all analyses, where water quality data were reported as 'less than detection limit', and the detection level was sufficiently close to the default TV, a nominal value of half the reported detection limit was used to calculate the summary statistics.

Univariate statistics were performed using IBM SPSS software (Version 22.0 for Windows). Analysis of variance (ANOVA) was used to test for significant differences in total macroinvertebrate species richness upstream (reference) and downstream (potentially exposed) of the project area, with sites within each reach used as replicates.

2.3.4 Multivariate analysis

All multivariate analysis of community structure data (macroinvertebrates) was performed using the PRIMER package v7 (Plymouth **R**outines in **M**ultivariate **E**cological Research; Clarke and Gorley 2015). In addition, all multivariate analyses were done on the basis of Bray- Curtis dissimilarities calculated from log₁₀ abundance data. Analyses applied to the data included some or all of the following:

- Describing pattern amongst the fauna assemblage data using ordination techniques based on Bray-Curtis similarity matrices (Bray and Curtis 1957). Ordination of data was done by Multi-Dimensional Scaling (MDS) (Clarke and Warwick 2001). Ordinations were depicted as two-dimensional plots based on the site by site similarity matrices.
- For any groups found in step 1 or selected *a priori* (i.e. reach), Analysis of Similarity (ANOSIM) – effectively an analogue of the univariate ANOVA – was conducted to determine if locations were significantly different from one another. The ANOSIM test statistic reflects the observed differences between groups compared with the differences amongst replicates (sites) within each group. The test is based upon rank similarities between samples in the underlying Bray-Curtis similarity matrix. The analysis presents the significance of the overall test (Significance level of sample statistic).
- The SIMPER routine was used to examine which taxa were contributing to the separation of any groups that were found to be separated in ordination analysis.

3 RESULTS

3.1 Habitat Characteristics

3.1.1 Substrate characteristics

The structure and diversity of substrates are known to influence macroinvertebrate assemblages, with greater substrate complexity generally equating to higher species richness and abundance (Erman and Erman 1984, O'Connor 1991, Jähnig and Lorenz 2008). Inorganic substrate at Munglinup River was typically dominated by gravel, sand and silt (Appendix 3). Upstream reference site MRU5 was the only site with bedrock or boulders. Mineral substrate diversity was typically homogeneous upstream and downstream of the project area, ranging from 4 size classes (at MRD3, MRD4 and MRU3) to 6 size classes (at MRU5 and MRD5).

3.1.2 Instream habitat characteristics

Diversity of in-stream habitat has a crucial role in influencing the richness, abundance and assemblage structure of aquatic fauna, with greater habitat complexity (such as aquatic macrophyte, detritus and large woody debris) generally leading to increased species diversity and abundance (Erman and Erman 1984, Heino 2000). In-stream habitat at Munglinup River was typically dominated by large woody debris, trailing vegetation, detritus (leaf litter), and mineral substrate (Appendix 3). Similar to substrate characteristics, diversity of in-stream habitat was typically homogenous upstream and downstream of the project area, ranging from 4 habitat types (at MRU2, MRD5, MRD3) to 5 habitat types (at MRU5, MRU3, MRD4). Of note, was the lack of aquatic macrophytes at nearly all sampling sites (i.e. emergent, submerged or floating types), with only a small percent cover (20%) of submerged vegetation, *Ruppia* sp. (aquatic grass) recorded at MRD4.

3.2 Water quality

3.2.1 General

Raw data for spot measurements of water quality, made in conjunction with aquatic fauna sampling, are provided in Table 3 and Table 4. Surface waters of the project area were generally characterised as saline² (23,400 - 35,800 $\mu\text{S}/\text{cm}$), alkaline pH (8.1 – 8.4), and well oxygenated (79.9% - 122.5% DO). Water clarity was generally high, with total suspended solids concentration below 11 mg/L at all sites. Concentrations of heavy metals were generally low, and below the limit of reporting (LOR) for most metals at the majority of sites (Table 3 and Table 4).

There were few obvious longitudinal gradients or upstream / downstream patterns in water quality along Munglinup River. However, there was evidence of spatial variability in electrical conductivity upstream and downstream of the project area. It is unknown if the reverse salinity gradient reflects clearing in the headwater catchment, intrusion of groundwater of lower EC in the downstream reach, or a combination of both.

² Fresh defined as < 1,500 $\mu\text{S}/\text{cm}$; brackish = 1,500 – 4,500 $\mu\text{S}/\text{cm}$; saline = 4,500 - 50,000 $\mu\text{S}/\text{cm}$; hypersaline > 50,000 $\mu\text{S}/\text{cm}$ (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 $\mu\text{S}/\text{cm}$ as recommended by ANZECC/ARMCANZ (2000).

3.2.2 Comparison against default guidelines

Water quality data were compared against the ANZECC/ARMCANZ (2000) default guideline (trigger value) range for slightly-moderately disturbed freshwater lowland rivers in South West (SW) and South Central (SC) regions of Australia (see Appendix 2). Default TVs for physical and chemical stressors are considered to provide a level of protection of 95% of species. TVs for toxicants (i.e. dissolved metals) were compared at alternative levels of protection (i.e. 95%, 90% species protection) which is considered appropriate considering historical land use in proximity to the Munglinup River.

Concentrations of the majority of water quality analytes across the project area were generally below/within default ANZECC/ARMCANZ water quality guidelines (Table 3, Table 4). Exceedances of ANZECC/ARMCANZ (2000) default 95% TVs were recorded for DO, EC, pH, some nutrients (N-total, N-NO_x, P-total) and dissolved metals (dB) (Table 3, Table 4). These are discussed in the following subsections.

pH

All pH values were considered alkaline and ranged from 8.09 (MRD3) to 8.62 (MRU5) (Figure 4). All values fell outside the default TV range for SW Australia (pH 6.5 - 8.0), but were within the range for SC Australia (pH 6.5-9). pH is a measure, on a logarithmic scale (0-14), of the concentration of hydrogen ions making the nature of a body of water acidic or basic (alkaline). At a lower pH (increasing acidity) heavy metals become increasingly soluble in water and can concentrate to levels that are potentially toxic to aquatic life. Alternately higher pH (increasingly basic) levels cause dissolved ammonium (NH₄⁺) to become chemical ammonia (NH₃) which is also highly toxic. The majority of aquatic organisms survive in a pH range of 6.5-9.0, though some have adapted to survive in water with pH levels outside of this range (Osmond 1995).

Dissolved oxygen

Daytime dissolved oxygen (DO) saturation was typically good across all sites and ranged from 79.9% saturation (MRD3) to 122.5% saturation (MRU3). DO saturation at MRD3 (79.9%) was just below the lower limit TV (80% saturation), whilst MRU3 was slightly higher than the upper limit TV (120% saturation) (Figure 4). All other sites were within the recommended range for DO saturation (Figure 4). DO generally exhibits a diurnal pattern, reflecting the flux between aquatic respiration and photosynthesis, so spot measurements of DO such as these provide only a snapshot of typical daily conditions, which may vary considerably depending on the time of measurement.

Electrical conductivity

Electrical conductivity (EC) far exceeded the default TV for the SW Australia (300 µS/cm) and SC Australia (5000 µS/cm) freshwater systems at all Munglinup River sites. Conductivity ranged from 23,400 µS/cm (MRD3) to 35,800 µS/cm (MRU5) which constitute “saline” conditions (Figure 4). ANZECC/ARMCANZ (2000) acknowledge that the default TV for EC may not be representative of local background levels in all areas of Australia, and that higher conductivity values will occur during summer/dry season when water levels are reduced due to evaporation. In such instances, ANZECC/ARMCANZ (2000) recommend developing SSTVs relevant to local conditions.

Of note, was a clear spatial / longitudinal trend in EC levels along the Munglinup River. A reverse salinity trend was observed with EC readings significantly higher in the upper catchment (mean 33,800 µS/cm), compared to the reach downstream (mean 26,433 µS/cm) of the mining tenement (One-way ANOVA df = 1, F = 9.597 *p* = .036). This has been documented for nearby systems, the Oldfield River and Jerdacuttup River (WRC 2004).

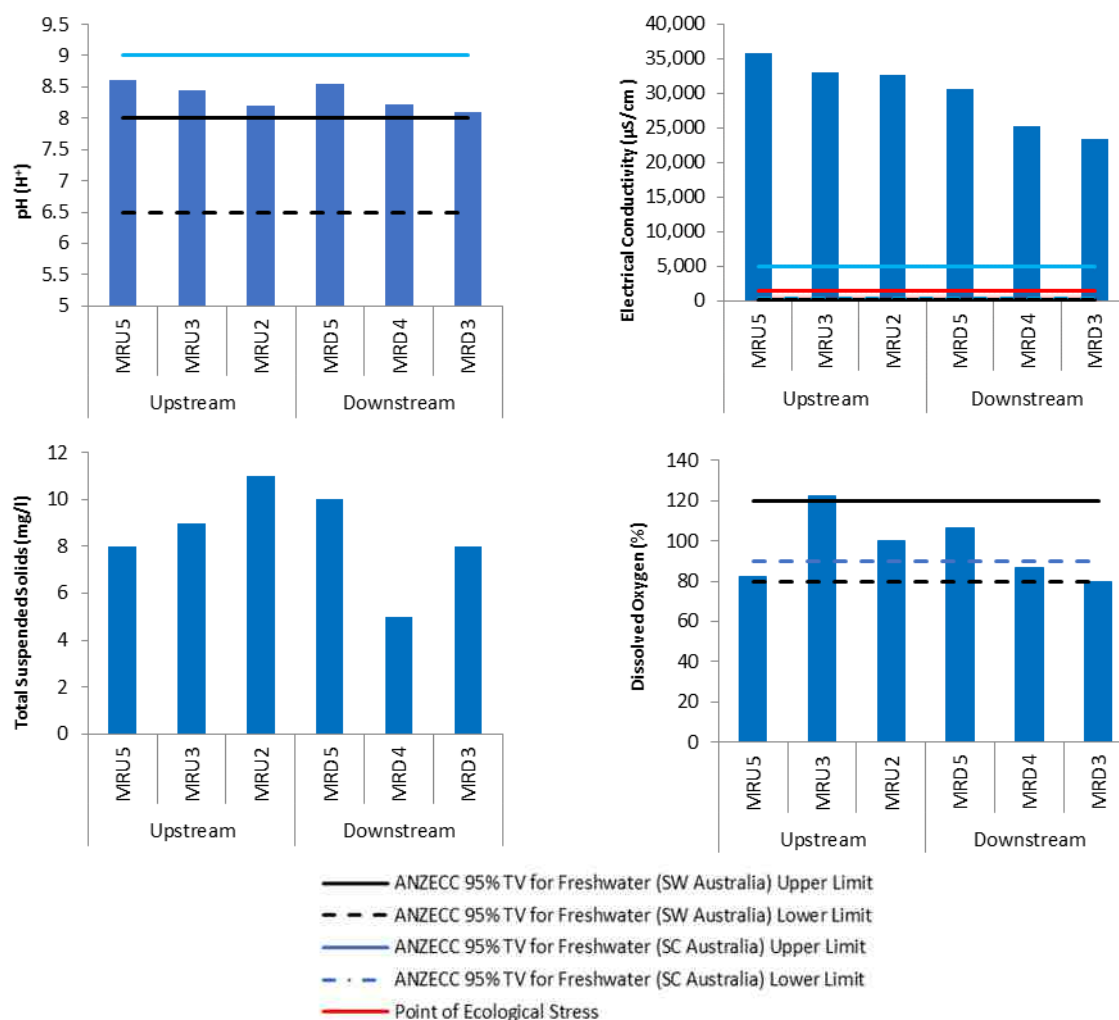


Figure 4. Comparison of pH, EC, TSS and DO amongst all sites sampled along the Munglinup River. South-West (black) and South Central (Blue) ANZECC/ARMCANZ (2000) default 95% species protection level TVs are indicated for all parameters, where available, with lower limits of the TVs (dashed line) shown for pH and DO and EC.

Nutrients

There were a number of exceedances of default TVs for protection against nitrogen enrichment, suggesting some pre-existing enrichment at pools within the survey area. Total Nitrogen (N-total) levels exceeded the SC Australia TV (1.0 mg/L) at all sites, and the SW Australia TV (1.2 mg/L) at three sites (MRU5, MRU2 and MRD3). N-NO_x levels were mostly at the level of detection (LOD) and below both the SW and SC eutrophication TVs (0.1 mg/L and 0.15 mg/L, respectively) at all pool habitats (Figure 5). Total phosphorus (P-total) levels were below respective SW and SC TVs (0.065 mg/L and 0.1 mg/L, respectively) for all six sites sampled (Figure 5).

Nitrate (NO₃) levels were mostly below the limit of detection (<0.01 mg/L) with all sites below the 95% TV (0.7 mg/L NO₃) for protection against nitrate toxicity (Figure 5, Table 4). It should be noted, that the ANZECC/ARMCANZ (2000) 95% TV for NO₃ (as a toxicant) is currently under review, as it is considered too conservative. The revised TV for NO₃ (95% species protection) is likely to be around 8.8 – 11 mg/L NO₃ (equivalent to 2 - 2.5 mg/L N-NO₃) (R. van Dam, eriss, pers. com.). The new TV 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-NO₃ (~13 mg/L NO₃) for freshwaters (CCME 2014).

It must also be noted that one-off spot measurement of nutrients is rarely a good indicator of eutrophication because of the dynamic and rapid nature of nutrient cycling within aquatic ecosystem foodwebs. Nutrient enrichment in aquatic systems can lead to increased algal growth and cyanobacterial blooms (ANZECC/ARMCANZ 2000), which may become more apparent as water levels recede, nutrients evapo-concentrate, and water temperature increases. While phytoplankton are a natural part of aquatic ecosystems, nuisance blooms caused by excess nutrients can result in adverse impacts to the aquatic ecosystem through toxic effects, reductions in dissolved oxygen and changes in biodiversity. Highly eutrophic waters tend to support high abundances of pollution-tolerant species, but few rare taxa, and overall, a less complex community structure.

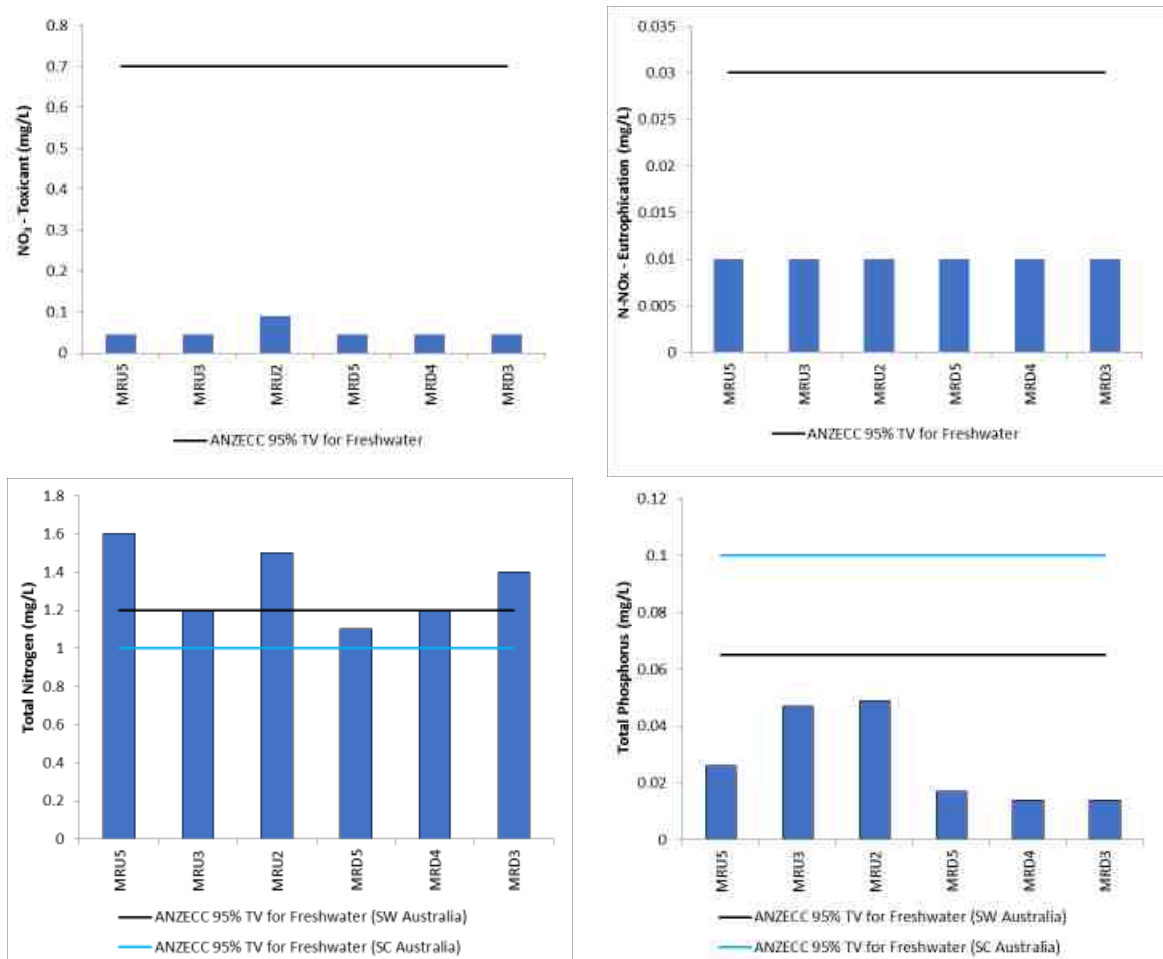


Figure 5. Comparison of nutrient concentrations (N-NO_x, NO₃, N-total, P-total) amongst sites on the Munglinup River. ANZECC/ARMCANZ (2000) South-West (black) and South Central (Blue) species protection level TVs are provided.

Metals

A number of dissolved metals (i.e. dCd, dCr, dCo, dNi, dPb, dZn) were recorded in concentrations below their respective limit of detection (Table 4). However, dissolved boron was consistently recorded above the ANZECC/ARMCANZ (2000) 95% species protection TV (0.37 mg/L) at all Munglinup River sites (Figure 6, Table 4). Boron is a naturally occurring element present in groundwater resulting primarily from the leaching processes from rocks and soils, particularly marine sediments, containing borates and borosilicates. It is generally released very slowly and at low concentrations into the environment by natural weathering processes.

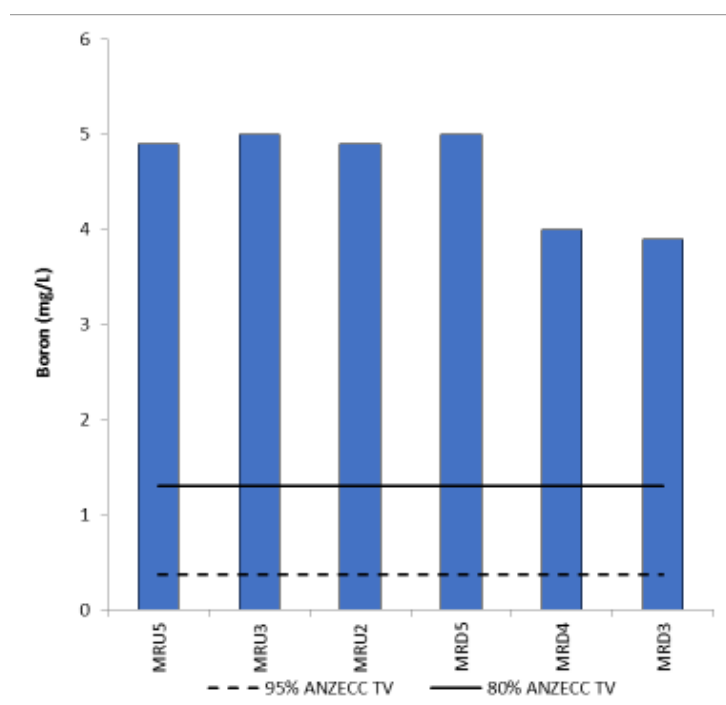


Figure 6. Total Boron (mg/L) in comparison to the ANZECC/ARMCANZ (2000) default TV's for 95% species protection (dashed line) and 80% species protection (black line).

Table 3. Water quality variables recorded from sampling sites on Munglinup River in April 2018, compared to default ANZECC/ARMCANZ (2000) TV's of physical and chemical stressors for South-West (SW) and South Central (SC) Australia for slightly disturbed ecosystems (95% of species protection). Exceedances shown as follows:

- stressors exceed default 95% SW TV
- stressors exceed default 95% SC TV
- stressors exceed default 95% SW TV and 95% SC TV

Analyte	LOR	SW TV's	SC TV's	Upstream			Downstream		
		95%	95%	MRU5	MRU3	MRU2	MRD5	MRD4	MRD3
DO Field (% Saturation)	0.1	80-120	90	82.5	122.5	99.9	106.4	87	79.9
Econd Field (µS/m)	0.2	120-300	100-5000	35800	33000	32600	30600	25300	23400
N-total (mg/L)	0.01	1.2	1	1.6	1.2	1.5	1.1	1.2	1.4
P-total (mg/L)	0.005	0.065	0.1	0.026	0.047	0.049	0.017	0.014	0.014
Temp (°C) (in situ)	0.1	-	-	18.8	20.1	19.4	19.1	20	19.8
pH (H+) (in situ)	0.1	6.5-8	6.5-9	8.4	8.2	8	8.3	8.1	8.1

Table 4. Toxicant water quality variables recorded from sampling sites on Munglinup River in April 2018, compared to default ANZECC/ARMCANZ (2000) TVs for alternative levels (95%, 90%) of species protection. Exceedances shown as follows;

■ toxicants exceed default 95% TV

■ toxicants exceed default 90% TV

Analyte	LOR	ANZECC TV's		Upstream			Downstream		
		95%	90%	MRU5	MRU3	MRU2	MRD5	MRD4	MRD3
Al (mg/L)	0.005	0.0055	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Alkaline (mg/L)	1	-	-	279	336	324	291	235	244
As (mg/L)	0.001	0.013	0.042	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
dB (mg/L)	0.02	0.37	0.68	4.9	5	4.9	5	4	3.9
dBa (mg/L)	0.002	-	-	0.092	0.085	0.085	0.087	0.076	0.078
CO ₃ (mg/L)	1	-	-	16	<1	<1	1	<1	<1
Ca (mg/L)	0.1	-	-	244	207	203	193	162	165
dCd (mg/L)	0.0001	0.0002	0.0004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cl (mg/L)	1	-	-	12000	11200	10800	10200	8350	7950
dCo (mg/L)	0.001	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
dCr (mg/L)	0.005	0.001	0.006	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
dCu (mg/L)	0.001	0.0014	0.0018	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
dFe (mg/L)	0.005	-	-	0.021	0.019	0.081	0.017	0.05	0.1
HCO ₃ (mg/L)	1	-	-	308	409	394	352	287	297
Hardness (mg/L)	1	-	-	3900	3400	3400	3100	2500	2500
K (mg/L)	0.1	-	-	159	149	147	140	112	109
Mg (mg/L)	0.1	-	-	800	699	701	636	513	497
dMn (mg/L)	0.01	1.9	2.5	0.069	0.2	0.18	0.16	0.17	0.2
dMo (mg/L)	0.01	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Na (mg/L)	0.1	-	-	7440	7010	6930	6760	4960	4850
N-NH ₃ (mg/L)	0.01	0.9	-	<0.01	<0.01	0.04	0.01	<0.01	<0.01
N-NO ₂ (mg/L)	0.01	-	-	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
N-NO ₃ (mg/L)	0.01	0.7	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
N-NO _x (mg/L)	0.01	0.03	-	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
dNi (mg/L)	0.01	0.011	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
OH (mg/L)	1	-	-	<1	<1	<1	<1	<1	<1
dPb (mg/L)	0.001	0.0034	0.0056	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
S (mg/L)	0.1	-	-	660	620	610	580	460	450
S-SO ₄ (mg/L)	0.1	-	-	1980	1850	1820	1740	1380	1330
Se-total (mg/L)	0.01	0.011	0.018	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Si (mg/L)	0.05	-	-	0.39	3.2	2.7	3.7	3.6	3.2
Sr (mg/L)	0.002	-	-	2.8	2.4	2.3	2.4	2	2
TDS-calc (mg/L)	5	-	-	20000	19000	18000	17000	14000	13000
TSS (mg/L)	1	-	-	8	9	11	10	5	8
dU (mg/L)	0.001	-	-	<0.0010	<0.0010	<0.0010	0.0012	<0.0010	<0.0010
dV (mg/L)	0.001	-	-	0.0015	0.0037	0.0015	0.0028	0.0028	0.0021
dZn (mg/L)	0.01	0.008	0.015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

3.3 Macroinvertebrate fauna

3.3.1 Taxonomic composition and species richness

A total of 46 macroinvertebrate taxa were recorded from the project area during sampling in April 2018. A complete list of taxa, as well as their relative abundance is given in Appendix 4. Of these 46 taxa, 36 taxa were recorded upstream of the project area, and 39 taxa were recorded downstream of the project area.

The taxonomic listing also includes larval and pupal stages for groups such as Diptera (two-winged flies) and Coleoptera (aquatic beetles). Current taxonomy is not sufficiently developed to allow identification of all larval and pupal stages of all members of these groups to species level. In many instances, it is likely that these stages are the same species as the larval/adult stages recorded from the same location. However, because this could not be definitively determined, they were treated as separate taxa. In any case, different life stages of macroinvertebrates will often have different functional roles in the ecosystem, providing good functional reason to treat them as separate taxa.

Across all sites, the composition of macroinvertebrates was dominated by Insecta, which accounted for 61% of all taxa recorded (Table 5). Of the insects, Coleoptera (aquatic beetles; 29% of insects) and Diptera (flies and mosquitoes; 54% of insects) were particularly well represented, followed by Hemiptera (true bugs; 7% of insects) and Trichoptera (caddisfly larvae; 7% of insects). Odonata (dragonfly and damselfly), Plecoptera (Stonefly) and Ephemeroptera (Mayfly) were all absent from the Insect assemblages. These fauna groups are often considered sensitive receptors of freshwater environments, and their absence suggests background salinity likely exceeds species tolerances. The most numerous taxa (single species or representing a mixture of several species) in benthic samples varied slightly among/within reach, but, across all sites these included two Chironomid taxa (non-biting midges) *Dicortendipes* spp. and *Cladotanytarsus* spp., Chironomid pupae, Chiltoniidae spp. (an amphipod), a micro-crustacean Calanoida spp and an aquatic gastropod *Coxiella* sp.

Macroinvertebrate diversity varied in pool habitats between and within reaches (Figure 7). Taxa richness was highest at upstream site MRU5 (30 taxa), and lowest at upstream site MRU2 (18 taxa) (Figure 7). Importantly, there was no statistical difference in the mean taxa richness upstream (24 taxa) and downstream (22 taxa) of the project area (one-way ANOVA $df=1$, $F = 0.481$, $p = 0.526$).

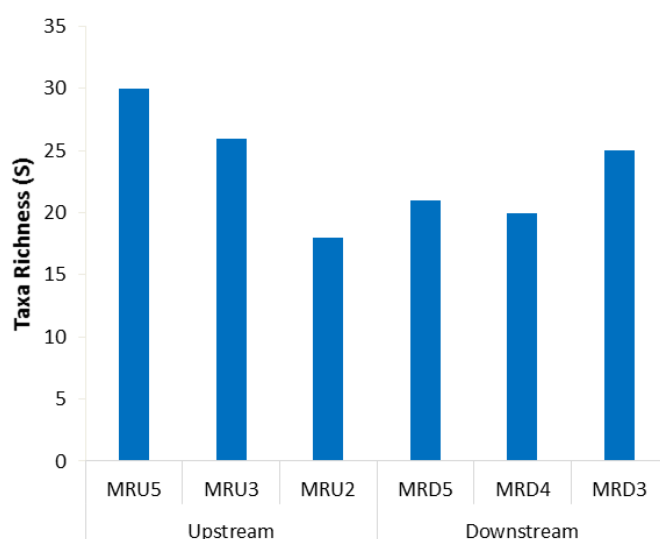


Figure 7. Taxa richness (S = number of species) recorded from Munglinup River April 2018

Table 5. Taxa richness (S) and percentage composition of major macroinvertebrate fauna groups and major insect orders from across the study area (all sites combined), and each of the individual sites.

	All sites		MRD3		MRD4		MRD5		MRU2		MRU3		MRU5	
Groups	S	%	S	%	S	%	S	%	S	%	S	%	S	%
Insecta	28	61%	12	48%	13	65%	13	62%	12	67%	16	62%	18	60%
Crustacea	7	15%	5	20%	3	15%	4	19%	3	17%	5	19%	4	13%
Oligochaeta	3	7%	2	8%	2	10%	3	14%	0	0%	1	4%	2	7%
Acarina	4	9%	3	12%	1	5%	0	0%	1	6%	2	8%	2	7%
Mollusca	1	2%	1	4%	1	5%	1	5%	1	6%	1	4%	1	3%
Others*	3	7%	2	8%	0	0%	0	0%	1	6%	1	4%	3	10%
Insecta														
Coleoptera	8	29%	4	57%	3	50%	1	25%	2	33%	6	86%	5	50%
Diptera	15	54%	1	14%	1	17%	1	25%	1	17%	1	14%	1	10%
Odonata	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Hemiptera	2	7%	1	14%	1	17%	1	25%	1	17%	0	0%	1	10%
Trichoptera	2	7%	1	14%	1	17%	1	25%	2	33%	0	0%	2	20%
Ephemeroptera	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Thysanoptera	1	4%	0	0%	0	0%	0	0%	0	0%	0	0%	1	10%

* Others include Nematoda (roundworms), Collembola (springtails)

3.3.2 Ephemeroptera Plecoptera Trichoptera (EPT) taxa richness

The number of EPT taxa is commonly used as an indicator of ecosystem health. EPT refers to three orders of aquatic insects, Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), whose members in general tend to be more sensitive to water quality than other orders of aquatic macroinvertebrates (Marchant *et al.* 1995, Marshall *et al.* 2001). The EPT metric originated in the United States during the 1970s (Eaton and Lenat 1991, Lenat and Penrose 1996) and is now widely employed in many countries. In Australia it has been adopted as one of the metrics for the National River Health Program. Disturbed and degraded rivers typically have fewer EPT taxa than pristine rivers. Trend analysis has also shown EPT taxa richness to have an advantage over total taxa richness for monitoring ecosystem change, as EPT is typically “more stable and hence more predictable” (Lenat and Penrose 1996).

Application of the EPT metric to naturally salinised systems is problematic, as background water quality typically exceeds species stressor tolerances (i.e. osmotic stress). Although a few select species of Trichoptera can inhabit saline environments, diversity of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) typically declines with increasing salinity (Kefford *et al.* 2011).

Ephemeroptera and Plecoptera appear to have never evolved salinity tolerance despite being among the oldest insects (Kefford *et al.* 2012). As such, the EPT metric could not be used as a measure of ecosystem health in the current study.

3.3.3 Ecological Value and Conservation significance of macroinvertebrates

No state or federal listed macroinvertebrate species of conservation significance were identified from sampling along the Munglinup River in April 2018. The majority of macroinvertebrate taxa recorded from Munglinup River pool habitats were considered salt-tolerant, common, and ubiquitous species with distributions extending across Southern Australia. Several cosmopolitan species found in the Munglinup River have been used in the past as indicators of river health for the south eastern aquatic bioregion (Cook *et al.* 2008). These include salt tolerant species *Coxiella* sp. (aquatic snail) and *Symphitoneuria wheeleri* (caddisfly larvae) which were common both upstream and downstream of the project area.



Plate 3. *Coxiella* Sp. found at all sites on the Munglinup River

Symphitoneuria wheeleri was the only Trichoptera species identified during the survey and was found at multiple sites both upstream and downstream of the project area (Plate 4). This species is known to be closely associated with saline waters (St Clair 2000) and is an indicative species of most rivers in the Eastern South Coast bioregion (Stewart 2009, Cook et. Al 2008).

Coxiella (Plate 3) is a genus of halophilic (salt thriving) gastropod snail found commonly in saline lakes and coastal waterways on the south-eastern coast of Western Australia, inland salt lakes and throughout Tasmania. In addition to salt tolerance *Coxiella* is tolerant of high temperatures, low dissolved oxygen and desiccation (Williams 1991).



Plate 4. *Symphitoneuria wheeleri*, a common eastern south coast species, found at sites both upstream and downstream on Munglinup River.



Plate 5. *Haloniscus searlei*, a saline tolerant isopod species, found at MRD3

In addition to the indicative species, *Haloniscus searlei*, a species of isopod native to Western and Southern Australia, was also collected (Plate 5). While not extensively studied it has been found in areas of highly fluctuating salinity and habitat ephemerality. Mostly found in inland lakes, the species has been noted for its ability to survive out of water for short periods and is able to survive in environments of high physiological stress and physico-chemical instability (Williams 1983). Only a single individual of this species

was found during the study at the site MRD3.

Palaemonetes australis (glass shrimp) was found at all three downstream sites (MRD3, MRD4, MRD5) but was absent upstream. *Palaemonetes australis* is a euryhaline (salinity tolerant) shrimp that is widespread and endemic to Western Australia. They have been used in multiple studies as a bio-indicator of ecological health as shrimp occupy a unique environmental niche as an opportunistic omnivore and are known to be sensitive to heavy metal increases in polluted systems (Beatty & Morgan 2010, Webb D 2011).

3.3.4 Patterns in macroinvertebrate community composition

Macroinvertebrate species composition varied within and between reaches (Table 6, Figure 8). Multivariate analysis (ANOSIM) indicate separation between reach was moderate, but not significant (R statistic = 0.481, $p = 0.1$). This is likely due to the fact variation in assemblage composition within reach (average within group similarity; MRU 59% and MRD 57%) appears comparable to variation between reach (average similarity MRU vs MRD 51%). The small sample size ($n=3$) for each reach also

limits the ability of ANOSIM to detect a significant difference if it existed. The nMDS plot, based on Bray-Curtis similarities, and shadeplot reflect the results shown in the ANOSIM (Figure 8, Figure 9). Three taxa co-dominated all samples (upstream and downstream of the project area) and contributed at least 6% to average similarity between sites, including the copepod *Calanoida* spp., amphipod *Chiltoniidae* spp., and the non-biting midge *Dicortendipes* spp. Tight clustering of sites MRU3 and MRU5 in ordination space (assemblages 68% similar) is likely a function of salinity (highest EC readings in the study).

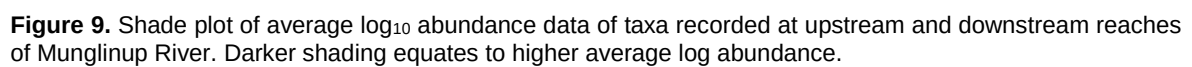
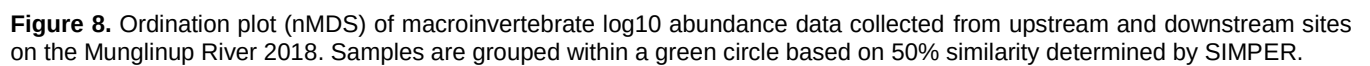
Although assemblages were not significantly different between reach, there were some notable differences in species composition upstream and downstream of the project area (Figure 9). These include:

- The glass shrimp *Palaemonetes australis* and aquatic worm *Enchytraeidae* spp. were recorded in high abundance at all downstream sites (reach MRD), but were absent upstream of the project area. It is unknown if this is a function of observed salinity trends.
- Ten species were recorded exclusively in the upstream reach of the Munglinup River including the non-biting midge *Orthocladinae* sp. (V46), the water scavenger beetles *Helochaes* sp. and *Berosus* sp. (larvae), diving beetle larvae *Platynectes* sp., velvet water bug *Hebrus axillaris*, water mite *Oribatida* sp., springtail *Entomobryodea* sp., immature caddisfly larvae *Leptoceridae* sp., copepods *Cyclopoida* spp. and thrips *Thysanoptera* spp.
- Seven species were recorded exclusively in the downstream reach of the Munglinup River including the midge fly larvae *Kiefferulus* spp., black fly larvae *Scatopsidae* spp., the segmented worm *Enchytraeidae* spp., water mite *Pezidae* sp., diving beetle larvae *Bidessini* sp., freshwater glass shrimp *Palaemonetes australis*, and the isopod *Haloniscus searlei*.

Importantly, none of the species recorded exclusively in the reach of Munglinup River downstream of the project area are considered rare or restricted, with distributions of these species likely in local and or regional saline systems (see section 3.3.3).

Table 6. Bray-curtis similarity (%) between each site sampled on the Munglinup River.

	MRD3	MRD4	MRD5	MRU2	MRU3	MRU5
MRD3						
MRD4	64					
MRD5	47	60				
MRU2	48	48	49			
MRU3	48	57	59	53		
MRU5	51	48	54	56	68	



3.4 Fish

3.4.1 Species composition and richness

A total of three fish species were recorded in the project area; the Swan River Goby *Pseudogobius olorum*, common jollytail minnow *Galaxias maculatus* and the western hardyhead *Leptatherina wallacei* (Plate 5). None of these species are listed for conservation significance or endemic to the region. These fish species are all salt tolerant and are widely distributed in inland rivers along the south coast of Western Australia, predominantly west of Esperance (Morgan *et al.* 2006). The absence of any true freshwater native species in the Munglinup River is probably a result of their inability to tolerate the higher salinities experienced in much of the main channel and upper catchment. No exotic or introduced fish species were caught in the current study.

Pseudogobius olorum is a hardy species of goby widespread along the west and southern coast of Australia. It is known to occur in a range of habitats and varying quality water bodies from freshwater rivers and streams to estuaries and hypersaline lakes and pools with salinity in excess of seawater. As a typically benthic species, their diet consists of a mix of algae, detritus and small invertebrates. (Halse 1981; Last *et al.* 1983). The species live for around a year and will go through 1 or 2 breeding seasons in their lifetime (Spring and Autumn when optimal breeding conditions arise) after which majority of mature individuals are thought to die off (late spring, summer). (Gill *et al.* 1996). It is generally accepted that *P. olorum* average around 40mm in length reaching a maximum size of 60mm (Total Length) (Allen 2002). A study on the size classes of a cohort of *P. olorum* found gonads were not well developed in the species until they reached a size in excess of 25mm (Gill *et al.* 1996).

Galaxias maculatus is typically considered a diadromous species, meaning it spawns in fresh or estuarine water, spends its larval or juvenile life (at least 4 months) at sea and returns to breed in freshwater as sub-adults (Mitchell 1989). However, literature suggests *G. maculatus* is non-diadromous in WA and may be recruiting through upstream migration for breeding in the Jerdacuttup and Oldfield rivers, similar to land-locked populations in south-eastern Australia (Chapman *et al.* 2006, Pollard 1971, 1972). Distribution extends across most of the southern coast of Australia including Tasmania, New Zealand and South America (Allen 2002). The ability of *G. maculatus* to adapt to various habitats, facilitated by a flexible life history with a marine larval phase, has no doubt aided in it having a large geographical range (Chapman *et al.* 2006)

Leptatherina wallacei is endemic to the southwest coastal drainage division and is commonly seen in estuaries and some freshwater streams up to 100kms inland (Allen 2002). Its life cycle spans around a year and after breeding in spring and summer adults will die. The species are sexually mature around 45-55mm but can grow as large as 70mm (Prince *et al.* 1982). *L. wallacei* is highly salt tolerant but known to prefer the upper reaches of estuaries as opposed to other species of hardyhead (*A. presbyteroides*, *A. elongata*) who are recorded much closer to inlets and river mouths (Prince *et al.* 1982).



Plate 5. Fish Species recorded from Munglinup River April 2018. (From Left to right) Common Jollytail Minnow *Galaxias maculatus*, Western Hardyhead *Leptatherina wallacei*, Swan River Goby *Pseudogobius olorum*. Photos by M. Allen.

Of note, was the lack of record of sympatric estuarine/marine vagrants including Black Bream *Acanthopagrus butcheri*, Yellowtail Trumpeter *Amniataba caudavittata* and Sea Mullet *Mugil cephalus*. These species are confirmed in the Oldfield River, and may be present in the Munglinup River but were not detected in the current study. Nevertheless, these species are common and widespread in coastal rivers across the South Coast bioregion (Cook et al. 2008).

3.4.2 Abundance

A total of 8314 freshwater fish were caught over the 4-day sampling period in April 2018. The Swan River goby was most abundant (6089 individuals), followed by the common jollytail minnow (1563 individuals) and the western hardyhead (662 individuals). All three species were recorded at the majority of sites, with only the western hardyhead absent at site MRU5 (Table 7). The large number of fish collected suggest the conditions in Munglinup River are highly favourable to these species.

Longitudinal trends were evident in the abundance of each species, however, average abundances were not significantly different between reach for any species (i.e. $p \leq 0.05$). *P. olorum* and *G. maculatus* were recorded in higher abundance at sites upstream of the project area, compared to downstream. Conversely, *L. wallacei* was recorded in lower abundance upstream of the project area, compared to the downstream reach.

Table 7. List of native freshwater fish species recorded at each site sampled, showing common names.

			Up stream				Down stream				Grand total
Fam ily	Scientific name	Comm on name	M RU5	M RU3	M RU2	Total	M RD5	M RD4	M RD3	Total	
Native fishes											
Gobiidae	<i>Pseudogobius olorum</i>	Sw an River Goby	1363	2819	895	5077	448	210	354	1012	6089
Galaxiidae	<i>Galaxias maculatus</i>	Common Jollytail Minnow	84	505	625	1214	211	13	125	349	1563
Atherinidae	<i>Leptatherina wallacei</i>	Western Hardyhead	0	2	11	13	6	618	25	649	662
Total taxa abundance			1447	3326	1531	6304	665	841	504	2010	8314
Total taxa richness			2	3	3	3	3	3	3	3	3

3.4.3 Length Frequency Analysis

Swan River Goby, *Pseudogobius olorum*

Length frequency plots of *Pseudogobius olorum* from Munglinup River are provided in Figure 10. Upstream sites had a greater number of individuals (5077) compared to downstream (1052). Individuals from a range of size-classes were recorded in both reaches, including new recruits (<10 mm), juveniles (11-20mm), sub-adults (21-30mm) and adults (>30mm). The high number of individuals and range of size classes suggests a stable population upstream and downstream of the Project area.

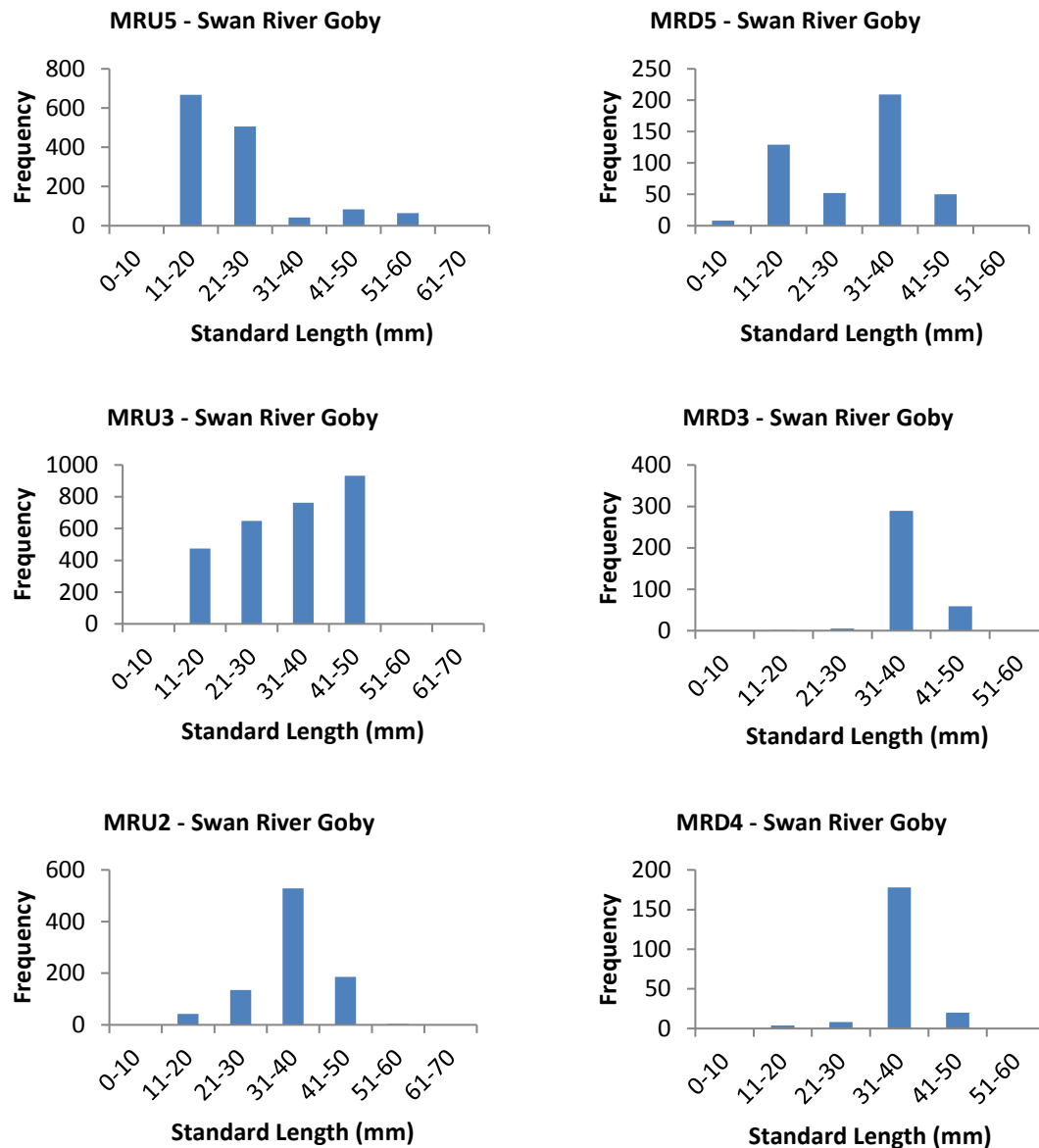


Figure 10. Length-frequency histograms for Swan River Goby – Munglinup River, April 2018.

Common Jollytail Minnow, *Galaxias maculatus*

Length frequency plots of *Galaxias maculatus* from Munglinup River are provided in Figure 11. Upstream sites had a greater number of individuals (1214) compared to downstream (349). Individuals were recorded from size classes in the range of sub-adults (30-100mm) and adults (>100mm). No new recruits or juvenile fish were recorded from this species. It is unknown if *G. maculatus* is recruiting in upstream tributaries of the Munglinup River (as documented for the Oldfield River) or downstream in estuarine/marine environments. The high number of sub-adults / adults upstream and downstream of the project area suggest successful recruitment to the system even though no young of year were recorded in the current study.

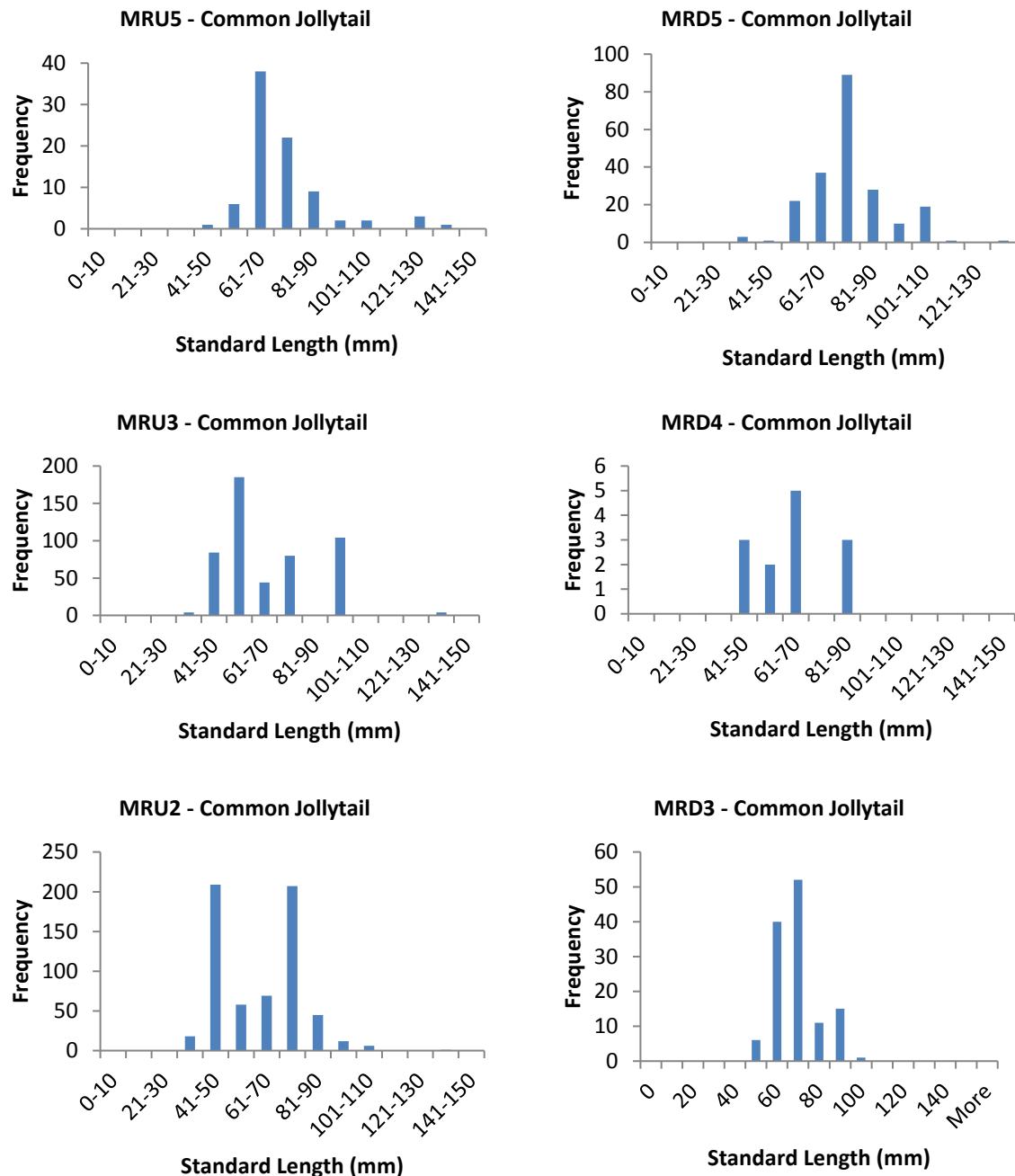


Figure 11. Length-frequency histograms for Common Jollytail Minnow – Munglinup River, April 2018.

Western Hardyhead, *Leptatherina wallacei*

Length frequency plots of *Leptatherina wallacei* from Munglinup River are provided in Figure 12. Downstream sites had a greater number of individuals (662) compared to upstream (13). Given that *L. wallacei* is known to inhabit upstream reaches, elevated salinity may in part, account for the observed lower abundance upstream of the project area. MRD4 had by far the greatest abundance (618) and range of size classes (juveniles, sub-adults and adults). MRD4 was also the only site to have fish in the juvenile size class for the species (<20mm). Individuals recorded were generally sub-adults (20-40mm) and adults (>40mm).

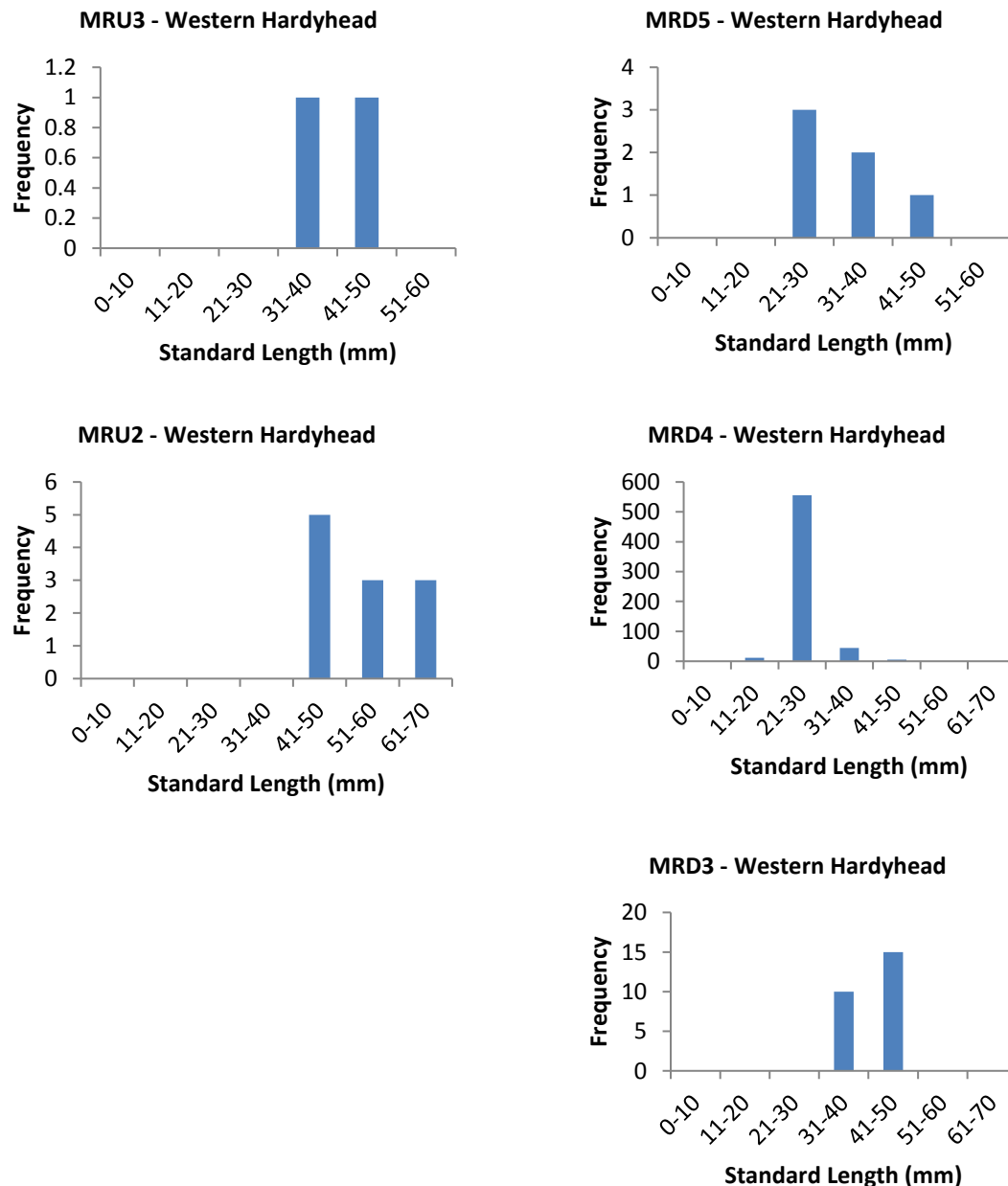


Figure 12. Length-frequency histograms for Western Hardyhead – Munglinup River, April 2018. Note: No fish were caught at MRU5.

3.5 Crayfish

No native or introduced crayfish species were observed or recorded in the current study.

Recent studies have found only one species of koonac, *Cherax preissii* is present in the Bremer River within the Eastern South Coast bioregion (Cook *et al.* 2008). The occurrence of *C. preissii* represents a range extension, as this species was previously thought to occur only as far east as the Kalgan River (Shipway 1951, Cook *et al.* 2008). Although the Bremer River is due west of the Fitzgerald River National Park, it is possible current distribution of *C. preissii* extends to the Munglinup River. It is unlikely, however, that any *Cherax* species, could support a population in the highly saline environment of the Munglinup river as salinity levels lethal to the species (above 30,000 $\mu\text{S}/\text{cm}$) or

growth inhibiting (23,000 $\mu\text{s}/\text{cm}$) were recorded at all sites (Morrissy 1984, Nickoll 1996). In addition, the absence of catch from the current study indicates if a population exists it is likely in low abundance or restricted distribution. The species is classified as least concern on the IUCN redlist, and is not listed for conservation on any state or federal legislation.

3.6 Rakali (water rat) - *Hydromys chrysogaster*

There were no opportunistic sightings of the Australian water rat, *Hydromys chrysogaster* or evidence to suggest presence (i.e. feeding middens) at any site sampled along the Munglinup River.

H. chrysogaster is widespread throughout Australia including Tasmania and some offshore islands. Land clearing, pollution and salinisation is thought to be the cause of substantial declines in the south west Rakali populations (Lee 1995). *H. chrysogaster* is currently listed as Least Concern conservation status by IUCN, and as Priority 4 species (rare, near threatened and other species in need of monitoring) in Western Australia (Vernes 1998, DPaW 2014, IUCN 2015c).

H. chrysogaster are known to occupy a range of habitats, though they prefer permanent waterbodies with dense, low-lying vegetation, and low-density canopy cover which provides protection from predators, such as foxes, cats and raptorial birds (McNally 1960, Speldewinde *et al.* 2013). An adaptable and opportunistic feeder, the diet of *H. chrysogaster* includes freshwater mussels (e.g. *W. carteri*), freshwater crayfish (e.g. *Cherax* sp.), fish, frogs, spiders and insects (Woollard *et al.* 1978). They consume little plant material and will only do so if their preferred prey is unavailable (Olsen 1983). *H. chrysogaster* do not need completely fresh water and can survive in areas where rivers and streams have become polluted or are brackish (Watts and Aslin, 1981).



Plate 6. Introduced European fox (*Vulpes vulpes*) captured on the infra-red trail cam at MRU5.

The WA Museum has confirmed records of *H. chrysogaster* being present in the Fitzgerald River National Park (approx. 80km's east of Munglinup). However, the fact the Munglinup River does not appear to support a diverse and/or abundant food source for water rats, particularly freshwater mussels and crayfish, suggests the system is unlikely to provide a critical habitat for the species. In addition, it is likely predation pressure is high, given the presence of introduced foxes and presumably feral cats (Plate 7).

3.7 Other vertebrate fauna

3.7.1 Turtles

No long neck turtles (Genus *Chelodina*) were observed or caught at any site sampled along the Munglinup River in the current study. Only one species, *Chelodina colliei* (*syn. C. oblonga* Georges and Thompson 2010) endemic to south west Western Australia is known to occur close to the study area. There are multiple records of *C. colliei* from the Fitzgerald River National Park (approx. 80km's east of Munglinup). Turtles outside of the national park boundaries are at risk of a growing number of threats including predation by exotic species, habitat loss and climate change. Female turtles must leave the water to lay their eggs which makes both the individual and the eggs vulnerable to introduced

predators such as foxes (Clay 1981). Studies on species in the genus *Chelodina* found that they are able to tolerate brackish water for only short periods of time and that high salinity cause's stress to freshwater reptiles, reducing growth rates and negatively impacting overall health of individuals (Bower et. al 2016). Munglinup River is unlikely to provide a suitable permanent habitat for *C. colliei* due to elevated salinity and presence of high level predators such as the European fox (Plate 6).

3.7.2 Frogs

No native frog species were observed during sampling or confirmed from playing audio calls at each site. This is unsurprising as the survey was not a targeted nocturnal survey for frog species, and weather conditions at the time were not conducive to breeding and calling.

Frog species found in the Wheatbelt are highly adapted to life in arid environments able to spend long periods of time in deep burrows or moist depressions beneath rocks. 14 species of native amphibian are known to occupy the south-eastern Wheatbelt region (Table 8). These include 5 species of *Neobatrachus* (ground burrowing frogs) 3 Species of *Crinia* (Froglets), 2 species of *Pseudophryne* (Toadlets), 2 species of *Heleioporus* (burrowing frogs), *Limnodynastes dorsalis* (Western Banjo Frog) and *Myobatrachus gouldii* (Turtle Frog) (WAM 2018). None of these species are listed as threatened or priority fauna in Western Australia.

Frog species generally cannot tolerate high salinity in their surrounding water as they osmoregulate through the skin and dehydrate when exposed to highly saline environments. This is not thought to greatly affect the adult's survival as they are able to relocate, however eggs and tadpoles are much more susceptible to fatalities due to high persistent salinity (Chinathamby 2006). Therefore, it is likely the Munglinup River is not a suitable breeding habitat for any of the known frog species due to the elevated background salinity.

Wheatbelt Amphibian Species	Common Name
<i>Neobatrachus pelobatoides</i>	Humming Frog
<i>Neobatrachus albipes</i>	White-footed Trilling Frog
<i>Neobatrachus kunapalari</i>	Wheatbelt Frog
<i>Neobatrachus wilsmorei</i>	Plonking Frog
<i>Neobatrachus sutor</i>	Shoemaker Frog
<i>Crinia pseudinsignifera</i>	Bleating Froglet
<i>Crinia georgiana</i>	Quacking Frog
<i>Crinia glauerti</i>	Clicking Froglet
<i>Pseudophryne occidentalis</i>	Western Toadlet
<i>Pseudophryne guentheri</i>	Crawling Toadlet
<i>Heleioporus albopunctatus</i>	Western Spotted Frog
<i>Heleioporus eyrei</i>	Moaning Frog
<i>Limnodynastes dorsalis</i>	Western Banjo Frog
<i>Myobatrachus gouldii</i>	Turtle Frog

Table 8. Frog species known to occur in the Wheatbelt and South-Eastern Western Australia Bioregion (WA Museum).

3.7.3 Avian fauna

Three species of Avian Fauna were confirmed along the Munglinup River, the Pacific black duck (*Anas superciliosa*), the grey teal duck (*Anas gracilis*) and the White-faced heron (*Egretta novaehollandiae*). None of these species are listed at state or federal level, and all are considered to have a widespread distribution throughout south-west Australia.

4 DISCUSSION

4.1 Water quality

In general, water quality of the Munglinup River can be considered saline, alkaline, clear and well oxygenated. Concentrations of heavy metals, with the exception of boron, were mostly below the limit of detection and of no ecological concern, however, dissolved boron was elevated above default ANZECC/ARMCANZ (2000) guidelines. Boron is often naturally elevated in Western Australian waterways influenced by groundwater (Hart 1974, WRM unpub. data). The Munglinup system can be considered moderately eutrophic, as a result of nitrogen enrichment, however potential for toxicity to fauna is of little ecological concern. Accumulation of leached nitrogen in sediments may be a major contributor to the eutrophication of the system, given various potential point (e.g. stock wastes, agricultural fertilisers) and diffuse sources (e.g. groundwater, overland run-off). Previous studies of river systems in the Eastern South Coast bioregion (including Munglinup, Oldfield and nearby Jerdacuttup) have also found these systems to be typically saline, alkaline and have higher levels of nitrogen in comparison to south-western rivers (Cook *et al.* 2008, Mayer 2005, WRC 2004).

There were few obvious longitudinal gradients or upstream / downstream patterns in water quality along the Munglinup River. However, there was evidence of spatial variability in electrical conductivity upstream and downstream of the project area, with EC readings significantly higher in the upper catchment compared to the reach downstream of the project area. Munglinup River is a naturally saline system known to have been highly saline for more than a decade (Massenbauer 2006). Waterways along the Esperance Coast Basin are fed by naturally saline groundwater, in an area with flat topography and receive low annual rainfall. The catchment is also subject to secondary salinisation effects as a result of extensive land clearing for agriculture (Mayer 2005, Pinder *et al.* 2005). It is unknown if the observed salinity trend is due to clearing in the headwaters of the catchment, intrusion of groundwater of lower EC in the downstream reach, or a combination of both factors.

Elevated dissolved boron is likely a function of several factors including the geochemical nature of the drainage area, proximity to marine coastal regions, and possible inputs from agricultural or municipal effluents. In saline or marine environments boron is known to occur in high concentrations, typically around 4.5 mg/L (Butterwick *et al.* 1989). Boron is also an essential trace element for plant growth and is often included as a component of modern agricultural fertiliser. In higher concentrations, it can also be used as a non-selective herbicide for weed control (Butterwick *et al.* 1989, WHO 2003). High boron concentrations in surface waters along Munglinup River are not unexpected given background salinity of the system, which suggest connection with the underlying groundwater table. It is assumed historical and current land use practice (i.e. fertilizer application) has had little influence on background boron concentrations in the system. Although dB levels in the current study are elevated above default guidelines, they reflect current natural background condition (i.e. baseline condition), and it is likely aquatic fauna of pool habitats have adapted to these conditions.

4.2 Macroinvertebrate fauna

Spot sampling in April 2018 confirms a relatively low diversity of macroinvertebrate fauna of the Munglinup River. No state or federal listed macroinvertebrate species of conservation significance or groundwater dependent fauna were recorded in the current study. Species considered sensitive receptors of freshwater environments were typically absent due to background salinity, with a suite of salt-tolerant species recorded in the current study. Taxa richness and species composition can be considered homogenous upstream and downstream of the project area.

Results of the current study are in-line with previous macroinvertebrate surveys in nearby rivers (i.e. Oldfield River, Jerdacuttup River and Young River). Total species richness of the Munglinup River (46 taxa) was similar to mean total richness documented by Stewart et. al (2009) for rivers of the Eastern South Coast bioregion (45 taxa). A number of groups of Insects were notably absent in the current study, including Odonata (dragonfly and damselfly), Plecoptera (Stonefly) and Ephemeroptera (Mayfly). This suggests application of the EPT index as a measure of ecosystem health of rivers in the Eastern South Coast Aquatic region would be problematic.

Similar to observations by Cook et. al (2008) for rivers of the Eastern South Coast bioregion, elevated background salinity appears to be a driving factor affecting diversity and composition of macroinvertebrates in Munglinup River. Elevated salinity in freshwater systems can directly impact fauna through effects on osmoregulatory physiology, as the maintenance of constant solute body concentration is impaired (Bayly 1972, Kefford *et al.* 2003, 2011), and affects the rates of many ecological processes such as organic matter decomposition and nutrient cycling (Schäfer *et al.* 2012). The majority of macroinvertebrate taxa recorded from Munglinup River pool habitats were considered salt-tolerant, common, and ubiquitous species with distributions extending across the South Coast bioregion. Given that fauna recorded in the current study were found to have adaptations allowing them to survive in saline water for all or a majority of their life stages, it is unlikely that true freshwater species with little tolerance for high or fluctuating salinity levels (including native crayfish, turtles and fish) would be present or dependent on the system. Further, species confined to the downstream reach of the Munglinup River have populations outside the project area, locally and regionally (Cook et al. 2008, Stewart et al. 2009). As such, adverse effects (if any) from an intermittent discharge regime is unlikely to impact overall macroinvertebrate species populations for the South Coast bioregion.

4.3 Fish and crayfish

The Munglinup River appears to support a depauperate but highly abundant native fish fauna, which is comparable to other naturally saline systems of the Eastern South Coast Bioregion (see Cook et al. 2008, Stewart et al. 2009). Three fish species were recorded including the Swan River Goby *Pseudogobius olorum*, common jollytail minnow *Galaxias maculatus* and the western hardyhead *Leptatherina wallacei*. Abundances of *P. olorum* and *G. maculatus* was considered homogenous upstream and downstream of the project area, and none of the three species are listed for conservation under State or Federal legislation. Abundances of *L. wallacei* were more prevalent downstream. The common jollytail is considered the only “true” freshwater species when landlocked, can tolerate salinities up to 50 ppt and is considered restricted to the region (Cook et al. 2008). *G. maculatus* can be considered an indicator species of ecosystem health for rivers within the Eastern South Coast bioregion (Cook et al. 2008). A large population of sub-adult / adult *G. maculatus* were recorded in the current study, however, there were no new recruits recorded. It is unknown if this represents seasonality in population structure at the time of sampling (i.e. all juvenile recruits had grown to sub-adult size by the time of sampling), or populations in the Munglinup River may be diadromous (spawn at sea/in the estuary, and juveniles migrate back up the river once matured).

Of the two remaining fish species, both are considered salt tolerant (i.e. estuarine species) and are widely distributed in inland rivers along the south coast of Western Australia, predominantly west of Esperance (Morgan *et al.* 2006). Size/age class structure indicate *P. olorum* is successfully recruiting along Munglinup River, upstream and downstream of the project area. Although no new recruits or juvenile *L. wallacei* were recorded, known life history traits indicate the species spawn close to the ocean in estuaries and spend their early life-stages in a marine environment returning to freshwater rivers as sub-adults in order to mature and then breed.

No native crayfish were recorded in the current study. Similar to the macroinvertebrate fauna, it is unlikely that true freshwater fish and crayfish species with little tolerance for high or fluctuating salinity levels would be present or dependent on the system.

4.4 Other vertebrate fauna

Munglinup River does not appear to support other vertebrate aquatic fauna of conservation significance, specifically freshwater turtles and/or water rats. For the latter, this may be an artefact of a lack of an abundant and diverse food source, with no freshwater mussels or crayfish recorded in the current study. There is potential for opportunistic bird use in areas where vegetation is healthy and is suitable for foraging and/or nesting, however, the system is unlikely to provide significant habitat for conservation significant species in a local/regional setting. No native frog species were observed during sampling or confirmed from playing audio calls at each site. This is unsurprising as the survey was not a targeted nocturnal survey for frog species, and weather conditions at the time were not conducive to breeding and calling.

5 CONCLUSION

In general, the Munglinup River can be considered of moderate regional conservation value. Spot-sampling of water quality and aquatic fauna of the Munglinup River in April 2018 suggest comparable ecological value to other naturally salinised systems in the Eastern South Coast bioregion, but lower ecological value than freshwater systems in the Western South Coast bioregion (i.e. rivers of South West Australia). This is similar to observations by Cook et al. (2008) which ranked the Oldfield River in the top three rivers in terms of overall 'ecological value' in the Eastern South Coast bioregion. Water quality of the Munglinup River was generally considered good, with concentrations of most stressors and toxicants below respective default TVs. Salinity, and to a lesser degree nutrient enrichment, appear to be the main factors influencing the diversity and composition of aquatic fauna in this system and is typical of surrounding rivers of the Eastern South Coast bioregion. However, the Oldfield and Munglinup rivers are considered good condition examples of naturally saline south-east rivers, supporting healthy aquatic faunas and floras, and as such presents a relatively undisturbed system. Diversity of macroinvertebrates and fish is comparable to that recorded at nearby naturally salinised river systems east of the Pallinup River, but lower than freshwater systems in South West Australia. Species considered sensitive receptors of freshwater environments were typically absent due to background salinity, with a suite of salt-tolerant fauna recorded. Although no species recorded from spot-sampling are currently listed under state or federal conservation acts, the Common Jollytail, *Galaxias maculatus* has a very limited distribution in Western Australia, and the healthy population of this species in the Munglinup River is noteworthy.

6 RECOMMENDATIONS

The current study provides insight into water quality and ecological values present at Munglinup River pool habitats upstream, and downstream of the project area in autumn (April) 2018. It is acknowledged the current dataset does not account for any seasonal or temporal (inter-annual) variation in water quality parameters or aquatic faunal assemblages, and hence, provides only a single snapshot of ecosystem values. Additional baseline sampling of water quality and aquatic fauna (macroinvertebrates and fish) at the same six sites is required. ANZECC/ARMCANZ (2000) recommends three years of baseline data are required to provide a robust baseline dataset that encompasses a degree of temporal variability against which future changes (impacts) may be assessed. At a minimum, it is recommended that sampling of water quality and aquatic fauna is conducted in September (spring) 2018, but ideally also in spring 2019, to build on data collected in April 2018, in order to accurately define ecosystem values and provide a baseline dataset against which any changes post project development may be assessed.

Water quality data indicate several parameters (i.e. EC, pH, dissolved boron, total nitrogen) are elevated in pool habitats at Munglinup River, relative to default ANZECC/ARMCANZ (2000) TVs. These elevated parameters reflect naturally elevated levels, presumably due to the influence of groundwater in pool habitats. It is necessary to develop system-specific operational water quality guidelines (site-specific trigger and threshold values) in accordance with ANZECC/ARMCANZ (2000) protocols to document baseline (i.e. background) condition. These operational guidelines can then be used for ongoing monitoring purposes, to detect any potential change in water quality at pools of Munglinup River when discharging. It is strongly recommended that regular (monthly) water quality sampling of at least two (2) pools is initiated by MRC staff as soon as possible to develop a robust baseline dataset. Further, targeted sampling events following large rainfall periods provide the opportunity to document natural disturbances within the system (i.e. 24-48hr nutrient spikes from catchment flows). ANZECC/ARMCANZ (2000) recommends monthly sampling over two years. As this is not always practicable or feasible, fortnightly sampling over a shorter duration of time (i.e. typically 6 months), but one that still covers seasonal variation, is sufficient to combine with water quality data obtained from baseline studies to derive operational water quality guidelines.

In addition, a Hazard analysis should be undertaken on groundwater data to ascertain any potential contaminants of concern (PCOC). Analytes identified as being of no, or negligible risk, with no apparent source from which to become elevated, may be omitted from further surface water monitoring requirements. Analytes that pose medium or high potential risk should continue to be monitored.

Monitoring of aquatic fauna (macroinvertebrates and fish) on an annual basis (i.e. spring) during the construction and operational phase is recommended to detect changes, should they occur, in water quality and water-dependent ecological values of the Munglinup River. The sampling design used in baseline studies should be applied for ongoing monitoring to provide replicate sites upstream and downstream of the Project. This will allow statistical testing to distinguish if any potential changes are the result of natural / stochastic changes (either locally or regionally), or from mining operations associated with the Project.

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APPENDICES

Appendix 1. Site photographs



MRU5



MRU3



MRU2



MRD5



MRD4



MRD3

Appendix 2. ANZECC/ARMCANZ (2000) default trigger values

Table A2-1. Default trigger values for some physical and chemical stressors for south west Western Australia for slightly disturbed ecosystems (TP = total phosphorus; FRP = filterable reactive phosphorus; TN = total nitrogen; NOx = total nitrates/nitrites; NH₃ = NH₄⁺ = ammonium).

	TP (mg/L)	FRP (mg/L)	TN (mg/L)	NOx (mg/L)	NH ₃ (mg/L)	NH ₄ ⁺ (mg/L)	DO % saturation ^f	pH
Aquatic Ecosystem								
Upland River ¹	0.02	0.01	0.45	0.2	0.9 ⁵	0.06	90	6.5 – 8.0
Lowland River ¹	0.065	0.04	1.2	0.15	0.9 ⁵	0.08	80 - 120	6.6 – 8.0
Lakes and Reservoirs	0.01	0.005	0.35 ³	0.01	0.9 ⁵	0.01	90	6.5 – 8.0
Wetlands ³	0.06	0.03	1.5	0.1	0.9 ⁵	0.04	90 - 120	7.0 – 8.5 ⁴

¹ All values during base river flow not storm events.

² Derived from daytime measurements; may vary diurnally and with depth; data loggers required to assess variability.

³ Elevated nutrients in highly coloured wetlands do not appear to stimulate algal growth.

⁴ In highly coloured wetlands, pH typically ranges 4.6 – 6.5.

⁵ General level for slightly-moderately disturbed ecosystems and not specifically formulated for south-west WA; figure may not protect species from chronic toxicity.

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

Aquatic Ecosystem		Comments
Salinity	(µS/cm)	
Upland and lowland rivers	120-300	Values will vary depending on geology. First flush after seasonal rain may result in temporarily high values
Lakes, reservoirs and wetlands	300-1500	Higher conductivities will occur during summer when water levels are reduced due to evaporation
Turbidity	(NTU)	
Upland and lowland rivers	10-20	
Lakes, reservoirs and wetlands	10-100	Shallow lakes may have higher turbidity naturally due to wind-induced re-suspension of sediments. Lakes and reservoirs in catchments with highly dispersible soils will have high turbidity. 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. Default trigger values for some physical and chemical stressors for south central Western Australia for slightly disturbed ecosystems (TP = total phosphorus; FRP = filterable reactive phosphorus; TN = total nitrogen; NOx = total nitrates/nitrites; NH₃ = NH₄⁺ = ammonium).

	TP (mg/L)	FRP (mg/L)	TN (mg/L)	NOx (mg/L)	NH ₃ (mg/L)	NH ₄ ⁺ (mg/L)	DO % saturation ^f	pH
Aquatic Ecosystem								
Lowland River ¹	0.1	0.04	1	0.1	0.1	0.1	90	6.5 – 9.0
Lakes and Reservoirs	0.025	0.01	1	0.1	0.1	0.025	90	6.5 – 8.0

Table A2-4. Default trigger values for salinity and turbidity for the protection of aquatic ecosystems, applicable to south central Western Australia (ANZECC/ARMCANZ 2000).

Aquatic Ecosystem		Comments
Salinity	(μS/cm)	
Upland and lowland rivers	100-5000	Salinity can be highly variable depending on flow.
Lakes, reservoirs and wetlands	300-1000	Wetlands can have substantially higher salinity due to saline groundwater intrusion and evaporation.
Turbidity	(NTU)	
Upland and lowland rivers	1-50	Turbidity and SPM are highly variable and dependent on seasonal rainfall runoff.
Lakes, reservoirs and wetlands	1-100	Shallow lakes and reservoirs may have higher turbidity naturally due to wind induced resuspension of sediments. Lakes and reservoirs in catchments with highly dispersible soils will have high turbidity.

Table A2-5. Water Quality trigger values for toxicants. Refer ANZECC/ARMCANZ (2000) Section 3.3.2.4 and tables 3.4.1 to 3.4.4 for further guidance on applying the trigger values. All values are mg/L. ID = insufficient data to develop TV.

Compound	Trigger values for freshwater Level of protection (% species)			
	99%	95%	90%	80%
METALS and METALLOIDS				
Aluminium pH > 6.5	0.027	0.055	0.08	0.15
Aluminium pH < 6.5	ID	ID	ID	ID
Arsenic (As III)	0.001	0.024	0.094	0.36
Arsenic (As IV)	0.0008	0.013	0.042	0.14
Boron	0.09	0.37	0.68	1.30
Barium	ID	ID	ID	ID
Cadmium	0.00006	0.0002	0.0004	0.0008
Cobalt	ID	ID	ID	ID
Chromium (Cr III)	ID	ID	ID	ID
Chromium (Cr VI)	0.00001	0.001	0.006	0.04
Copper	0.001	0.0014	0.0018	0.0025
Iron	ID	ID	ID	ID
Manganese	1.2	1.9	2.5	3.6
Mercury (inorganic)	0.00006	0.0006	0.0019	0.0054
Molybdenum	ID	ID	ID	ID
Nickel	0.008	0.011	0.013	0.017
Lead	0.001	0.0034	0.0056	0.0094
Selenium (Se total)	0.005	0.011	0.018	0.034
Selenium (Se IV)	ID	ID	ID	ID
Uranium	ID	ID	ID	ID
Vanadium	ID	ID	ID	ID
Zinc	0.0024	0.008	0.015	0.031
NON-METALLIC INORGANICS				
Ammonia	0.32	0.9	1.43	2.3
Chlorine	0.0004	0.003	0.006	0.013
Nitrate	0.017	0.7	3.4	17

Notes:

Co default TV for aquatic ecosystems = Interim guideline based on Canadian WQG (Nagpal 2004).

Fe default TV for aquatic ecosystems = Interim guideline based on Canadian WQG (ANZECC/ARMCANZ 2000).

H = should be adjusted for site-specific water hardness using algorithms from Table 3.4.3 of ANZECC/ARMCANZ (2000).

Note: hardness modified TV (HMTV) for Cu may be under-protective for key sensitive species (Markich *et al.* 2005).

ID = insufficient data to derive TV at the time guidelines were published.

NP = not provided in the guidelines.

Appendix 3. Substrate and habitat data

Table A3.1. Substrate percentage composition data collected during April 2018. All values are % unless indicated otherwise.

Substrate/Habitat	Upstream			Downstream		
	MRU5	MRU3	MRU2	MRD5	MRD4	MRD3
Mineral	75	53	60	65	40	60
Emergent veg	0	0	0	0	0	0
Submergent veg	0	0	0	0	20	0
Floating Veg	0	0	0	0	0	0
algal cover	5	2	0	0	0	0
Detritus	5	10	10	5	5	10
Trailing veg	10	15	15	10	15	15
LWD	5	20	15	20	20	15
Other	0	0	0	0	0	0

Table A3.2. In-stream habitat percentage composition data collected during April 2018. All values are % unless indicated otherwise.

Substrate/Habitat	Upstream			Downstream		
	MRU5	MRU3	MRU2	MRD5	MRD4	MRD3
Bedrock	60	0	0	0	0	0
Boulders	10	0	0	0	0	0
Cobbles	5	0	5	5	0	0
Pebbles	5	5	0	5	10	0
Gravel	2	5	5	5	10	10
Sand	18	60	30	50	60	70
Silt	0	30	30	5	20	10
Clay	0	0	30	30	0	10

Appendix 4. Macroinvertebrate fauna data

Table A4.1. Macroinvertebrate taxa abundance data collected during April 2018. Abundances are log10 scale classes: 1 = 1 individual, 2 = 1- 10, 3 = 11 – 100, 4 = 101 - 1000, 5 = >1000.

Phylum/Class/Order	Family	Lowest Taxon	MRD3	MRD4	MRD5	MRU2	MRU3	MRU5
NEMATODA		Nematoda spp.	2	0	0	0	1	1
MOLLUSCA								
GASTROPODA								
Hypogastropoda	Pomatopsidae	<i>Coxiella</i> spp.	2	3	3	3	3	3
ANNELIDA								
OLIGOCHAETA								
Tubificida	Enchytraeidae	Enchytraeidae spp.	4	3	2	0	0	0
	Naididae	Naididae spp. (imm./dam.)	0	3	3	0	4	4
		<i>Pristina sima</i>	3	0	2	0	0	3
ARTHROPODA								
CRUSTACEA								
MAXILLOPODA	Calanoida	Calanoida spp.	4	4	3	2	2	3
	Cyclopoida	Cyclopoida spp.	0	0	0	0	2	0
	Harpacticoida	Harpacticoida spp.	0	0	2	0	2	2
MALACOSTRACA								
Amphipoda	Chiltoniidae	Chiltoniidae spp.	4	4	2	3	3	4
		Amphipoda spp. (imm./dam.)	3	0	0	3	4	3
Decapoda	Palaemonidae	<i>Palaemonetes australis</i>	1	3	2	0	0	0
Isopoda	Scyphacidae	<i>Haloniscus searlei</i>	1	0	0	0	0	0
CHELICERATA								
ARACHNIDA								
Mesostigmata		Mesostigmata spp.	2	2	0	0	2	0
	Sarcoptiformes	Oribatida sp.	0	0	0	0	0	1
	Trombidiformes							
	Pezidae	Pezidae sp.	1	0	0	0	0	0
		Acarina spp. (imm./dam.)	2	0	0	1	2	2
HEXAPODA								
ENTOGNATHA								
Entomobryomorpha		Entomobryodea spp.	0	0	0	0	0	2
Poduromorpha		Poduroidae spp.	2	0	0	3	0	2
INSECTA								
Hemiptera	Hebridae	<i>Hebrus axillaris</i>	0	0	0	0	0	1
	Velidae	Velidae spp.	2	1	1	1	0	0
Coleoptera	Dytiscidae	<i>Bidessini</i> sp. (L)	1	0	0	0	0	0
		<i>Necterosoma penicillatum</i>	1	0	2	0	2	0
		<i>Platynectes</i> sp. (L)	0	0	0	0	0	1
	Hydraenidae	<i>Ochthebius</i> spp.	2	2	0	0	1	2
	Hydrophilidae	<i>Berosus</i> spp. (L)	0	0	0	0	2	2
		<i>Enochrus eyrensis</i>	0	1	0	1	0	0
		<i>Helochares</i> spp.	0	0	0	0	2	0
		<i>Helochares tatei</i>	0	1	0	2	2	2
	Diptera	Ceratopogonidae	0	2	1	0	2	0
		Ceratopogoninae spp. (P)	2	3	2	0	3	2
		Dasyheleinae spp.	0	0	1	0	2	0
	Chironomidae	Chironomidae spp. (P)	2	2	2	1	3	4
	Chironominae							
	Chironomini	<i>Kiefferulus</i> spp.	0	2	0	0	0	0
		<i>Polypedilum</i> spp.	4	3	0	1	0	0
	Tanytarsini	Tanytarsus spp.	0	4	2	3	4	5
		<i>Dicrotendipes</i> spp.	4	4	2	2	3	3
		Cladotanytarsus spp.	3	3	2	2	3	4
	Orthocladinae	Orthocladinae sp. (V46)	0	0	0	0	0	3
	Tanypodinae	<i>Procladius paludicola</i>	0	0	2	3	3	3
	Ephydriidae	Ephydriidae spp.	0	0	2	0	1	3
	Scatopsidae	Scatopsidae spp.	2	0	0	0	0	0
	Stratiomyidae	Stratiomyidae spp.	0	0	1	0	2	2
	Tabanidae	Tabanidae spp.	1	0	0	1	1	2
Trichoptera	Leptoceridae	Leptoceridae spp. (imm./dam.)	0	0	0	2	0	3
		<i>Symphitoneuria wheeleri</i>	1	1	2	2	0	3
Thysanoptera		Thysanoptera spp.	0	0	0	0	0	2
Taxa Richness			25	20	21	18	26	30

Appendix 5. Munglinup Literature Review



Munghlinup Graphite Project

Aquatic Ecological Values of the Munghlinup River: Literature Review



May 2018



Munglinup Graphite Project

Aquatic Ecological Values of the Munglinup River: Literature Review

Prepared for:

MRC Graphite Pty Ltd

PO Box 235, Welshpool DC, WA 6986.

by:

Wetland Research & Management

16 Claude Street, Burswood, WA 6100

T: +61 8 9361 4325

e-mail: Admin@wetlandresearch.com.au

FINAL Report

May 2018

Study Team

Project management: Adam Harman
Field work: Andrew Storey & Fintan Angel
Map compilation: Emma Thillainath
Report: Adam Harman & Chris Hofmeester
Reviewed by: Jess Delaney

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1 INTRODUCTION

1.1 Project background

MRC Graphite Pty Ltd is proposing to develop the Munghlinup Graphite Project, situated 105 km west of Esperance, and 4 km north of the town of Munghlinup on mining lease M51/745, in Western Australia. Mine development requires the potential provision for emergency discharge of surplus project water into the Munghlinup River, a seasonally flowing tributary of the Oldfield River. Though the quality of water to be discharged into the Munghlinup River is unknown, discharge and disturbance of creeklines poses potential risk to the health of adjacent and downstream aquatic ecosystems, which needs to be appropriately assessed. Wetland Research & Management (WRM) were contracted to undertake a desktop review of the Project area, in order to document known water quality and aquatic fauna values of the Munghlinup River. This desktop review will compliment a baseline survey of the water quality and aquatic fauna of the Munghlinup River to be undertaken in Autumn 2018. The primary purpose of the review and baseline survey is to understand the importance of a range of ecological values of pools in the Munghlinup River, and the local/regional distribution of these values to support environmental approvals, as required.

1.2 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, zooplankton and macroinvertebrates.

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 km²) defined as short range endemics (SREs; Harvey 2002, EPA 2009). Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) uses the International Union for Conservation of Nature (IUCN) Red List criteria for assigning species and communities to threat categories under the *WC Act*. Not all Western Australian species listed by the IUCN are also listed by the DBCA.

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*. Aquatic invertebrates in particular have historically been under-studied. 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 environmental impact assessment.

1.3 Regional setting

The Project is located within the South West Botanical Province of Western Australia, which is recognised globally as one of the “biodiversity hotspots” of the world due to a combination of high species diversity, high numbers of endemic plants, and high levels of threat to biodiversity in the region (Gole 2006). This area extends from Shark Bay in the North, to Israelite Bay towards the south east of the State and follows the 350 mm rainfall isohyet. The South Coast region, where the Project area is located, occupies the south eastern part of the South West Botanical Province, contributing significantly to the overall biodiversity of the area (Danks 2004).

The South Coast region contains around 107 rivers and major tributaries, which are perennial or ephemeral in nature (Cook *et al.* 2008). Broadly, two separate aquatic bioregions are recognised within the South Coast region; the Western South Coast bioregion, consisting of rivers from Gardner River in the west to Bluff River, and the Eastern South Coast bioregion, consisting of rivers lying between the Pallinup River and the Thomas River in the east (Cook *et al.* 2008, Stewart *et al.* 2009).

The Munglinup River, with a catchment area of approximately 32,300 ha, falls within the Eastern South Coast bioregion. The river originates on the sandplain north of the South Coast Highway and only flows for short periods in winter (Figure 1). The corridor in which the river flows is well vegetated, with land surrounding the corridor being cleared for agricultural uses including cropping and grazing. The Munglinup River is a major tributary of the Oldfield River, which has a catchment area of approximately 217, 200 ha (Gee and Simons 1997). The two systems join approximately 13 km southwest of the town of Munglinup.

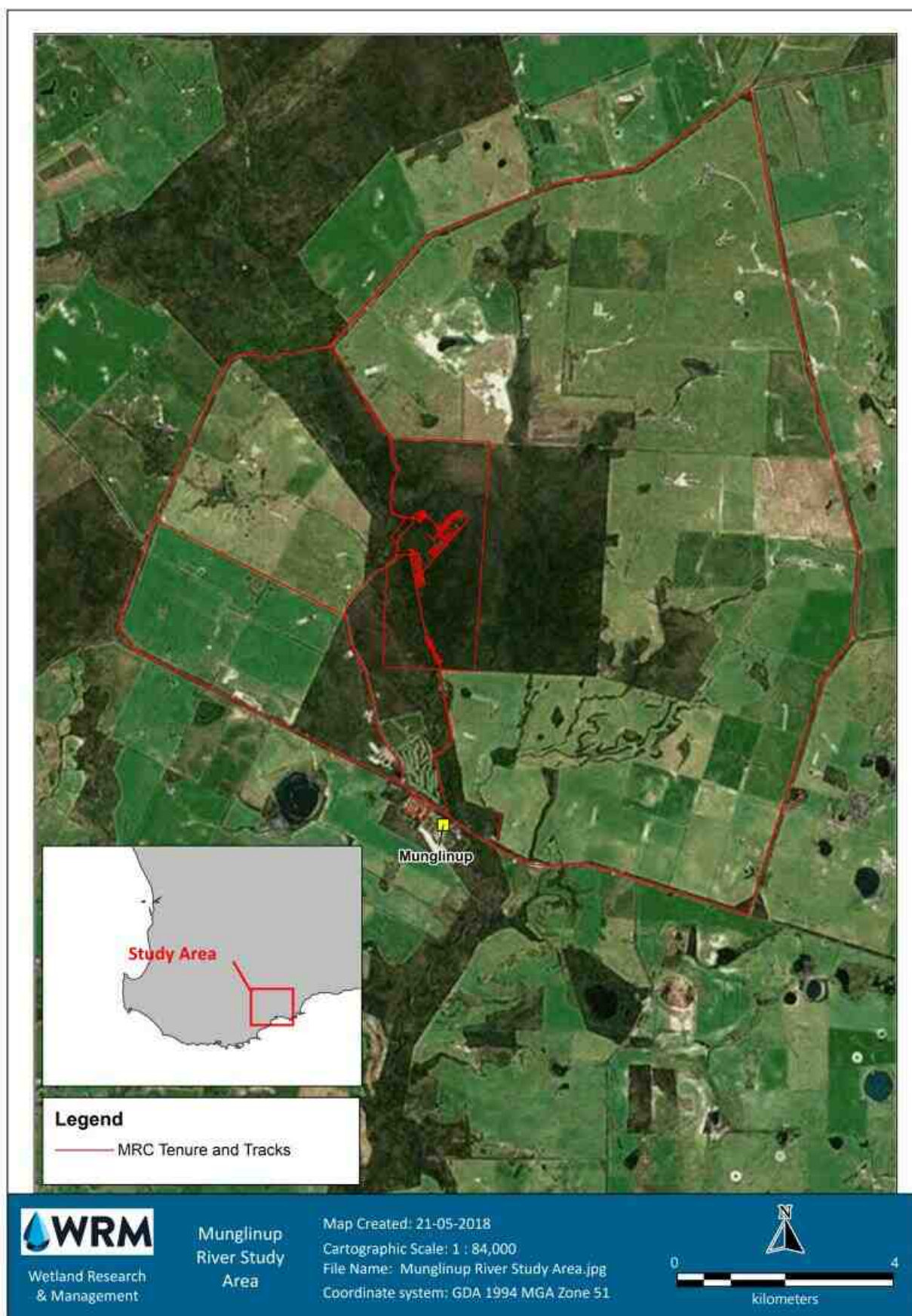


Figure 1. Overview of location of the Munghlinup River project area.

1.4 Climate

The climate of the area is Mediterranean, typified by cool, wet winters (June - August) and hot, dry summers (December - February). The weather is determined by eastward moving high and low-pressure systems. The average monthly minimum and maximum temperatures for Munglinup (Munglinup West 012044) range from 12.6 to 28.9 °C during summer months and from 6.6 to 18.0 °C during winter months (Figure 2). The average annual rainfall is 473.4 mm at Munglinup West (station 012044, 2002-2018), 508.5 mm at Munglinup Melaleuca (station 012281, 1975-2013), and 430.7 mm at Ravensthorpe (station 010633, 1901-2018) (Figure 3). Average annual evaporation is greatest during the summer months and is approximately 1750 mm (Hodgkin, 1997).

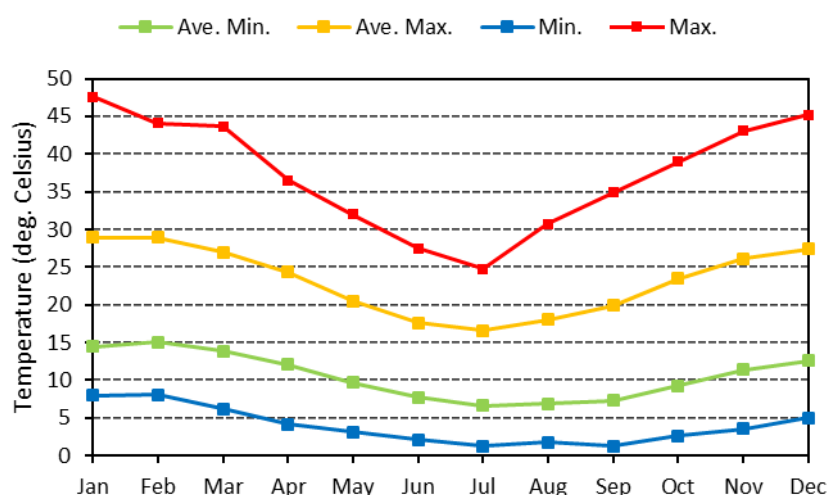


Figure 2. Maximum and minimum monthly temperature for Munglinup West together with average maxima and minima for the period 2002 – 2018 (data supplied by Climate Services, BOM, Perth).

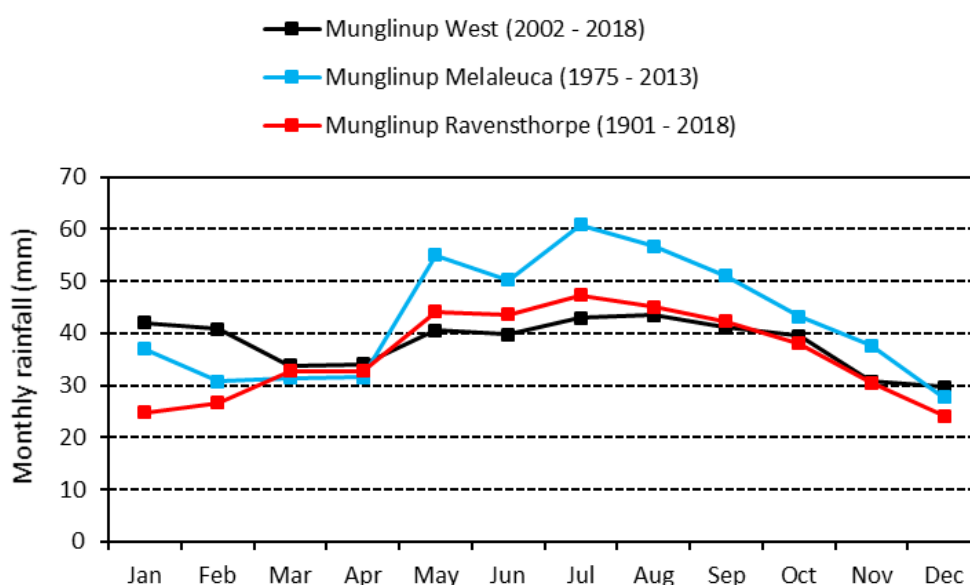


Figure 3. Average monthly rainfall for Munglinup West (2002 – 2018), Munglinup Melaleuca (1975 – 2013) and Munglinup Ravensthorpe (1901 – 2018) (data supplied by Climate Services, BOM, Perth).

2 DATABASE SEARCHES AND LITERATURE REVIEW

Publicly available water quality and aquatic fauna technical reports and published scientific papers were reviewed to document the ecological values of the Project area, and wider surrounding area. Where data were not available for the Munglinup River, a regional context (South Coast bioregion) is provided.

The review was undertaken to identify the presence of aquatic fauna, including invertebrates, fish, crayfish, frogs, turtles and rakali (water rats), and determine their conservation significance and likelihood of occurrence within the Munglinup River. Various reference sources were utilised including government documents, scientific journal papers and technical reports. Federal and State database searches were undertaken for a quadrat of approx. 40km¹ from - 33.67154°S, 120.66925°E:

- EPBC Act Protected Matters Search Tool
- DBCA/WA Museum NatureMap
- DBCA Threatened Fauna database
- Atlas of Living Australia.

The responsibility for the accuracy of such data remains with the issuing authority, not with WRM. Definitions for species classified as either threatened or priority are presented in Appendix 1.

A review of publicly available literature was also undertaken to assess the water quality of the Munglinup River, and water quality of the South Coast bioregion more-widely. This would provide context for the aquatic fauna communities identified in the literature review and database searches.

3 ECOLOGICAL VALUES OF AQUATIC SYSTEMS IN THE PROJECT AREA

Many aquatic fauna surveys have been conducted within the South Coast bioregion of Western Australia, however, these studies have largely focused on freshwater fishes and crayfishes of south west rivers (Beatty & Morgan 2005, Morgan *et al.* 1998, 2000, 2003, 2004). Few studies have been undertaken on the water quality and aquatic fauna of the Eastern South Coast bioregion, and few within the Munglinup River itself. As such, knowledge of the water quality and aquatic fauna in the immediate vicinity of the Project area is limited.

Danks (2004) provides a broad overview of biodiversity values, including aquatic fauna, and threats in the South Coast Region. The Water Corporation (2011) and the Department of Water and Environmental Regulation (1998-2000) provide a summary of water quality data collected from the Munglinup River. Morgan *et al.* 2006 provide a summary of the fish fauna of the south coast of Western Australia including the Munglinup and Oldfield River catchment. Cook *et al.* 2008 undertook a comprehensive water quality, macroinvertebrate and fish study in 33 waterways across the South Coast bioregion between 2006 and 2008. Results from this study are also presented in Stewart *et al.* 2009.

3.1 Wetland classification

A search of the DoW Groundwater Proclamation Areas (2009) identifies the Project Area as being in the Kondinin-Ravensthorpe groundwater area, this area is yet to be formally gazetted. No rivers or surface water bodies listed under the Rights in Water and Irrigation Act (RIWI Act) 1914 were identified within the Project Area. No Ramsar listed sites or South Coast significant wetlands were listed within 40km of the Project area.

¹ Atlas of Living Australia only allows a search up to 10km from nominated GPS coordinates.

3.2 Water quality

In general, river systems of the Eastern South Coast bioregion are more saline, slightly more alkaline, and have higher nitrogen levels compared to those of the Western South Coast bioregion (Cook *et al.* 2008, Stewart *et al.* 2009). Stewart *et al.* (2009) found the mean salinity level in Eastern rivers was 23.29 ppt, compared to 1.50 ppt in Western rivers. On average, pH in Eastern rivers was 7.38, compared to 6.07 in Western rivers, and mean total nitrogen levels were 14.83 mg/L in Eastern rivers, compared to 9.35 mg/L in Western rivers (Stewart *et al.* 2009). Salinity was found to be the main factor influencing macroinvertebrate assemblage differences between the two bioregions (Stewart *et al.* 2009).

Gee and Simons (1997), in their summary of risks to catchments of the Esperance region, determined that both the Oldfield and Munglinup rivers had a “salinity hazard rating” of low – medium, suggesting that salinisation provides a moderate risk to the system. The Munglinup River is considered a naturally saline system (Massenbauer 2006), and therefore species composition largely reflects individual tolerances to background salinity levels.

The Munglinup River is classified as a category 1 Eutrophic River (Very high, combined nitrogen and phosphorus risk) in the South Coast Regional Initiatives Planning Team (SCRIPT). The relative contributions of the various point (*e.g.* stock wastes, agricultural fertilisers) and diffuse sources (*e.g.* groundwater, overland run-off) is unknown, but accumulation of leached nitrogen and phosphorus in sediments is likely a major contributor to the eutrophication of the system.

The Water Corporation of Western Australia sampled a range of water quality parameters in the Munglinup River in 2010 and 2011, comparing them against the National Health and Medical Research Council (NMRC) drinking water quality guidelines (Water Corporation 2011). All values fell within the guidelines set by the NMRC, however, the mean and maximum nitrate concentrations were equal to the ANZECC/ARMCANZ default trigger value (0.01 mg/L) for slightly disturbed lowland rivers in south-coast Australia (Table 1, Appendix 2).

Table 1. Water quality readings taken at Munglinup River by the Water Corporation showing ANZECC/ARMCANZ guidelines. Note: ID = insufficient data to derive trigger value.

Parameter	South-west Australia 95% TV	South-coast Australia 95% TV	Min	Max	Mean
pH (pH units)	6.5 – 8.0	6.5 – 9.0	6.57	7.43	7.00
Hardness (mg/L)	ID	ID	14	15	15
TDS (mg/L)	250	300	73	79	76
Turbidity (NTU)	20	50	0.3	0.4	0.4
Nitrate (mg/L)	0.15	0.1	<0.05	0.1	0.1
Aluminium (mg/L)	0.055	0.055	0.016	0.020	0.018
Iron (mg/L)	ID	ID	0.035	0.08	0.058
Manganese (mg/L)	1900	1900	<0.002	0.004	<0.002

The Department of Water and Environmental Regulation (DWER; formerly the Department of Water) sampled a range of water quality parameters at seven locations along the Munglinup River between 1998 and 2000 as part of the South Coast Wetland Monitoring Program. Several parameters were recorded in concentrations in excess of ANZECC/ARMCANZ default guidelines, including pH, EC, turbidity, and total nitrogen (Table 2). Of note, is the background level of EC (mean 29.9 mS/cm) and total nitrogen (mean 2 mg/L).

Table 2. Water quality readings taken at Munglinup River by the DWER. Note: ID = insufficient data to derive trigger value.

Parameter	South-west Australia 95% TV	South-coast Australia 95% TV	Min	Max	Mean
pH (pH units)	6.5 – 8.0	6.5 – 9.0	6.8	8.9	7.820988
EC (mS/cm)	0.3	5	0.63	116	29.94688
Temperature (°C)	ID	ID	9.9	28.3	17.88025
Turbidity (NTU)	20	50	10	150	21.6
DO (mg/L)	ID	ID	1.53	15.2	8.282625
TN (mg/L)	0.065	0.01	0.56	7.3	2.029383
TP (mg/L)	1.2	1	0.01	0.67	0.075679

Located approximately 50 km to the west of the Munglinup/Oldfield Rivers is the Jerdacuttup River, also within the Eastern South Coast bioregion. A review of water quality data of the Jerdacuttup River for the Jerdacuttup River Action Plan (Water and Rivers Commission 2004) found the system to be naturally saline (7700– 117,300 $\mu\text{S}/\text{cm}$) due to the transport of stored salts in the soil, both from previous marine incursion and wind and rain-borne salt of marine origin. Dissolved oxygen ranged between 2.7 to 9.3 mg/L, pH ranged between 7.4 and 9, and turbidity levels were consistent at around 10 NTU (Water and Rivers Commission 2004). The greatest threat to the system, in terms of water quality, was deemed to be the high nutrient levels. Total nitrogen levels ranged between 1.2 – 9.3 mg/L (the ANZECC/ARMCANZ recommended guideline for total nitrogen is 1 mg/L), and total phosphorous levels ranged between 0.02 and 0.24 mg/L (the ANZECC/ARMCANZ recommended guideline for total phosphorous is 0.1 mg/L).

3.3 Macroinvertebrates

3.3.1 General

No scientific reports detailing the aquatic macroinvertebrate fauna of the Munglinup River were found even though an extensive literature review was undertaken. Results of aquatic macroinvertebrate surveys in nearby rivers (*i.e.* Oldfield River, Jerdacuttup River and Young River) are presented here as an indication of the type of macroinvertebrate fauna to be expected.

Cook *et al.* (2008) sampled macroinvertebrates from 33 waterways across the South Coast region, including seven sites on the Oldfield River, four sites on the Jerdacuttup River, and five sites on the nearby Young River. Stewart *et al.* (2009) was able to broadly identify two distinct aquatic bioregions within the South Coast region, based on the macroinvertebrate assemblage data collected; the Western South Coast bioregion, consisting of rivers from Gardner River in the west to Bluff River, and the Eastern South Coast bioregion, lying between the Pallinup River and the Thomas River in the east.

Across the 33 waterways, Stewart *et al.* (2009) identified five species of amphipod, four species of isopod, one species of shrimp, five species of crayfish, 35 species of Trichoptera (caddisfly), two species of stonefly (Plecoptera), nine species of Ephemeroptera (mayfly), 29 species of Odonata (dragonflies and damselflies), four species of bivalve (mussels and clams), and 12 species of gastropod (snails).

There was a high degree of disparity in macroinvertebrate assemblages between rivers of the Western and Eastern South Coast bioregions, with Eastern South Coast rivers, such as the Oldfield River, being generally less diverse (Stewart *et al.* 2009). For example, total species richness for Eastern South Coast rivers ranged from 15 - 79 species, compared to 29 - 134 species in Western South Coast rivers, with mean

species richness significantly lower (t-test, $p < 0.05$) in the Eastern South Coast bioregion (45 species), compared to the Western bioregion (69.7 species) (Stewart *et al.* 2009). Ephemeroptera, Plecoptera, Trichoptera (EPT index) richness, commonly used as an indicator of stream health, was also significantly lower in Eastern systems (2.47 vs. 12.44 species, $p < 0.05$) (Stewart *et al.* 2009). Differences in macroinvertebrate richness and composition likely reflect water quality differences between the two regions, with rivers from the Eastern South Coast bioregion being more saline, slightly more alkaline, and with higher concentrations of total nitrogen than the Western South Coast bioregion (Stewart *et al.* 2009).

Within the Eastern South bioregion, Cook *et al.* 2008 classified the Oldfield River as a high ecological value system on the basis it is in good condition, and is diverse, particularly in terms of invertebrate and fish species richness. The Oldfield River was ranked second from 15 rivers in the bioregion, and fifth overall (across the 33 waterways) for the South Coast. Criteria for assessment included equal weighting for the categories; naturalness (condition), diversity (or richness), and rarity.

3.3.2 Conservation significance

There are few endemic macroinvertebrate species in the Eastern South Coast bioregion, compared to



southwestern Australia. This is likely an artefact of species tolerance to saline conditions. There are at least three macroinvertebrate taxa of scientific interest within the bioregion, which are undescribed and potentially new to science. It has been suggested by Cook *et al.* 2008 that these taxa could be used as 'indicators' of river health in rivers of the Eastern South Coast bioregion. These include the unidentified amphipod Paramelitidae spp. and the bivalves *Westralunio* sp. and *Musculium* cf. *kendricki* (Plate 1).

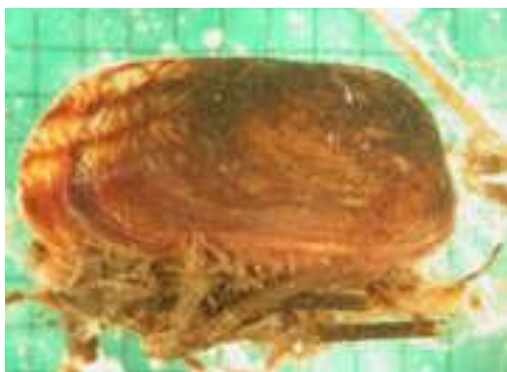


Plate 1. Potentially new species to science; the unidentified Paramelitidae spp. (top) and *Westralunio* sp. (bottom). Photographs are courtesy of Barbara Cook and Geraldine Janicke (CENRM).

An undescribed species of Paramelitidae spp. was recorded from 7 of 15 rivers sampled in the Eastern South Coast bioregion. It is unknown if this species occurs in the Munglinup River. Specimens were generally collected from sites along the lower reaches of rivers, with a distribution ranging from the Jerdacuttup River through to the Thomas River. It was not found in any rivers belonging to the Western South Coast bioregion.

Two species (consisting of two families; Sphaeriidae and Hyriidae) of 'freshwater' mussels were collected from waterways in the Eastern South Coast bioregion. Unidentified *Westralunio* sp. specimens were most abundant, collected in eight of the 15 rivers. This species is unlikely to be the EPBC listed (Vulnerable) *Westralunio*

carteri, which is known to be highly sensitive to increases in salinity (Kendrick 1976, Morgan *et al.* 2011, Klunzinger *et al.* 2012). This unidentified species appears to have affinities with more saline waterways and requires further taxonomic description. Specimens which closely resemble *Musculium kendricki*, a south west endemic (Korniushin 2000), were recorded from the Oldfield and Jerdacuttup Rivers, however, they were morphologically distinct, and thus appear to be a new, undescribed sphaeriid species.

The Eastern South Coast bioregion also contains two species of dragonfly of significance for the bioregion, the Western Swamp Emerald dragonfly *Procordulia affinis*, and *Zephrogomphus lateralis* (Cook *et al.* 2008). Both species are considered endemic to the south west Australia with potential to occur in the Munglinup River.

3.3.3 Database search

A search of NatureMap returned records of over 180 species of invertebrates within a 40 km radius of the Munglinup River, the majority of which were aquatic micro- and macro-invertebrates. A single species was considered to be of conservation significance, the water flea (Cladocera) *Daphnia jollyi*, which is currently listed as a Priority 1 (P1) species on the DBCA Threatened and Priority fauna list, and as Vulnerable on the IUCN Red List of threatened fauna. This species is considered highly unlikely to occur within the Munglinup River, as its preferred habitat is freshwater pools over granite outcrops. Historical water quality data suggest salinity levels in the Munglinup River most likely exceed the species tolerance.

A search of the Atlas of Living Australia (ALA) database for species within a 10 km radius of the Munglinup River returned macroinvertebrates from the families Ceinidae (amphipods), Dytiscidae, Leptoceridae, Potamiopsidae, Tanypodinae, Chironominae, Corixidae, Palaeomonidae, Sphaeromatidae, Paramelitidae, Libellulidae. There was no record of any conservation listed macroinvertebrate fauna.

A search of the EPBC Protected Matters database returned no Commonwealth listed aquatic invertebrate species within 40 km of the Munglinup River.

3.3.4 Variation in macroinvertebrate communities

There have been no studies of temporal variation in aquatic invertebrate species richness or abundance at Munglinup River, or the Eastern South Coast aquatic bioregion. Like fish, invertebrate communities are known to exhibit large variation in response to seasonal changes in habitat and food availability, water quality (salinity, temperature, nutrients), predation pressures and annual recruitment success. Prior analyses of south-west Australian riverine fauna have revealed a distinct seasonality in the invertebrate community structure, whereby summer/autumn fauna is typically distinct from winter/spring fauna (refer Bunn 1986, Bunn *et al.* 1986, 1988, Storey *et al.* 1990). This partly reflects emergence of species into terrestrial adult stages in summer/autumn as a mechanism to avoid desiccation when streams dry in summer, and the presence of fauna with drought-resistant stages in seasonal streams, resulting in inherent differences in the fauna of seasonal and perennial streams. Such seasonality is likely present in estuarine invertebrate communities but there is little documented information.

3.4 Fish & decapod crustacea

3.4.1 General

While decapod crustacea, such as shrimp and crayfish, are invertebrates, they have been included here with fishes as they are viewed by the Department of Primary Industries and Regional Development (DPRID; formerly the Department of Fisheries), and by the general community, as recreational and commercial fisheries species.

At least 16 fish, one shrimp and five freshwater crayfish species are known to occur (or historically occurred) in inland rivers of the south coast bioregion. These include two introduced freshwater fishes and one introduced crayfish. Most of these species occur within the few remaining suitable habitats of the Western South Coast bioregion, seldom occur in the East South Coast bioregion, and are unlikely to occur in the Munglinup River, though there has been only limited survey effort within the system to-date.

3.4.2 Estuarine (Euryhaline) Fishes

Cook *et al.* 2008 recorded five estuarine or euryhaline fish species across 33 waterways in the South Coast bioregion. They include the Black Bream *Acanthopagrus butcheri*, Swan River Goby *Pseudogobius olorum*, Western Hardyhead *Leptatherina wallacei*, sea mullet *Mugil cephalus*, and pouched lamprey *Geotria australis*. The black bream, swan river goby and western hardyhead have also been previously recorded from the Oldfield River (Morgan *et al.* 2006). These five species have potential to occur in the Munglinup River.

The pouched lamprey is of conservation importance and is listed as a P1 species by DBCA. Currently, there is no recovery plan for this species in Western Australia. This species belongs to an ancient lineage of jawless fishes whose morphology has remained largely unchanged for approximately 280 million years. *Geotria australis* is the only surviving species of Geotriidae in Australia, and one of four extant lamprey species found in the Southern Hemisphere (Potter 1996, Allen *et al.* 2002). Distribution of the species is sporadic between Perth and Albany (Morgan *et al.* 2011) but the majority of recent records are from the Warren and Donnelly river catchments (Morgan *et al.* 1998). Cook *et al.* 2008 recorded *G. australis* in the Western South Coast aquatic bioregion. It is unknown if its current distribution extends to the Munglinup River. Habitat alteration (including the construction of dams, extraction of groundwater and agricultural practices) and salinisation are believed to have led to the loss of pouched lamprey from many areas. The species also occurs in rivers of the south-eastern Australian mainland, Tasmania, New Zealand, and South America (Potter 1996; Morgan *et al.* 1998, 2011).

No other estuarine species are listed for conservation significance under State or Commonwealth legislation, or by the IUCN. However, the western hardyhead is a relatively common estuarine species endemic to south west Western Australia and inhabits coastal streams and estuaries between east of Esperance, to the Bowes River just north of Geraldton (Allen 2003, Morgan *et al.* 2006). The species can complete their entire life-cycles in either estuarine or freshwater environments.

3.4.3 Obligate Freshwater Fishes

A total of eleven native, obligate freshwater fish species have been recorded in the South Coast region (Allen 2003, Cook *et al.* 2008, Morgan *et al.* 2006, 2011). An obligate freshwater species is defined as one requiring the use of freshwater in order to complete its life cycle. Species known from the region include the freshwater cobbler *Tandanus bostocki*, the salamander fish *Lepidogalaxias salamandroides*, the western minnow *Galaxias occidentalis*, the western mud minnow *Galaxias munda*, the black stripe minnow *Galaxias nigrostriata*, the trout minnow *Galaxias truttaceus hesperius*, the common jollytail *Galaxias maculatus*, the western pygmy perch *Nannoperca vittata*, the Balston's pygmy perch *Nannatherina balstoni*, the little pygmy perch *Nannoperca pygmaea*, and the nightfish *Bostockia porosa*.

Many of the native freshwater fishes of the South Coast region have undergone extensive range contractions, with a number of species considered rare and having restricted distributions (Morgan *et al.* 1998, Galleotti *et al.* 2010, Beatty *et al.* 2014). Species listed under Federal and State endangered legislation include the western mud minnow *Galaxiella munda*, Balston's pygmy perch *Nannatherina balstoni*, western trout minnow *Galaxias truttaceus hesperius*, little pygmy perch *Nannoperca pygmaea*, black-stripe minnow *Galaxia nigrostriata*, and the Salamander fish *Lepidogalaxias salamandroides*. Conservation significance and range distribution is provided below:

- Western mud minnow is currently listed as Vulnerable (WC Act) and Lower Risk/Near Threatened (IUCN). The species is currently restricted to a few localities; Angove River, Boodjidup Brook, Donnelly River, Margaret River, Moore River, upper Vasse River and Wilyabrup Brook (Morgan *et al.* 2011).
- Balston's Pygmy Perch is one of the least common fishes in south-western Australia and is listed as Vulnerable at both State (WC Act) and Federal (EPBC Act) level. Margaret River is the

northern limit of the patchy distributional range which extends southwards to the Goodga River, east of Albany (Morgan *et al.* 1998, Morgan *et al.* 2011).

- Western trout minnow is listed as Endangered at State (*WC Act*) level and Critically Endangered under the Commonwealth (*EPBC Act*). Historically populations have been recorded from the King, Kalgan and Goodga Rivers near Albany in south-western Western Australia (Morgan *et al.* 1998). Currently populations are known from three locations: the Goodga River extending into Moates Lake (Goodga suite), the Angove River extending into Angove Lake (Angove suite), and the upper Kent River.
- Black-stripe minnow is listed as Endangered at State (*WC Act*) level and Lower Risk/Near threatened on the IUCN. Southern populations are located between Augusta and Albany, with the majority found on the Scott Coastal Plain, centred near Northcliffe in the D’Entrecasteaux National Park (Morgan *et al.* 1998; Morgan & Gill 2000).
- Little pygmy perch is listed as Endangered at State (*WC Act*) level. It is one of Australia’s most geographically restricted freshwater fish species, currently known from a geographical area of only 0.06 km², and a stream length of 1.2 km at the confluence of the Hay and Mitchell River (Morgan *et al.* 2013).
- Salamander fish is listed as Endangered at State (*WC Act*) level and Lower Risk/Near Threatened on the IUCN. It is locally common but restricted to ephemeral wetlands along the south coast between Augusta and Denmark.

Species listed for conservation under State and Federal legislation are highly unlikely to occur in the Munglinup River as current known distributions are confined to the south west bioregion, and do not extend to the Eastern South Coast bioregion. In addition, salinisation is a recognised threat to south-western Australia’s freshwater fishes (Morgan *et al.* 2003), and background salinity of the Munglinup River likely exceeds individual species tolerances (Beatty *et al.* 2011).

The only native freshwater fish species found in rivers in the Eastern South Coast bioregion (found in eight rivers including the Oldfield) is the Common Jollytail (or “Spotted minnow”) *Galaxias maculatus* (Cook *et al.* 2008, Morgan *et al.* 2006). The common jollytail is considered a “true” freshwater species, however it is known to tolerate salinities up to 50 ppt. This species has a remarkably widespread distribution, having been recorded in lower elevation coastal streams across southern Australia (including the South Coast of WA, South Australia, Victoria, Tasmania and New South Wales), New Zealand, Patagonian South America and the Falkland Islands (Allen 2003, Morgan *et al.* 2006). It is not listed for conservation significance under State or Commonwealth legislation, or by the IUCN.

The only introduced fishes recorded in the South Coast aquatic bioregion are freshwater species, the mosquitofish *Gambusia holbrooki* and rainbow trout *Oncorhynchus mykiss*. Neither species have been recorded within the Eastern South Coast aquatic bioregion, and as such are unlikely to be present in the Munglinup River.

3.4.4 Database search

A search of NatureMap returned the records of four estuarine species within a 40 km radius of the Munglinup River, the western hardyhead, swan river goby, sea mullet and black bream.

A search of the EPBC Protected Matters database returned no record of any Commonwealth listed freshwater or estuarine fish species occurring within a 40 km radius of the Munglinup River.

A search of the ALA database for fish species within a 10 km radius of the Munglinup River confirmed the presence of the common jollytail *Galaxias maculatus* in the system.

3.4.5 Freshwater Shrimp

The freshwater shrimp *Palaemonetes australis* is common in rivers, lakes and estuaries of south west Australia from Esperance to the Hill River (Bray 1976). The freshwater shrimp is not listed for conservation on any state or federal legislation. The salinity of the Munglinup River is within the known tolerance of adults.

3.4.6 Freshwater Crayfish

All of the 11 species of freshwater crayfishes native to Western Australia are endemic to the southwest bioregion (Austin and Knott 1996, Morgan *et al.* 2005). There have been no comprehensive surveys of freshwater crayfish in the Munglinup River, however, four of six native *Cherax* species have been found in rivers of the South Coast aquatic bioregion. These include the smooth marron *Cherax cainii*, two species of koonac *Cherax preissii* and *Cherax crassimanus*, and the gilgie *Cherax quinquecarinatus* (Cook *et al.* 2008). However, the majority of records fell within the Western South Coast bioregion, with only one species of koonac, *C. preissii* collected from rivers within the Eastern South Coast bioregion. The occurrence of *C. preissii* in the Bremer River represents a range extension, as this species was previously thought to occur only as far east as the Kalgan River (Shipway 1951, Cook *et al.* 2008). Although the Bremer River is due west of the Fitzgerald River National Park, it is possible current distribution of *C. preissii* extends to the Munglinup River. The species is classified as least concern on the IUCN redlist, and is not listed for conservation on any state or federal legislation.

Koonacs are typically found inland in seasonal wetlands with clay and organic sediments, and less commonly in perennial rivers (Austin & Knott 1996). These crayfish have a well-developed burrowing ability (*i.e.* spade like claws), digging short burrows in the banks along the margins (Shipway 1951). In this way, koonacs are able to withstand periods of low water level by retreating into burrows until flows return.

The remaining five native species of freshwater crayfish in Western Australia belong to the endemic genus *Engaewa*, with all species restricted to south-western Australia (Riek 1967, Horwitz and Adams 2000). The Dunsborough burrowing crayfish *Engaewa reducta* and Walpole burrowing crayfish *Engaewa walpolea* are listed as Endangered under State legislation (WC Act).

The distribution of the introduced yabby *Cherax destructor* also extends to the Western South Coast bioregion.

3.5 Frogs

Over 22 species of frog are known from the South Coast region (Danks 2004). Four species are endemic to the region, including the sunset frog *Spicospina flammocaerulea*, the spotted thighed frog *Litoria cyclorhyncha*, the south coast froglet *Crinia subinsignifera*, and the Walpole frog *Geocrinia lutea* (Danks 2004). Two of these species, the sunset frog and the Walpole frog, are listed for conservation significance. The sunset frog is listed as Endangered by the EPBC Act, and Vulnerable by State and IUCN listings. The Walpole frog is listed as Near Threatened by the IUCN. Neither of these species are considered likely to occur in the Munglinup River, as both are known only from a small area around Walpole, around 500 km to the west. The spotted thighed frog and the south coast froglet are more widely distributed throughout the South Coast region and current distribution may extend to the Munglinup River.

Frogs play an important role in functional ecosystems and have a requirement for water during their life cycle. They spend much of their lives in moist environments, such as marshes, swamps and along the riparian zone of rivers, due to their permeable skin which makes them susceptible to desiccation. Frogs

also need water during certain stages of their life cycle in which to lay eggs and for tadpoles to survive and metamorphose.

3.5.1 Database search

A search of the NatureMap database returned records of 13 species of frog within 40 km of the Munglinup River. It confirmed the presence of two endemic species, the spotted thighed frog *Litoria cyclorhyncha* and the south coast froglet *Crinia subinsignifera*.

A search of the ALA database returned a record of the white-footed trilling frog, *Neobatrachus abbiceps*, within a 10 km radius of the Munglinup River.

A search of the EPBC Protected Matters database returned no records of any Commonwealth listed frogs within 40 km of the Munglinup River.

3.6 Water Rat *Hydromys chrysogaster*

The rakali, or water rat *Hydromys chrysogaster*, is one of Australia's two truly amphibious mammals (the other being the platypus) (Australian Museum 2018). It is listed a Priority 4 (P4) species on the DBCA threatened and priority fauna list. Despite being a relatively rare and cryptic species, the rakali is found in all Australian states and territories, including the southern region of Western Australia between Moora north of Perth, to the Fitzgerald River National Park east of Albany (Atlas of Living 2018). Although there are no records of this species east of the Fitzgerald River National Park (Atlas of Living 2018), there have been no targeted studies undertaken in the Munglinup River to-date. Given the widespread distribution of rakali in a large variety of habitats from permanent freshwater rivers and lakes to brackish-water environments (Olsen 2008, Valentine *et al.* 2009, Smart 2009, Smart *et al.* 2011), there is potential for populations within the vicinity of the Munglinup River.

Recent surveys of water rats in the south-west have focused on the greater Perth region (Valentine 2009, Smart 2009, Smart *et al.* 2011, WRM 2016). Results from night-time trapping suggest water rats prefer areas with a high percentage of vegetation cover, stream cover, bank stability and habitat diversity. There was also some evidence from these recent studies to support previous findings (Watts & Aslin, 1981, Scott & Grant 1997) that water rats require access to permanent water sources. Watts & Aslin (1981) report water rats suffer from heat stress if access to permanent pools is lost. Water rats are omnivores and their diet includes freshwater molluscs, crayfish, insects, fish, birds, reptiles and small mammals (see Smart *et al.* 2011). Breeding can occur throughout the year, but more typically in spring. They build nests at the ends of tunnels dug into banks near tree roots or in hollow logs. Therefore, there is a requirement for stable stage heights that inundate banks, tree roots and large woody debris, without erosive flows (WRM 2007).

3.7 Southwestern snake-necked turtle

One species of freshwater turtle is known from the South Coast region; the southwestern snake-necked turtle *Chelodina colliei* (Danks 2004, Kuchling 2010). This species is endemic to southwest Western Australia and is listed as Near Threatened by the IUCN. It has a relatively widespread distribution throughout the southwest region, from Kalbarri in the north to Esperance on the southern coast. As such, it is considered possible to occur in the Munglinup Rivers, despite there being no record of this species east of the Fitzgerald River National Park on the ALA database.

Snake-necked turtles inhabit both permanent and seasonal waterbodies throughout their range. They can migrate relatively long distances overland if local conditions deteriorate (Gerald Kuchling, The University of Western Australia, pers. comm.) or they can burrow into the sediment and aestivate. Since their diet includes tadpoles, fish, and aquatic invertebrates, tortoises only eat when open water is present. In permanent waters, this species has two nesting periods (September-October and December-January) but in seasonal systems, nesting will only occur in spring.

4 CONCLUSIONS

In general, the Munglinup River can be considered of low-moderate regional conservation value, largely due to past anthropogenic disturbances, including catchment clearing and agricultural land use practices. Salinity, and to a lesser degree nutrient enrichment, are the main factors influencing the diversity and composition of aquatic fauna in rivers of the Eastern South Coast bioregion. Subsequently, macroinvertebrate richness is typically more depauperate in rivers within this bioregion, compared with those further to the west. In addition, the majority of fauna listed under federal and state conservation legislation do not have distributions which extend into the Eastern South Coast bioregion. Only two species listed under the WC Act are considered likely or possible to occur in the Munglinup River; the rakali (water rat) and south-western snake necked turtle. No species listed under the EPBC Act were considered likely or possible to occur in the Munglinup River. It is unknown if the freshwater mussels and sideswimmer (or scud) of scientific interest (*i.e.* potentially new to science) occur in the Munglinup River. Endemic species of fish, crayfish and frogs which occur, or have potential to occur in the Munglinup River have a documented wider distribution across the South Coast region.

5 POTENTIAL IMPACTS TO AQUATIC FAUNA AND DEVELOPMENTAL CONSIDERATIONS FOR INTERMITTENT RIVERINE DISCHARGES

5.1 Thermal pollution (Increased water temperature)

There is the potential for short-term changes to surface water temperature (thermal pollution), and associated impacts to the receiving section of Munglinup River. The mechanical process of riverine discharge typically results in slightly warmer water than background surface water, which tend to reflect ambient air temperature, but are also influenced by water colour, water depth and degree of riparian shading (ANZECC/ARMCANZ 2000).

Water temperature can impact the ecosystem through decreased oxygen supply (Chang *et al.* 1992, Meyer *et al.* 1999), increased metabolic rate of aquatic fauna (Rouse *et al.* 1997, Gillooly *et al.* 2001), changes to the timing of breeding, spawning and other life-history cycles, increased primary production leading to algal blooms (Robarts and Zohary 1987, Ochumba and Kibaara 1989) and, can ultimately reduce aquatic biodiversity (Parker *et al.* 1973, Ward 1976).

5.2 Erosion and siltation

Poorly designed discharge points, or large volumes of discharge, albeit intermittent, may lead to scouring and erosion, and consequent increases in turbidity and siltation at the receiving section of Munglinup River. Siltation/sedimentation is a major threat to the ecology of rivers. Increased suspended sediment concentrations from erosion can change the channel and bed morphology (Schumm 1977, Milhous 1998), smother large woody debris and other benthic and hyporheic habitats (Bartley and Rutherford 1999, Rutherford 2000), and coat organic deposits and algae upon which aquatic fauna depend as a food source (Arruda *et al.* 1983, McCabe and O'Brien 1983). Increased sediment loads also increases turbidity which

alters the light regime, affecting phytoplankton habitat and reducing the rate of photosynthesis, and consequently primary production is inhibited (Hoyer and Jones 1983, Grobbelaar 1985, Davies-Colley *et al.* 1992). Impacts to macroinvertebrate communities include mortality (Newcombe and MacDonald 1991), and decreased abundance and diversity (Quinn *et al.* 1992, Metzeling *et al.* 1995). Fish may also be affected by increased levels of fine sediment through reduced feeding efficiency (Vinyard and O'Brien 1976, Gardner 1981, Berkman and Rabeni 1987), decreased growth rates (Bianchi 1963, Hausle and Coble 1976) and increased disease (Koehn and O'Connor 1990).

5.3 Developmental/ management considerations

- Comprehensive baseline and ongoing monitoring of the quality of ground/surface water to be discharged into the Munglinup River, including water temperature, ions, salinity and nutrient levels.
- Comprehensive baseline and ongoing monitoring of surface water quality of the receiving creekline, involving the aforementioned physico-chemical parameters, in order to assess and act on any potential threats to aquatic fauna.
- Reducing scouring of the receiving creekline, by reducing flow velocity at the discharge point(s), where possible.
- Consideration into the design of the discharge point(s), in order to reduce the impacts of erosion and scouring on the receiving creekline, and thereby reduce potential impacts on the receiving environment, such as increased turbidity and siltation.

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APPENDICES

Appendix 1. Conservation Category Definitions

Table A1-1. IUCN Definitions

Category	Definition
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CE)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore 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 meets any of the criteria A to E for Endangered (see Section V), and it is therefore 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 meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore 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
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Table A1-2. EPBC Act (1999) Definitions

Category	Definition
Extinct (EX)	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (EW)	Taxa known to survive only in captivity.
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (VU)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Migratory (MG)	Consists of species listed under the following International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA) China-Australia Migratory Bird Agreement (CAMBA) Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)

Table A1-3. DBCA Threatened and Priority Fauna codes

Category	Definition
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

Appendix 2. ANZECC/ARMCANZ water quality guidelines

Table A2-1. Default trigger values for physical and chemical stressors for South-west Australia slightly disturbed ecosystems.

Ecosystem type	Chl a ($\mu\text{g L}^{-1}$)	TP ($\mu\text{g P L}^{-1}$)	FRP ($\mu\text{g P L}^{-1}$)	TN ($\mu\text{g N L}^{-1}$)	NO ₃ ($\mu\text{g N L}^{-1}$)	NH ₄ ⁺ ($\mu\text{g N L}^{-1}$)	DO (% saturation) ⁱ		pH	
							Lower limit	Upper limit	Lower limit	Upper limit
Upland river ^d	na ^a	20	10	450	200	80	90	na	6.5	8.0
Lowland river ^d	3–5	65	40	1200	150	80	80	120	6.5	8.0
Freshwater lakes & reservoirs	3–5	10	5	350	10	10	90	no data	6.5	8.0
Wetlands ^d	30	60	30	1500	100	40	90	120	7.0 ^e	8.5 ^e
Estuaries	3	30	5	750	45	40	90	110	7.5	8.5
Marine ^{g,h} Inshore ^c	0.7	20 ^b	5 ^b	230	5	5	90	na	8.0	8.4
Offshore	0.3 ^g	20 ^b	5	230	5	5	90	na	8.2	8.2

na = not applicable

a = monitoring of periphyton and not phytoplankton biomass is recommended in upland rivers — values for periphyton biomass (mg Chl a m^{-2}) to be developed;

b = summer (low rainfall) values, values higher in winter for Chl a ($1.0 \mu\text{g L}^{-1}$), TP ($40 \mu\text{g P L}^{-1}$), FRP ($10 \mu\text{g P L}^{-1}$);

c = inshore waters defined as coastal lagoons (excluding estuaries) and embayments and waters less than 20 metres depth;

d = elevated nutrient concentrations in highly coloured wetlands (given $>52 \text{ g}_{\text{wet}}\text{m}^{-1}$) do not appear to stimulate algal growth;

e = in highly coloured wetlands (given $>52 \text{ g}_{\text{wet}}\text{m}^{-1}$) pH typically ranges 4.5–6.5;

f = all values derived during base river flow conditions not storm events;

g = nutrient concentrations alone are poor indicators of marine trophic status;

h = these trigger values are generic and therefore do not necessarily apply in all circumstances e.g. for some unprotected coastlines, such as Albany and Geographe Bay, it may be more appropriate to use offshore values for inshore waters;

i = dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability (see Section 3.3.3.2).

Table A2-2. Default trigger values for conductivity (EC, salinity) and turbidity for South-west Australia slightly disturbed ecosystems.

Ecosystem type	Salinity (μScm^{-1})	Explanatory notes
Upland & lowland rivers	120–300	Conductivity in upland streams will vary depending upon catchment geology. Values at the lower end of the range are typically found in upland rivers, with higher values found in lowland rivers. Lower conductivity values are often observed following seasonal rainfall.
Lakes, reservoirs & wetlands	300–1500	Values at the lower end of the range are observed during seasonal rainfall events. Values even higher than $1500 \mu\text{Scm}^{-1}$ are often found in saltwater lakes and marshes. Wetlands typically have conductivity values in the range 500–1500 μScm^{-1} over winter. Higher values ($>3000 \mu\text{Scm}^{-1}$) are often measured in wetlands in summer due to evaporative water loss.
Turbidity (NTU)		
Upland & lowland rivers	10–20	Turbidity and SPM are highly variable and dependent on seasonal rainfall runoff. These values representative of base river flow in lowland rivers.
Lakes, reservoirs & wetlands	10–100	Most deep lakes and reservoirs have low turbidity. However, shallow lakes and reservoirs may have higher turbidity naturally due to wind-induced resuspension of sediments. Lakes and reservoirs in catchments with highly dispersible soils will have high turbidity. Wetlands vary greatly in turbidity depending upon the general condition of the catchment or river system draining into the wetland and to the water level in the wetland.
Estuarine & marine	1–2	Turbidity is not a very useful indicator in estuarine and marine waters. A more appropriate measure for WA coastal waters is light attenuation coefficient. Light attenuation coefficients ($\log_{10}$) of $0.05\text{--}0.08 \text{ m}^{-1}$ are indicative of unmodified offshore waters and $0.09\text{--}0.13 \text{ m}^{-1}$ for unmodified inshore waters, depending on exposure. Light attenuation coefficients ($\log_{10}$) for unmodified estuaries typically range $0.3\text{--}1.0 \text{ m}^{-1}$, although more elevated values can be associated with increased particulate loading or humic rich waters following seasonal rainfall events.

Table A2-3. Default trigger values for physical and chemical stressors for south central Australia slightly disturbed ecosystems.

Ecosystem type	Chl a	TP	FRP	TN	NO _x	NH ₄ ⁺	DO (% saturation)		pH	
	(µg L ⁻¹)	(µg PL ⁻¹)	(µg PL ⁻¹)	(µg NL ⁻¹)	(µg NL ⁻¹)	(µg NL ⁻¹)	Lower limit	Upper limit	Lower limit	Upper limit
Upland river	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Lowland river	no data	100	40	1000	100	100	90	no data	8.5	9.0
Freshwater lakes & reservoirs	no data	25	10	1000	100	25	90	no data	8.5	9.0
Wetlands	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Estuaries	5	100	10	1000	100	50	90	no data	8.5	9.0
Marine	1	100	10	1000	50	50	no data	no data	8.0	8.5

Table A2-4. Default trigger values for conductivity (EC, salinity) and turbidity for South-west Australia slightly disturbed ecosystems.

Ecosystem types	Salinity (µS cm ⁻¹)	Explanatory notes
Lowland rivers	100–5000	Salinity can be highly variable depending on flow.
Lakes, reservoirs & wetlands	300–1000	Wetlands can have substantially higher salinity due to saline groundwater intrusion and evaporation.
Turbidity (NTU)		
Upland & lowland rivers	1–50	Turbidity and SPM are highly variable and dependent on seasonal rainfall runoff.
Lakes & reservoirs/ wetlands	1–100	Shallow lakes and reservoirs may have higher turbidity naturally due to wind-induced resuspension of sediments. Lakes and reservoirs in catchments with highly dispersible soils will have high turbidity.
Estuarine & marine	0.5–10	Higher values are representative of estuarine waters.

Table A2-5. Trigger values for toxicants at alternative levels of protection (slightly–moderately disturbed systems).

Chemical		Trigger values for freshwater (µg/L ⁻¹)				Trigger values for marine water (µg/L ⁻¹)			
		Level of protection (% species)				Level of protection (% species)			
		99%	95%	90%	80%	99%	95%	90%	80%
METALS & METALLOIDS									
Aluminium	pH >6.5	27	55	80	150	ID	ID	ID	ID
Aluminium	pH <6.5	ID	ID	ID	ID	ID	ID	ID	ID
Antimony		ID	ID	ID	ID	ID	ID	ID	ID
Arsenic (AsIII)	1	24	94 ^C	360 ^C	ID	ID	ID	ID	ID
Arsenic (AsV)	0.8	13	42	140 ^C	ID	ID	ID	ID	ID
Beryllium		ID	ID	ID	ID	ID	ID	ID	ID
Bismuth		ID	ID	ID	ID	ID	ID	ID	ID
Boron		90	370 ^C	680 ^C	1300 ^C	ID	ID	ID	ID
Cadmium	H	0.06	0.2	0.4	0.8 ^C	0.7 ^B	5.5 ^{B,C}	14 ^{B,C}	36 ^{B,A}
Chromium (Cr III)	H	ID	ID	ID	ID	7.7	27.4	48.6	90.6
Chromium (CrVI)		0.01	1.0 ^C	6 ^A	40 ^A	0.14	4.4	20 ^C	85 ^C
Cobalt		ID	ID	ID	ID	0.005	1	14	150 ^C
Copper	H	1.0	1.4	1.8 ^C	2.5 ^C	0.3	1.3	3 ^C	8 ^A
Gallium		ID	ID	ID	ID	ID	ID	ID	ID
Iron		ID	ID	ID	ID	ID	ID	ID	ID
Lanthanum		ID	ID	ID	ID	ID	ID	ID	ID
Lead	H	1.0	3.4	5.6	9.4 ^C	2.2	4.4	6.6 ^C	12 ^C
Manganese		1200	1900 ^C	2500 ^C	3600 ^C	ID	ID	ID	ID
Mercury (inorganic)	B	0.06	0.6	1.9 ^C	5.4 ^A	0.1	0.4 ^C	0.7 ^C	1.4 ^C
Mercury (methyl)		ID	ID	ID	ID	ID	ID	ID	ID
Molybdenum		ID	ID	ID	ID	ID	ID	ID	ID
Nickel	H	8	11	13	17 ^C	7	70 ^C	200 ^A	560 ^A
Selenium (Total)	B	5	11	18	34	ID	ID	ID	ID
Selenium (SeIV)	B	ID	ID	ID	ID	ID	ID	ID	ID
Silver		0.02	0.05	0.1	0.2 ^C	0.8	1.4	1.8	2.6 ^C
Thallium		ID	ID	ID	ID	ID	ID	ID	ID
Tin (inorganic, SnIV)		ID	ID	ID	ID	ID	ID	ID	ID
Tributyltin (as µg/L Sn)		ID	ID	ID	ID	0.0004	0.006 ^C	0.02 ^C	0.05 ^C
Uranium		ID	ID	ID	ID	ID	ID	ID	ID
Vanadium		ID	ID	ID	ID	50	100	160	280
Zinc	H	2.4	8.0 ^C	15 ^C	31 ^C	7	15 ^C	23 ^C	43 ^C
NON-METALLIC INORGANICS									
Ammonia	D	320	900 ^C	1430 ^C	2300 ^A	500	910	1200	1700
Chlorine	E	0.4	3	6 ^A	13 ^A	ID	ID	ID	ID
Cyanide	F	4	7	11	18	2	4	7	14
Nitrate	J	17	700	3400 ^C	17000 ^A	ID	ID	ID	ID
Hydrogen sulfide	G	0.5	1.0	1.5	2.6	ID	ID	ID	ID

APPENDIX C-15: Applied Archaeology - Ethnographic and Archaeological Survey

Report of an Ethnographic and Archaeological Survey of Proposed Munglinup Graphite Project at Munglinup, Western Australia



Report prepared for:

Esperance Tjaltjraak Native Title Aboriginal Corporation
MRC Graphite PTY. LTD.

Report prepared by:

Applied Archaeology Australia



Applied Archaeology Australia Pty. Ltd.
PO Box 4025, Albany
Western Australia, 6330

August 2018

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The locations of cultural resources given in this report are provided to facilitate management and planning efforts only, specific to presented scope of works. Under the guidance of Traditional Owners, site location information is restricted in context and distribution. This report is not a public document. This project was carried out, and this report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Esperance Tjaltjraak Native Title Aboriginal Corporation (ETNTAC) and MRC Graphite Pty. Ltd. It should be noted that AAA relied upon written information and/or verbal accounts provided by the individuals indicated in the report. AAA can only relay this information and cannot be responsible for its accuracy or completeness. This report is not meant to represent a legal opinion. Any questions regarding our work and this report, the presentation of the information, and the interpretation of the data are welcome and should be referred to Managing Director.

David R. Guilfoyle
Managing Director
Applied Archaeology Australia
0458 266 522
dg@appliedarchaeology.com.au

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EXECUTIVE SUMMARY

Objective

The objective of this Aboriginal heritage assessment is to identify the range of ethnographic and archaeological values, places and features which may be impacted by the proposed MRC Graphite mine (M74/245) at Munglinup, Western Australia and to develop management recommendations to mitigate or lessen the impacts. The report assesses whether Section 5 or 6 of the *Aboriginal Heritage Act* (AHA) applies to any of the places or features. The scope of works is proposed by MRC Graphite Pty Ltd (hereafter, MRC).

Applied Archaeology Australia (AAA) coordinated the ethnographic and archaeological survey for Esperance Tjaltjraak Native Title Aboriginal Corporation (ETNTAC). The archaeological survey took place between the 23rd and 26th April 2018. The ethnographic survey took place on 26th and 27th April 2018. A second stage of archaeological survey was requested by MRC to inspect the dense vegetation zones deemed unsuitable for pedestrian survey during the initial fieldwork session. The stage two survey took place between the 8-11th July 2018.

Personnel

The archaeology survey involved the following personnel:

- David Guilfoyle (AAA: Archaeologist)
- Genevieve Carey (AAA: Archaeologist)
- Doc Reynolds (ETNTAC Aboriginal Liaison Officer, ALO1) 2 days
- Donald Abdulla (ETNTAC Aboriginal Liaison Officer, ALO2) 2 days
- Jordan Serve (MRC Graphite Representative)
- Myles Mitchell (AAA: Archaeologist)

The ethnographic survey involved the following personnel:

- Henry Dabb (Traditional Owner: Dabb Family)
- Terrence Yorkshire Senior (Traditional Owner: Yorkshire family)
- Diane Clinch (Traditional Owner: Boxer/Rogers Family)
- Veronica Williams-Bennell J.P. (Traditional Owner: Reynolds Family)
- Graham Tucker (Traditional Owner: Tucker Family)
- Murray Bullen (Traditional Owner: Bullen Family)
- Doc Reynolds (ETNTAC Aboriginal Liaison Officer)
- Myles Mitchell (AAA: Anthropologist)
- David Guilfoyle (AAA: Archaeologist)
- Genevieve Carey (AAA: Archaeologist)

There are six Traditional Owners, each representing one of the six families recognized as Esperance Tjaltjraak native title holders. Each of the survey participants were nominated by the individual who represents their respective family on the ETNTAC Circle of Elders.

Survey Approach

The ethnographic survey assessed the cultural significance of the place through one-on-one and group discussions and an on-ground assessment with a representative group of Traditional Owners. This information is combined with the results of an archaeological assessment and background research, to produce a cultural significance statement for the place(s) in accordance with Section 6.1 of the Burra Charter (Australia ICOMOS 2013). The report provides direct quotes from informants wherever possible as a primary data source.

The assessment considers the proponents 'needs' (Burra Charter Section 6.3) expressed in the form of the proposed scope of works, which represents a potential 'change in circumstances' for the place (Burra Charter section 6.5). It also considers the physical condition of the place and other external constraints (Burra Charter Section 6.3) as appropriate before developing management recommendations to form the basis of a 'policy for managing the place' (Burra Charter section 6.2).

The first round of archaeological survey was conducted with two qualified archaeologists and ALOs experienced in archaeological survey and accompanied by MRC representative Jordan Serve.

The second round of archaeological survey was conducted by a qualified archaeologist and an ALO. A safety induction was carried out prior to entering the site, and the team worked together to manage risks associated with such factors as exposure, dehydration, snakes, and sprains/soft tissue injuries. The team walked throughout the survey area, covering all vegetation zones and major landforms, paying particular attention to exposed areas of sand and open vegetation, as well as historic and new drill lines. It is estimated that ground surface visibility was approximately 20% across the survey area. In the thickest areas of vegetation, which is a large portion of the tenement, visibility was substantially lower than this.

The survey documentation included recording of standard archaeological field data observations in field books and survey forms, linked to field tablets. The team also utilised topographic maps and aerial imagery pre-loaded on the tablets. The survey involved photographic coverage and collection of GPS points for different areas within the project area and at each feature and survey photo points (PP – see Figure 57). The ground surface visibility and other associated environmental observations were noted. The team referred to field maps and GPS units with the boundary and route waypoints uploaded for navigation and cross-checking.

Areas Inspected

The team walked throughout the survey area, covering all vegetation zones and major landforms, paying particular attention to exposed areas of sand and open vegetation, as well as historic and new drill lines.

Limitations/Constraints

Much of the tenement is densely vegetated and almost impenetrable in parts. Additionally, the tenement contains a thick layer of ground cover. The survey is therefore of limited effectiveness across the vast majority of the tenement. However, the exposures identified within the historic drill lines provide a survey sample that is adequate to characterise the archaeological signature of this area.

Cultural resources may be hidden in such a way that only extensive excavations, use of remote sensing equipment (e.g., ground penetrating radar, magnetometer), or other technologies/methods not included in our scope of work will reveal them. Because archaeological materials, features, and other potentially significant cultural remains are commonly buried, they may not be identifiable from the surface or revealed in limited subsurface sampling. Several artefacts were observed in eroded, sub-surface contexts within tracks and eroded river terraces, and appear to be associated with run-off from historic drill lines.

It is estimated that ground surface visibility was approximately 20% across the survey area. In the thickest areas of vegetation, which is a large portion of the tenement, visibility was substantially lower than this.

Areas Excluded from the Survey

The small area within the tenement to the west of the Munghlinup River was not inspected because no mining operations are planned on this side of the river.

Findings

The assessment resulted in the identification of five archaeological places and two ethnographic places:

- MRC 01 (archaeological place - artefact scatter)
- MRC 02 (archaeological place - artefact scatter)
- MRC 03 (archaeological place - artefact scatter and ochre source)
- MRC 04 (archaeological place - artefact scatter)
- MRC 05/Mungan Wilgie Koort (archaeological place - artefact scatter, ochre source)
- Munghlinup River (ethnographic cultural place)
- Mungan Wilgie Koort (ethnographic cultural place)

All of these places are considered eligible under Section 5(a) of the AHA as an Aboriginal site due to the information that might yield further understanding of past settlement and subsistence patterns, the potential for stratified cultural deposits that may yield information on human chronologies, and the associated social and cultural values.

Archaeological Places and Features

There are five archaeological places located within the tenement. It is expected that more exist but are currently obscured by dense vegetation. The key management consideration for three of the places relate to their location within areas planned for open-cut mining, and so are likely to be destroyed. These places are quite similar in structure and organization and

detail aspects of the settlement patterns related to this wider area, and the range of activities being undertaken. The local geomorphology suggests that there is a high potential for stratified, sub-surface cultural deposits. These artefact scatters are of cultural value because they provide direct evidence of activities undertaken by the Traditional Owners' ancestors and may yield information important to our understanding of prehistory.

A process of archaeological management is required in this tenement. The places will be assessed as "Sites" under Section 5 of the *Aboriginal Heritage Act*, and as part of a larger heritage complex (Munglinup River). It is likely that they will be upheld as sites under the AHA because they demonstrate a distinct cluster of cultural materials and values in a discrete location. If upheld as sites by the DPLH, then MRC will require Section 18 consent to disturb these places. Section 18 consent in this context will be recommended to include conditions for salvage archaeology prior to disturbance.

In addition to the identified cultural places and archaeological places, several important isolated finds were identified – including a kobj (axe), a grinding stone, a unifacial point, and a number of backed artefacts. These formal implements are a feature of the southwest, yet it is unusual for a collection of these implements to be located in a small area. All these implements hold cultural value and are of major research interest, through the study of morphology and use-wear and residue analysis. Significant ochre sources have been identified across the tenement and within the rocky outcrop associated with *Mungan Wilgie Koort* (MRC 05). Ochre is of cultural significance and is afforded protection under the AHA (Section 6) if identified by Traditional Owners as such, with or without evidence of direct utilization of the ochre itself.

A further feature of interest is an embedded standing stone. It is not known for sure whether the standing stone is a cultural feature or naturally occurring. The vertical nature of the stone suggests human placement but it is not conclusive. The Traditional Owners were asked about the stone and shown pictures. They were not certain about it and wondered about the small size (H=280mm, W=260mm Th=40mm). This feature could be part of stone arrangement but it is very difficult to tell because the vegetation is so thick around it that other stones may be obscured. Stone arrangements are a relatively common archaeological feature in this region (Mitchell 2016). It is recommended that this location is zoned "amber" due to the high possibility that more cultural features exist around it, but are currently obscured by vegetation.

Additional archaeological heritage management process is required to manage unforeseen discoveries. Much of the tenement consists of very dense vegetation and ground cover and a number of artefacts were observed in sub-surface contexts. For these reasons, a process of ongoing management and monitoring is recommended given the high potential for cultural material to be exposed during any earth-moving activity.

Ethnographic Places, Values and Threats

The ethnographic survey resulted in the identification of a range of spiritual, social, ecological and cultural values associated with the area, including two interconnected heritage places – **Munglinup River** and the associated rocky outcrop (MRC 05) which the Elders on this survey now refer to as **Mungan Wilgie Koort**. Both places warrant protection under

Section 5 (b) of the *Aboriginal Heritage Act*, based on their association with the Mungan Nyitting Yarn (dreaming story) and a range of other heritage values.

The mythological significance of the Munglinup River has been identified in previous studies (Goode 2005: 31; Guilfoyle and Mitchell 2016: 61). In Noongar cultural understanding of the place, the rocky outcrop is directly connected to the river because it sits atop one of its tributaries.

As part of the ethnographic assessment, as directed by the Traditional Owners present on this survey, a HIS form for the Munglinup River has been prepared and submitted to DPLH, which would incorporate the boundary of the existing Oldfield River registration. This also includes Mungan Wilgie Koort as a contributing component; however, a separate HIS form and significance assessment has been completed for Mungan Wilgie Koort. There are management recommendations for both places. In addition, a range of cultural values were spoken about along with associated threats posed by the scope of works. These are documented in the body of the report.

Recommendations

It is recommended that the proposed works may proceed as planned, on the condition that any heritage clearance given is subject to compliance with the conditions imposed by the heritage survey team and the subsequent recommendations, and in line with the obligations under the *Aboriginal Heritage Act* (1972, as amended).

1. **It is recommended** that MRC and ETNTAC jointly establish a buffer zone around the Munglinup River to ensure the development minimizes impacts on the waterways.
2. **It is recommended** that MRC work with ETNTAC to minimise impacts of potentially dirty surface run-off in the Munglinup River by designing the operational surface water management system to ensure that releases of water from site via nominated points can be tested and controlled.
3. **It is recommended** that MRC implement a monitoring program for the Munglinup River to demonstrate that the project is not negatively impacting the river water quality and riverbank fringing vegetation. The monitoring system should be designed with input from ETNTAC and results of the monitoring be shared with ETNTAC.
4. **It is recommended** MRC and ETNTAC establish a 'no-go zone' around heritage place MRC 05 and that MRC include this information in the site induction for all staff.
5. **It is recommended** that MRC establish a new track in place of the existing one which truncates MRC 05, and work with ETNTAC and Shire of Esperance to rehabilitate the existing track.
6. **It is recommended** that MRC and ETNTAC ensure that procedures and protocols for the salvage and curation of artefacts within the development envelope is addressed within the heritage management plan (see recommendation 11)

7. **It is recommended** that MRC obtain all relevant approvals under the *Aboriginal Heritage Act* for the disturbance/recovery of archaeological material located within the Munglinup Graphite Project development envelope and work with ETNTAC to ensure that all salvage and recovery of objects is done in a culturally appropriate way.
8. **It is recommended** that the use of cultural monitors is outlined in the heritage management plan to enable the recovery of exposed artefacts and culturally important plants. Monitors should be used in areas identified as culturally sensitive.
9. **It is recommended** that MRC and ETNTAC develop and implement a cultural awareness and education plan. The education plan should include cultural awareness training for management and key decision makers as well as training for staff involved in clearing activities, that enables them to identify culturally sensitive materials and plants.
10. **It is recommended** MRC work with ETNTAC to look for opportunities to incorporate traditional names into the project features.
11. **It is recommended** that MRC and ETNTAC work together to develop a heritage management plan for the project that assists with observing and implementing these management recommendations, including legislative requirements, cultural protocols, cultural monitoring plan, salvage archaeology and curation plans.
12. In the event that MRC seeks to amend or to not uphold any of these recommendations, **it is recommended** that they notify ETNTAC in writing before commencing the program of works.

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1.0 INTRODUCTION

1.1 Objective

The objective of this Aboriginal heritage assessment is to identify the range of ethnographic and archaeological values, places and features which may be impacted by the proposed MRC Graphite mine (M74/245) at Munglinup, Western Australia and to develop management recommendations to mitigate or lessen the impacts. The report assesses whether Section 5 or 6 of the *Aboriginal Heritage Act* (AHA) applies to any of the places or features. The scope of works is proposed by MRC Graphite Pty Ltd (hereafter, MRC).

Applied Archaeology Australia (AAA) coordinated the ethnographic and archaeological survey for Esperance Tjaltjraak Native Title Aboriginal Corporation (ETNTAC). The archaeological survey took place between the 23rd and 26th April 2018. The ethnographic survey took place on 26th and 27th April 2018. A second stage of archaeological survey was requested by MRC to inspect the dense vegetation zones deemed unsuitable for pedestrian survey during the initial fieldwork session. The stage two survey took place between the 8-11th July 2018.

This report details the scope of the project and the heritage survey methods and results. This report also identifies management recommendations for the implementation of the project. The report serves to justify the management recommendations.



Figure 1. Ethnographic assessment.

1.2 Personnel

The archaeology survey involved the following personnel:

- David Guilfoyle (AAA: Archaeologist)
- Genevieve Carey (AAA: Archaeologist)
- Doc Reynolds (ETNTAC Aboriginal Liaison Officer, ALO1) – 2 days
- Donald Abdulla (ETNTAC Aboriginal Liaison Officer, ALO2) – 2 days
- Jordan Serve (MRC Graphite Representative)

- Myles Mitchell (AAA: Archaeologist)

The ethnographic survey involved the following personnel:

- Henry Dabb (Traditional Owner: Dabb Family)
- Terrence Yorkshire Senior (Traditional Owner: Yorkshire family)
- Diane Clinch (Traditional Owner: Boxer/Rogers Family)
- Veronica Williams-Bennell J.P. (Traditional Owner: Reynolds Family)
- Graham Tucker (Traditional Owner: Tucker Family)
- Murray Bullen (Traditional Owner: Bullen Family)
- Doc Reynolds (ETNTAC Aboriginal Liaison Officer)
- Myles Mitchell (AAA: Anthropologist)
- David Guilfoyle (AAA: Archaeologist)
- Genevieve Carey (AAA: Archaeologist)
- Jordan Serve (MRC Graphite Representative)

There are six Traditional Owners, each representing one of the six families recognized as Esperance Tjaltjraak native title holders. Each of the survey participants were nominated by the individual who represents their respective family on the ETNTAC Circle of Elders. In the opinion of the authors, the Aboriginal Consultants who participated in this survey are appropriate people to speak for Aboriginal Heritage in relation to the area surveyed.

1.3 Survey Area

The survey location is Mining Lease M74/245 situated along the eastern bank of the Munmlinup River, north of South Coast Highway near Munmlinup, Western Australia. A detailed location map for the tenement and proposed scope of works has been provided by MRC Graphite. MRC representative provided a tour of the tenement and information about the site layout plan, drilling results and graphite deposits to both the archaeological and ethnographic team (Figure 4).

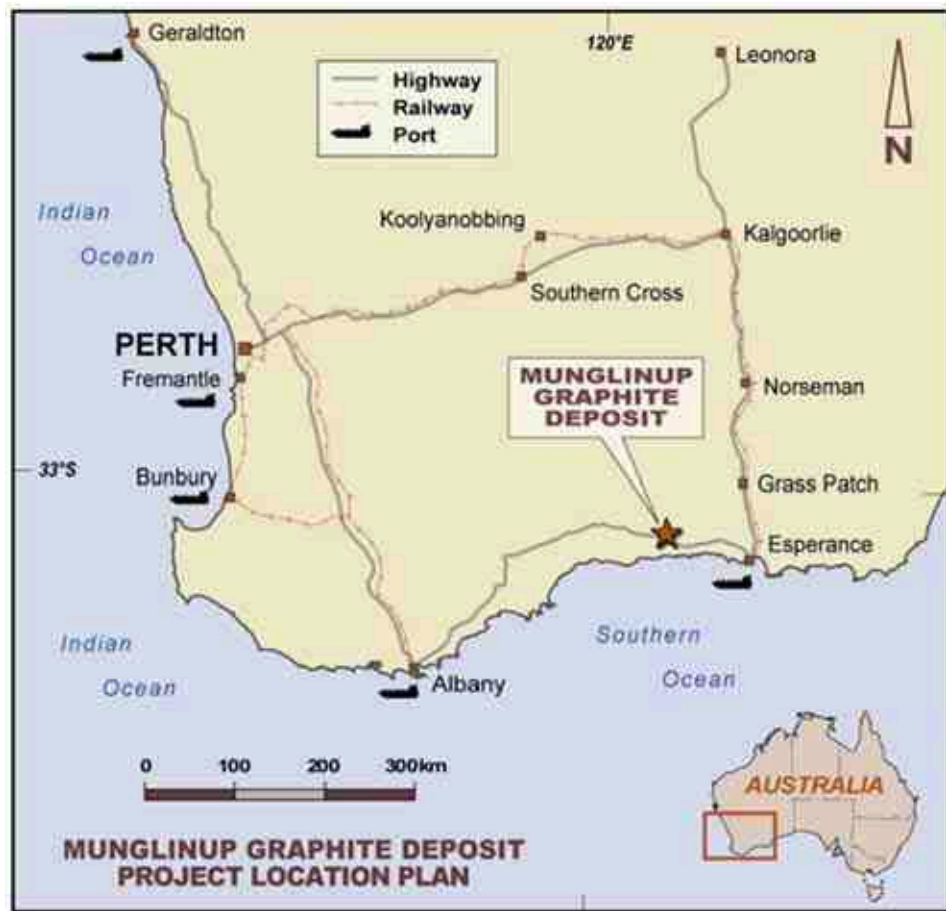


Figure 2. General location of the project area (map provided by MRC).



Figure 3. Map of Survey Location (provided by MRC Graphite)

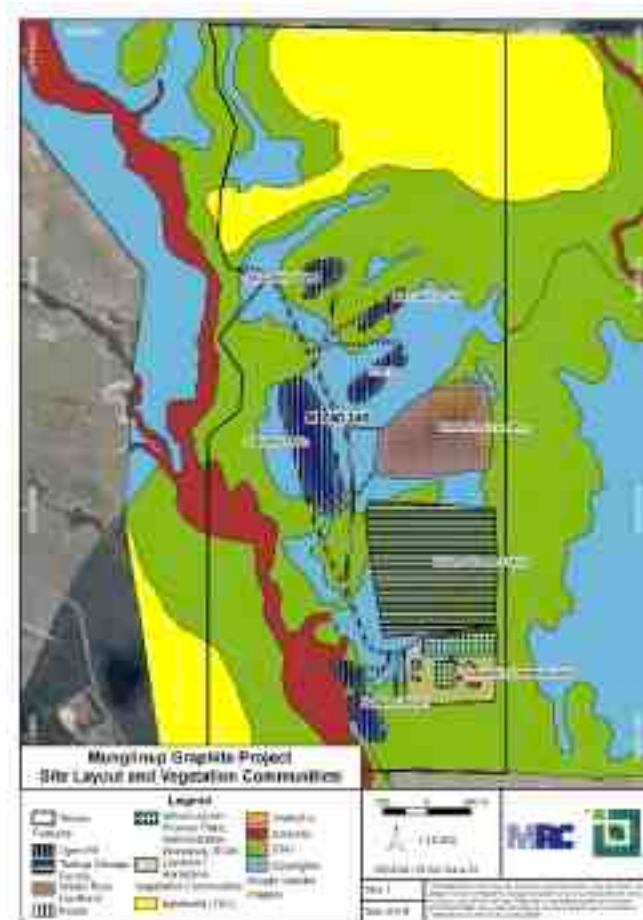


Figure 5. Proposed site layout and vegetation complexes (provided by MRC Graphite)





Figure 4. Graphite nodules and drilling results as explained by MRC representative Jordan Serve.

As per the information provided by MRC, the main deposits are steeply dipping to the east and comprise of numerous stacked layers of mineralised metasediments. Mineralisation starts at surface and has been defined to a maximum of approximately 76m vertical depth at the (Halberts) Main Zone. The mineralisation is hosted in soft saprolite and does not require drill and blasting. Mining will be done by conventional truck and shovel. The soft ore allows use of a scrubber to break up the ore, instead of a conventional crushing circuit.

1.4 Environment

This region is known for its incredible geological and biological diversity. At the broadest level, the project area is divided between a norther sector characterised by gently undulating rises on Tertiary marine sediments wrapping around occasional highs of Proterozoic gneiss, and laterites. Sediments are grey deep and shallow sandy duplex soils (usually gravelly), shallow gravels and pale deep sands, supporting Mallee scrub heath.



Figure 5. Major vegetation and landform systems within the tenement (river valley; mallee scrub; *E. platypus* woodland, laterite-capped hills/rises).

The southern sector of the project area is defined as part of a well-developed coastal river valley with gently to moderately inclined hillslopes, narrow alluvial flood plains and saline, poorly drained valley floors incised in Proterozoic gneisses and in Tertiary sediments. The main sediments are colluvium, alluvium and Tertiary sediments over granitic rocks, with grey shallow and deep sandy duplexes, alkaline grey shallow sandy duplexes and pale deep sands supporting Mallee, yate and Eucalyptus

In the north, the main vegetation systems within the tenement include *Eucalyptus pleurocarpa* mid open mallee woodland, over *Micromyrtus elobata* subsp. *elobata* tall sparse shrubland, over *Melaleuca tuberculata* var. *tuberculata*, *Leucopogon crassifolius*, and *Hibbertia gracilipes* low sparse shrubland. In the south and central, the main vegetation systems include *Eucalyptus platypus* or *E. dielsii* low open forest, over *Acacia* spp. and *Melaleuca* spp. mid sparse; *Eucalyptus flocktoniae* and/or *E. uncinata* mid woodland, over *Acacia* spp. and *Melaleuca* spp. mid sparse shrubland. Also present are clusters of *Lepidosperma* spp. or *Austrostipa* spp. low sparse sedgeland/grassland. A detailed flora and fauna report has been delivered as part of this undertaking (Ecologia 2015).

Placed in a regional context, the major soil, landform, geological and vegetation systems encompassing the tenement and surrounding river valley are shown in Figure 5 and Table 1.

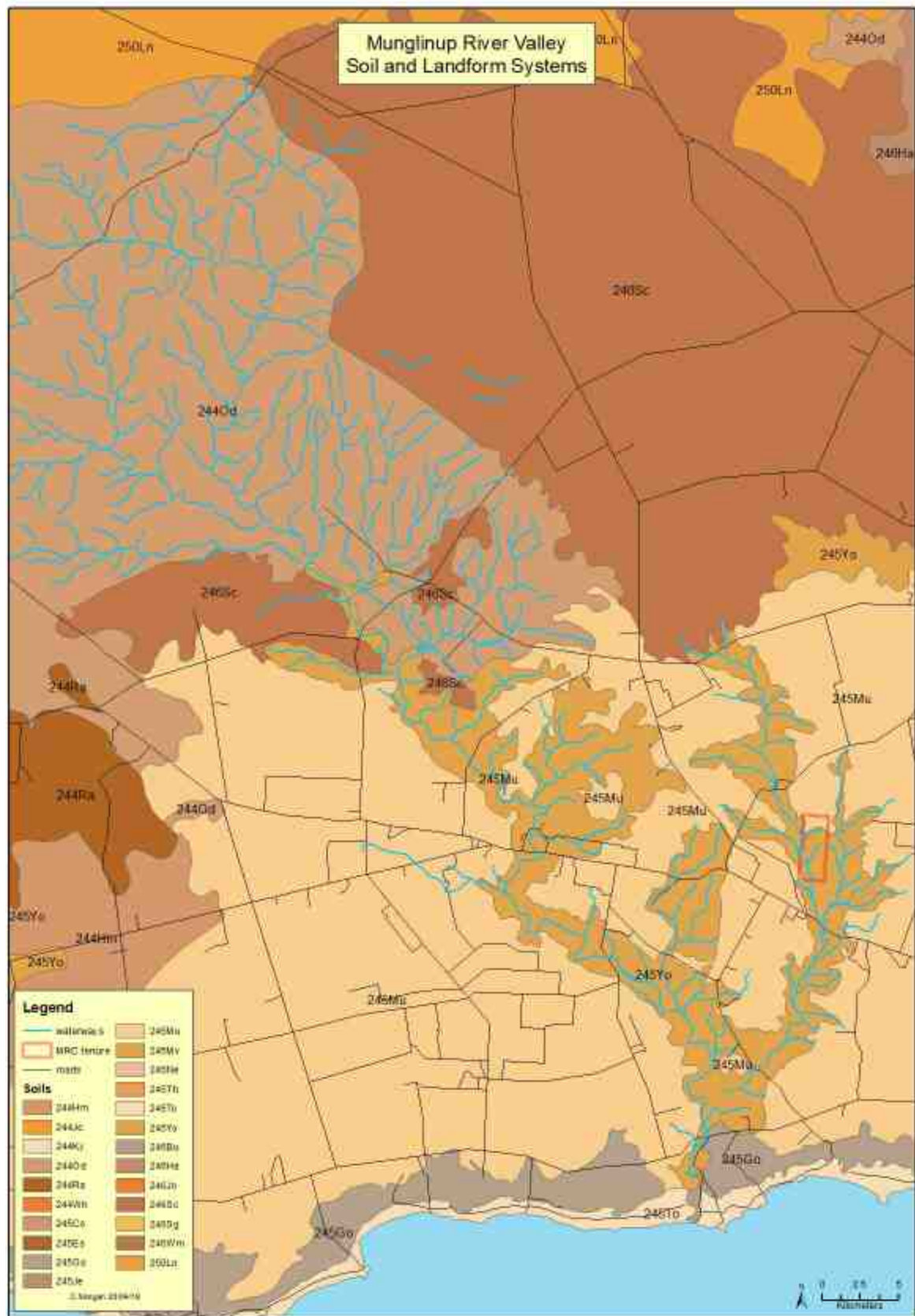


Figure 6. Major soil and landform systems encompassing the project area.

Table 1. Major landform and soil systems in the Oldfield and Munglinup valley.

MAP UNIT	NAME	Description
244Hm	Hammersley System	Level to gently undulating sandplain with swamps, in the eastern Albany Sandplain Zone, with grey sandy duplex (deep and shallow), pale deep sand and alkaline grey shallow sandy duplex. Mallee-heath.
244Jo	Jonacoonack System	Valleys and breakaways on Tertiary sediments, in the eastern Albany Sandplain Zone, with bare rock, stony soil, pale shallow sand and pale deep sand. Mallee-heath.
244Ky	Kybulup System	Undulating low hills and rises on weathered granite and gneiss, in the Ravensthorpe Zone, with alkaline shallow loamy duplex (red and grey), grey shallow sandy duplex and non-cracking clay. Mallee scrub.
244Od	Oldfield System	Dissected headwater plains and rises on Proterozoic and Archaean granite and gneiss, in the eastern Ravensthorpe Zone, with grey sandy duplex (shallow and deep) and deep sandy gravel. Mallee with scrub-heath in gravelly areas.
244Ra	Ravensthorpe System	Undulating low hills on Archaean greenstone of metasediments and ultramafics in the Ravensthorpe Zone, with alkaline red shallow loamy duplex, shallow gravel and self-muching cracking clay, non-cracking clay and stony soil. Salmon gum, York
244Wh	Whoogarup System	Mountains and hills on Proterozoic quartzite and metasediments in the Barren Ranges, with bare rock, stony soil, grey deep sandy duplex and shallow sand. Scrub heath and mallee.
245Co	Condingup System	Gently undulating plain of sand sheets and linear dunefields with pale deep sands and grey deep sandy duplex soils (sometimes gravelly). Shrub heath commonly with Banksia.
245Es	Esperance System	Level to gently undulating mid-level plain with poor external drainage. Incised by river valleys (mapped as Young System). The southern boundary is defined by a low escarpment which forms a boundary to the Gore System below.
245Go	Gore System	Discontinuous level to gently undulating coastal plain with subdued sand dunes, lakes and swamps. Unconsolidated Pleistocene sediments.
245Je	Jerdacorrup System	Coastal mobile dune field and deflating plain. Soils are pale deep sands and calcareous deep sands.
245Mu	Munglinup System	Gently undulating plain and rises on Tertiary marine sediments wrapping around occasional highs of Proterozoic gneiss
245Mv	Merivale System	Level to very gently undulating internally drained plain with numerous swamps. Soils are grey sandy duplex soils (occasionally gravelly or alkaline) with associated pale deep sands
245Ne	Ney System	Low hills and hills on Archaean granite and gneiss with slopes of colluvium. In places aeolian sand may be present on apron slopes
245Th	Thomas River System	Gently to moderately inclined hillslopes of short coastal valleys incised into the Tertiary land surface. Soils are shallow loamy duplex soils with associated pale deep sands
245To	Tooregullup System	Holocene coastal sand dunes with some remnants of Pleistocene Formations. Soils are calcareous deep sands and calcareous shallow sands.
245Yo	Young System	Well-developed coastal river valleys with gently to moderately inclined hillslopes, narrow alluvial flood plains and saline, poorly drained valley floors incised in Proterozoic gneisses and in Tertiary sediments.
246Bu	Buramina System	Level to very gently undulating plain on Tertiary sediments with aeolian accretions fringing the north eastern part of the mallee zone. Soils are calcareous loams, grey non-cracking clays and alkaline grey shallow sandy duplex soils.
246Ha	Halbert System	Level to gently undulating plain with numerous salt lakes within a paleo valley on Tertiary marine sediments (Plantagenet and Werrilup formations). Soils are alkaline grey shallow sandy duplex soils and salt lake soils.
246Jn	Johnston System	Gently undulating inland plain with occasional rises on Archaean granite deeply weathered
246Sc	Scaddan System	Level to gently undulating plain with numerous clay pans and salt lakes, and small areas of undulating rises. The geology comprises Tertiary sediments overlying Proterozoic granites with some minor Pleistocene sand sheets.
246Sc10	Scaddan 10 Subsystem	Slightly elevated gently undulating plain. Tertiary marine sediments / Prot. granite & gneiss. Alkaline grey shallow sandy duplex soils & calcareous loamy earths. Mallee shrubland / Melaleuca species with E. occidentalis woodland in Swamps.
246Sg	Salmon Gums System	Level to very gently undulating, slightly elevated, inland plain with few surface drainage features and occasional swamps. Soils are alkaline grey shallow sandy duplex soils with associated calcareous loamy earths and red non-cracking clays
246Wm	Wittenoom System	Scattered low hills and hills on Archaean granite and gneiss with slopes of mixed colluvium
250Ln	Lillian System	Mallee sandplain with occasional rock outcrop

2.0 BACKGROUND

2.1 Definitions of Aboriginal Heritage Places

The legal definition of an Aboriginal heritage place in Western Australia is covered in Section 5 of the *Aboriginal Heritage Act* (1972, as amended). Aboriginal Heritage Places are defined as:

- (a) any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;
- (b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;
- (c) any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the State;
- (d) any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

Under Section 6, the act also applies to Aboriginal Objects, defined as:

- (1) Subject to subsection (2a), this Act applies to all objects, whether natural or artificial and irrespective of where found or situated in the State, which are or have been of sacred, ritual or ceremonial significance to persons of Aboriginal descent, or which are or were used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people past or present.
- (2) Subject to subsection (2a), this Act applies to objects so nearly resembling an object of sacred significance to persons of Aboriginal descent as to be likely to deceive or be capable of being mistaken for such an object.
- (2a) This Act does not apply to a collection, held by the Museum under section 9 of the *Museum Act 1969*, which is under the management and control of the Trustees under that Act.
- (3) The provisions of Part VI do not apply to an object made for the purpose of sale and which —
 - (a) is not an object that is or has been of sacred significance to persons of Aboriginal descent, or an object so nearly resembling such an object as to be likely to deceive or be capable of being mistaken for the same; or
 - (b) is an object of the kind referred to in paragraph (a) that is disposed of or dealt with by or with the consent of the Minister.

2.2 Regional Archaeological Context

To understand and model the archaeological landscape requires an appreciation of regional patterns of change and adaptation¹. Archaeological evidence in the Esperance area indicates a history of occupation and use by social groups extending from at least 13,000 years before present (Smith 1993)². People adapted to, and shaped the natural environment, embedding systems of movement, settlement, and subsistence that exists today in the form of archaeological places and features that dot the landscape. Such places include stone artefact scatters, gnamma holes, lizard traps, quarry sites, scarred trees, burials, rock art sites, hearths/camps, and associated features. There is ethnographic information detailing the complex knowledge and associations of people using this area associated with hunting, fishing, settlement and seasonal movement.

There is evidence to suggest that people exploited the now submerged continental shelf during times of lower sea levels associated with the height of the last glacial maximum (approximately 18,000 years ago). During most of the period between 40,000 and 10,000 years ago the majority of the approximately 100 Recherche Archipelago Islands would have been granite domes in this wider coastal plain. The earliest radiometric date for human occupation currently available from the study area is 13,000 BP, from the rock shelter site of Cheetup Cave. At this stage, sea levels were some 85 metres below current levels and the coastline a minimum of 80 km distant from the current coastline (based on the 50-fathom line on marine charts). By c. 7,000 to 10,000 years ago, when the Recherche Archipelago Islands probably became separated from the mainland, the shoreline of that coastal plain would have been reduced to 10km from the current coastline (Smith 1993:32).

The direct evidence for utilization of the now submerged plain is in the form of stone artefacts and other cultural features located on the islands of the Archipelago. During an expedition to Middle Island in 1984, archaeologists identified stone artefacts atop the massive granite dome of Flinders Peak on Middle Island (approximately 6 kms offshore from Cape Arid) (Dortch and Morse 1984). The findings indicate that the chert and quartz artefacts, some of which were located near shallow gnamma holes, were created prior to the island's formation.

A striking example of Aboriginal usage of gnamma holes and other water sources on Middle Island's granite features is the find of some 14 flaked artefacts (ten are of a dark honey-coloured chert, probably deriving from now submerged outcrops) found around a soak or large, shallow gnamma hole at the 174 m-high summits of Flinders Peak (Dortch 2007:7-8).

The Australian coastline did not "stabilize" to its present form until approximately 6-5000 years ago. With rising sea levels following the end of the last Ice Age, a period of

¹ The presentation and prior research for the cultural setting section of this report is taken largely from previous AAA reports, especially Guilfoyle et al: 2012.

² Radiocarbon (¹⁴C) dates reported here are expressed as "radiocarbon years before present" or simply, "B.P.". Due to a variety of factors that cause fluctuations in amount of radiocarbon at any given time, radiocarbon dates -- especially those from the late Pleistocene epoch -- may differ from actual calendar (cal AD/BC) equivalents by hundreds or even several thousand years.

environmental instability and adjustment affected human populations, altering patterns of mobility, technological adaptation, and settlement. Numerous archaeological resources can be expected to now lie submerged on the continental shelf, and also in the deep Holocene sands that are a prominent feature of the Esperance coastline today.

The majority of the recorded archaeological sites in this region derive from the work of Smith (1993). Most of the archaeological sites observed by Smith were classified as short-term camps, consisting of stone artefact scatters of less than 300 artefacts and less than 50m² in area. The largest sites are associated with large granite domes and/or sources of permanent freshwater (see 2.4 Predictive Model of Site Distribution).

Recent wildfires and further archaeological investigations in recent years have revealed a complex of large archaeological sites and features throughout the region, requiring greater investigation before detailed understanding of the changing settlement-subsistence patterns can be developed.

Further field study... is greatly needed in formulating a more complete conception of Aboriginal hunter-gatherer land usage and cultural history from late Pleistocene times to the historic period along the 600-km-long coastal zone between King George Sound and Israelite Bay (Dortch 2007:9).

Cheetup Cave (DIA Side Id. No. 2620) remains the type-site for the Esperance region, located in the north-east corner of Cape le Grand National Park. Archaeological excavations have uncovered a number of stone artefacts, faunal and botanical material with radiocarbon dates indicating human use of this site intermittently from 13,000 years to 200 years ago. Smith (1982, 1996) uncovered a feature believed to be a macrozamia pit that was 'lined' with Xanthorrhoea (balga tree) leaf bases and containing a number of cycad or Zamia Palm (*Macrozamia riedlei*) kernels. The significance of this find is explained by Morse et al. (2007):

Use of these nuts, which require pre-treatment in the form of leaching or fermentation to detoxify them, is well documented in Ethnohistorical accounts from south western Australia (Smith 1982:119). Similar detoxification processes recorded in northern and eastern Australia led Beaton (1982) to identify the 'Basic Leaching Technology'. This process – a complex procedure involving leaching, fermenting, roasting and aging is argued by Beaton to have allowed large scale gatherings of Aboriginal people supported by the processing of cycads as 'communion food'. Beaton's evidence for zamia exploitation is dated to 4300 yr BP and occurs in stratigraphic association with stone artefacts of the small tool tradition. This has led Beaton (1982) to argue that the communal exploitation of cycads was instrumental in facilitating late Holocene social networks and the rapid dissemination of ideas (ie use of small tools). Smith's evidence from Cheetup however dates cycad processing technology to the Pleistocene. A radiocarbon date of 13 245 ± 315 (GX 6605) was obtained from a layer of charred wood and ash which overlay the macrozamia pit. While there is no evidence for the use of cycads as communion food in the Esperance area, Smith (1996) notes that the Cheetup evidence is significant in demonstrating complex

resource management and risk reduction behaviour nearly 10,000 earlier than is indicated by Beaton's data. Historical descriptions of zamia processing recorded by George Grey (1841) are remarkably similar to that identified archaeologically at Cheetup.



Figure 7. (left) Senior Traditional Owner Graham Tucker in Cheetup Cave. (right) The Western Australian Museum, Flinders University staff and students, working with the Esperance Traditional Owners to record the complex stone arrangements at Boodjari Yoork.

Archaeological site patterning also relates to changing themes, including period of European exploration and early settlement. European exploration began during the 1600's, and several of these expeditions noted the presence of Indigenous people on the mainland. By the early 1800s, a South Coast sealing and whaling industry had established itself though focused on the islands of the Recherche Archipelago with regular incursions to the mainland. Several documented incidents describe the direct impacts of interactions between Indigenous and non-Indigenous people in the Esperance area during this time.

By the late 1800s, the Dempster, Moirs and others had settled in the region and surveyed for suitable grazing land across the area, as far east as Eucla. Relationships with the earliest settlers were often hostile though some working relationships eventually developed - albeit exploitative relationships by today's standards. Many people were progressively moved into Reserves and Missions via successive government policies aimed at controlling the lives of Indigenous people; however, the community maintains strong cultural connections to the Esperance area and surrounds, including that encompassing the current APE. Indeed, strong historical connections, including historical family camps, are directly associated with the Munglinup River.

2.3 Regional Ethnographic Context

The survey area is situated within Nyungar³ country, also referred to as the "South-West" cultural bloc by Berndt (1980: 84). Nyungar people form a distinct cultural bloc now and into the distant past, based on shared linguistic and cultural traditions, a cohesive social structure and kinship network, shared regional identity, and a common geographical

³ "Noongar" and "Nyungar" are alternative spellings for the same word. "Noongar" is used in The Single Noongar Native Title Claim across the Southwest, while "Nyungar" is the spelling used by the Esperance Nyungars

connection to the lands and waters that make up the southwest corner of the Australian continent.

Nyungar country is defined on a geographical as well as cultural basis as it coincides very closely with the Southwest Australian Floristic Region, an environmental zone that defines the southwest corner of the Australian continent based on flora and rainfall (Hopper and Gioia 2004). The bloc also coincides with the South West Coast Drainage Basin (Ferguson 1985; Peterson 1976; Smith 1993: 86). The rivers of this Basin are fundamental to the economic and spiritual lives of Nyungar people. During traditional times the rivers and their tributaries formed movement corridors and resource rich landscape features that were integral to Nyungar economy and society, and Nyungar culture attaches powerful spiritual associations to the rivers through creation and nyitting (dreaming) stories. Of particular prominence are nyitting stories associated with the 'Waugal', a spiritual snake responsible for carving out and creating many landscape features, particularly the rivers, lakes and estuaries.

The term 'Nyungar', also sometimes spelled Noongar, Nyoongar or other variations, is a common term used almost ubiquitously around the region for local Aboriginal people. However, its use as a term of identity is thought to be a linguistic adaptation that originated during the post-European contact period. It originally meant man in the languages of the Southwest (Bates and White 1985:47) and Aboriginal people used to identify as 'Bibbulmun' rather than 'Nyungar' (Bates and White 1985:46). While some Southwest people still identify with this term, Nyungar is now more widely accepted and Bibbulmun is more commonly used as the identifier of people with customary rights and responsibilities to particular areas of the Southern forests from the Denmark area in the east to the Nannup area in the north-west.

There are a range of social structures which further delineate Nyungar people and connect them to particular parts of the Southwest region. This is articulated succinctly in the Nyungar evidence provided to the Federal Court hearings (Federal Court of Australia 2006:38), during which the Nyungar claimants noted that the southwest region:

... was occupied and used by Aboriginal people who spoke dialects of a common language and who acknowledged and observed a common body of laws and customs. Those Aboriginal people recognized local and regional names within the broader society but shared a commonality of belief, language, custom and material culture, which distinguished them from neighbouring Aboriginal groups and societies. Responsibility for and control, particular areas of land and waters, were exercised by sub-groups or families, but the laws and customs under which the sub-groups possessed those rights and interests were the laws and customs of the broader society

Internal distinctions within the Nyungar bloc have been described variously by different scholars, perhaps most notably by Berndt (1980: 82) who delineated the Southwest cultural bloc into 13 sub-groups composed of 'dialectal units' of the broader Nyungar linguistic group but also identified detailed distinctions among the affiliated groups on the basis of social organisation. He divides them into four distinct categories. The first incorporates seven sub-groups encompassing the northern and western majority of Nyungar country and is based on social organisation which adheres to a matrilineal descent system and paternal ritual affiliation (Berndt 1980: 82). The second comprises two sub-groups, Bibelmen (Bibulmun) and Mineng, and is based on similar organisation to the first, but uses a patrilineal descent

system. The third comprises the Ballardong and Nyaginyagi, and utilizes two alternating descent systems between different generations, but is focussed on patrilineal local decent groups, which Berndt suggests is similar to the social organisation of Western Desert people (Berndt 1980: 83-4). Berndt's fourth category refers to the Wudjari (Esperance Nyungars) and Goreng. Berndt describes the Wudjari and Goreng as similar to the third category (Ballardong and Nyaginyagi) because they are based on patrilineal descent. However, he distinguished between the third and fourth categories on the basis that the Wudjari and Goreng maintained named totemic groups which he suggests are probably 'patrilocal descent units' (Berndt 1980: 84).

Within and between the sub-groups articulated by Berndt there are further distinctions, subgroupings and notions of identity that form the intricacies of Nyungar society. This society has its roots deeply etched in the traditional social structures of the pre-contact period and like all societies continues to evolve and change as a result of both internal and external influences. European invasion and subsequent settlement of the region is of course a major external influence and the impacts on Nyungar society have been severe and far-reaching. Nyungar culture and society has evolved and adapted in the face of these disruptions and continues to be a distinct Aboriginal identity. Among all of the layers of connection and identity that comprise the fabric of Nyungar society, perhaps the most fundamental is that of family and kinship. Nyungar people identify most fervently with their extended family and they will very often define their primary identity on the basis of family.

Also fundamental to Nyungar identity and culture is connection to country. This concept articulates a series of rights and responsibilities that every Nyungar person maintains to certain places, landscapes and regions. Perhaps the two most important aspects of connection to country are 1) the responsibility to care for country and 2) the right to speak for country. The responsibility to care for country is something that Nyungar people inherit from their ancestors and bequeath to their children. Upholding these responsibilities are fundamental to Nyungar culture and identity. On this basis, being able to uphold these responsibilities is pivotal to Nyungar people's sense of purpose and self-worth and therefore, well-being. Intertwined with the responsibilities that people maintain to country are rights to make collective decisions affecting country.

The combination of these rights and responsibilities are the basis for contemporary Nyungar custodianship. What this means in a practical sense, is that Nyungar people expect to have a 'seat at the table' in decisions that affect their lands and waters. Put another way, Nyungar people have a customary set of rights and responsibilities that require them to have real power in all decisions affecting their country. As all Nyungar people are now living within the modern economy of Australia, their time and input has costs associated with it and they require remuneration accordingly. While the *Aboriginal Heritage Act* (1972) stipulates the need to consult with Aboriginal people about a narrowly defined set of places and materials, Nyungar people have a custodial interest and responsibility over a much broader set of places and issues than those defined by the act.

The Traditional Owners living in Esperance today are known collectively as the Esperance Nyungars or Esperance Tjaltjraak. They are also sometimes referred to as Wudjari people. However, Wudjari is a somewhat conflicted name and not all of the Traditional Owners identify with the title. Indeed, ethno-historic documents present a long-held questioning of the term Wudjari which is tied to a range of competing positions about identity, territory and

law in Aboriginal society around the Esperance region during the past 200 years (Eyre 1845; Forrest 1875; Curr 1886; Helms 1896; Tindale 1974; Bates and White 1985; Von Brandenstein 1988). The ethno-historic picture is one of dynamic negotiations over territory and identity that was related to the broad scale expansion of Western Desert law and language (Gibbs and Veth 2002). There appear to have been sustained attempts to initiate Nyungar people of the Esperance region into the Western Desert rites, and there was fissioning within local Aboriginal society as a result of some people joining desert law and some refusing to do so. Ultimately, the Nyungar connection won out and today The Esperance Nyungars stand as proud members of the Nyungar nation, in name and in spirit.



Figure 8. (left) Esperance Traditional Owners gather On Country as part of cultural NRM projects. (right) Esperance Traditional Owners gather with Waigly Kaip Nyungar Elders for a workshop at Munglinup.

On the 14th of March 2014, the Federal Court recognized the Native Title rights and interests of The Esperance Nyungars, including their connection to country, culture and heritage. This connection is manifest in the deep sense of responsibility that Esperance Nyungar people hold towards their country, and everything in it, the landscapes, seascapes, plants, animals, rocks, water, cultural materials, and cultural heritage (tangible and intangible). This is a responsibility that the current Elders take very seriously, as they carry on the work of their forebears during a turbulent point in the long historical trajectory of The Esperance Nyungars. There are many new and existing threats to culture, heritage and country in the Esperance region, which require careful management.

In March 2015, the Esperance Nyungars established their prescribed body corporate and they chose the name Esperance Tjaltjraak Native Title Aboriginal Corporation. This decision was based on the wishes of the late Mr Tom Bullen, a founder of the Esperance Nyungar native title claim, and one of the last senior knowledge holders of his generation. Tjaltjaraak refers to the blue mallee gum (*Eucalyptus pleurocarpa*), which is commonly found in Esperance Nyungar country. It is said that the distribution of blue mallee gum corresponds directly to Esperance Nyungar territory, and where the blue mallee gum ceases to grow to the north and east of the region, local Aboriginal people know that it is no longer Nyungar country (Doc Reynolds 11 October 2011). Thus, Tjaltjraak is an important word for the Esperance Nyungars with reference to identity and territory.

In summary, there remains a deep connection between country and identity for Esperance Nyungar people. That is, the identity of Esperance Nyungar people is derived directly from

their country. Esperance Nyungar identity and culture is based on the deep connection to their land and the profound responsibility that they feel to care for and manage their country.

2.4 Predictive Model of Site Distribution

With any archaeological project, levels of predictive modelling are applied to assist with field planning, survey methodology, and to evaluate survey results. There are many ways to undertake a predictive model, with the intent to identify ‘decision-making processes’ among past human societies. In general, predictive models focus on the economic (settlement-subsistence) decisions related to ecological criteria of a specific landscape.

“For instance, an area that has easy access to fresh water, a high number of plant and animal species or suitable camping areas (e.g., gentle slope), or is at the conjunction of several different landforms, can be described as having high resource complexity and locational suitability. The logic here is that areas where a number of resources and good camping locations coincide are likely to have been a focus of Aboriginal settlement/use in the past, and this will be reflected in the presence of a high density of archaeological places. The converse applies to areas of low resource complexity and/or suitable camping locations. A predictive model aims to identify high, medium, and low areas of archaeological potential across a region” (Guilfoyle 2006: 41).

These models are useful to explain aspects of the archaeological landscape but may sometimes overlook the social dimensions in human decision-making, and broader factors related to group dynamics, kinship systems, trade and exchange relationships, and connections with the spiritual landscape that may not fit into any model based on broad ecological criteria.

Nonetheless, isolating ‘predictive statements’ for a defined area can be useful to determine expected survey results and actual survey results, and so the predictive model is the basis for isolating the reasons for any divergence. For example, an area expected to contain a high number of archaeological sites but, following a survey, little site data was identified, we might then relate this result to prevailing social structures, or natural site formation processes (low ground surface visibility).

There are a variety of methods of archaeological predictive modelling, although all models fall into four main categories. They are:

1. predictive modelling based on background research
2. predictive modelling based on percentages of known sites associated with specific environmental variables (slope, distance from water, etc)
3. predictive modelling based on regression analysis
4. predictive modelling based on landform and/or terrain unit association

An effective predictive model is dependent on large datasets of high quality data. Unfortunately, in this region, the datasets available are largely from the existing DPLH register of Aboriginal sites. Interrogation of this database for this area demonstrates a somewhat fragmentary and inaccurate dataset; related to the way information was collected and managed prior to the use of field GPS units, and the type of information that is collected

and stored to satisfy legislative requirements (general, broad categories of site data and vague site boundaries). For these reasons, the predictive modelling here adopts type 1 and type 4.

With these limitations in mind, the team examined regional and cross-regional data to develop a series of predictive statements related to current APE. First, a review of existing understandings or archaeological site patterns was reviewed. Most of the recorded archaeological sites in the Esperance region derive from the work of Moya Smith (1993) as summarized succinctly here by Morse et al (2007):

As part of her PhD research in the 1980s, Moya Smith (1993) identified and analyzed 217 archaeological sites in an area between Esperance and Cape Arid. The great majority of sites recorded are non-stratified scatters of stone artefacts, sometimes associated with other features including gnamma holes, lizard traps, stone quarries, stone arrangements and paintings. Smith found that site location is associated with topographical features, notably granite domes or pavements, watercourses, salt lakes and swamps. In areas near the coast nearly 60% of sites are located on and around granites. As noted in conversation with Indigenous consultants, granite domes are known to provide a variety of vegetation and other food sources; they are convenient look out posts to watch for game animals and approaching people; they provide easy access to shelter from wind, rain and sun, are predictably used for gnamma holes and lizard traps and importantly have desirable water catchment properties (Morse et al 2007:3).

Most of the archaeological sites observed by Smith were classified as short-term camps, consisting of stone artefact scatters of less than 300 artefacts and less than 50m² in area. The largest sites are associated with large granite domes and/or sources of permanent freshwater.

Dortch (1984) suggests that that past land use patterns involved seasonal movements linked to the availability of key resources, whereby groups most likely congregated on the coast during summer and autumn, dispersing inland during the winter months. Dortch (2002) has classified the diverse range of sites throughout the region into categories of either ‘congregative’ or ‘dispersive’, reflecting the ‘periodic congregation and dispersal of families, local descent groups, and bands’ (Dortch 2002:13). These contrasting settlement/mobility systems create contrasting archaeological signatures that, at the regional scale, provide evidence for notions of ‘group mobility, dispersal, and amalgamation through reciprocal agreements on land access and usage’ (Dortch 2002: 13).

These regional studies demonstrate the dynamic nature of the archaeological record and developed broad chronological sequences and patterns of technological change; however, assemblage analysis is mostly limited to documenting patterns between site size/densities and environmental systems. While the above regional surveys and interpretations provide some use for generalized predictive statements about the character of archaeological resources in certain areas, there is little attempt to compare and characterise different assemblages at the regional level, and so an inability to discern variation in patterns of land usage.

For this undertaking, and in considering of the limitations of a fragmentary and limited existing database, an assessment of previously recorded sites within a 10km radius of the project area were used to define basic relationships with soil/vegetation systems.

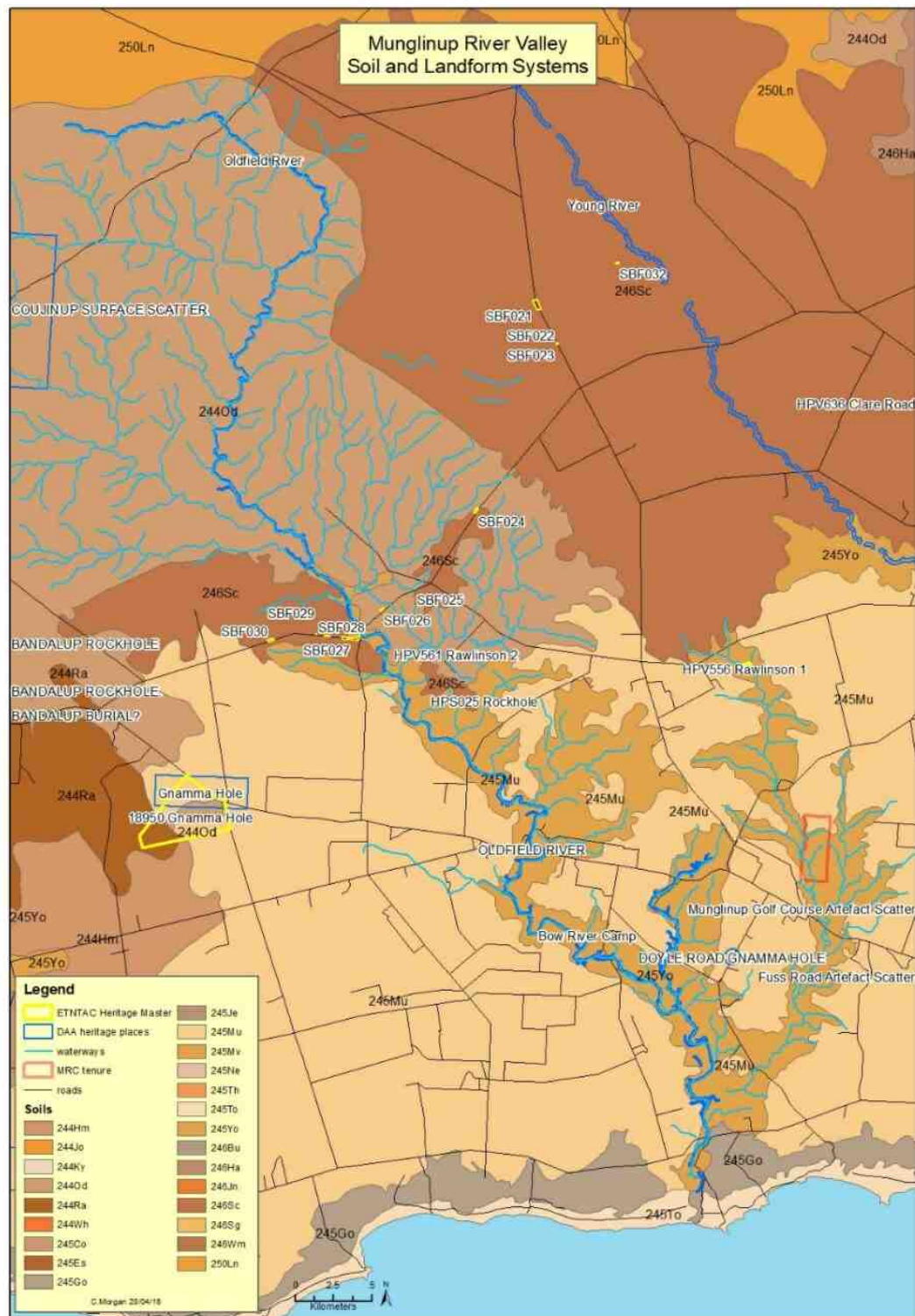


Figure 9. Examining relationships between known cultural features and landform units.

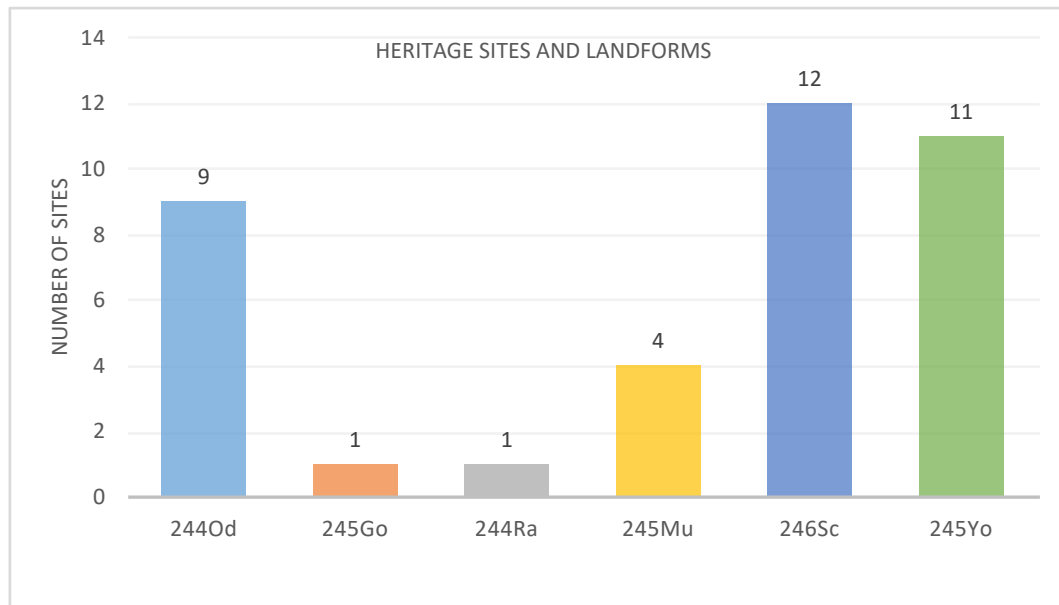


Figure 10. Graph showing the relationship of known sites and key soil/landform units encompassing the project area.

From a sample of 38 known heritage places encompassing the Munmlinup/Oldfield River valleys and the current project area, most are in the Scaddan System (246Sc), the Young System (245Yo), and the Oldfield System (244Od). The Scaddan System is defined by level to gently undulating plain with numerous clay pans and salt lakes, and small areas of undulating rises. The geology comprises Tertiary sediments overlying Proterozoic granites with some minor Pleistocene sand sheets. The Young System is characterised by well-developed coastal river valleys with gently to moderately inclined hillslopes, narrow alluvial flood plains and saline, poorly drained valley floors incised in Proterozoic gneisses and in Tertiary sediments. The Oldfield System is characterized by dissected headwater plains and rises on Proterozoic and Archaean granite and gneiss, in the eastern Ravensthorpe Zone, with grey sandy duplex (shallow and deep) and deep sandy gravel, and Mallee with scrub-heath in gravelly areas.

As with regional archaeological models across this region, this (albeit limited) sample indicates a bi-modal pattern of settlement and subsistence. That is, a focus of settlement across low, undulating plains and rises, in the upper catchments, and another along river valleys and granite outcrops towards the coast. This likely reflects seasonal movement between the coast and inland areas, along waterways as principal corridors, connected by granite outcrops as central places (nodes). This model has been documented by archaeological research specific to the Esperance area (Smith 1993) and conforms to generalized ethnographic models related to the seasonal movement of people between coast and headwaters (Dortch 2002), utilising riverine corridors as principal avenues of movement.

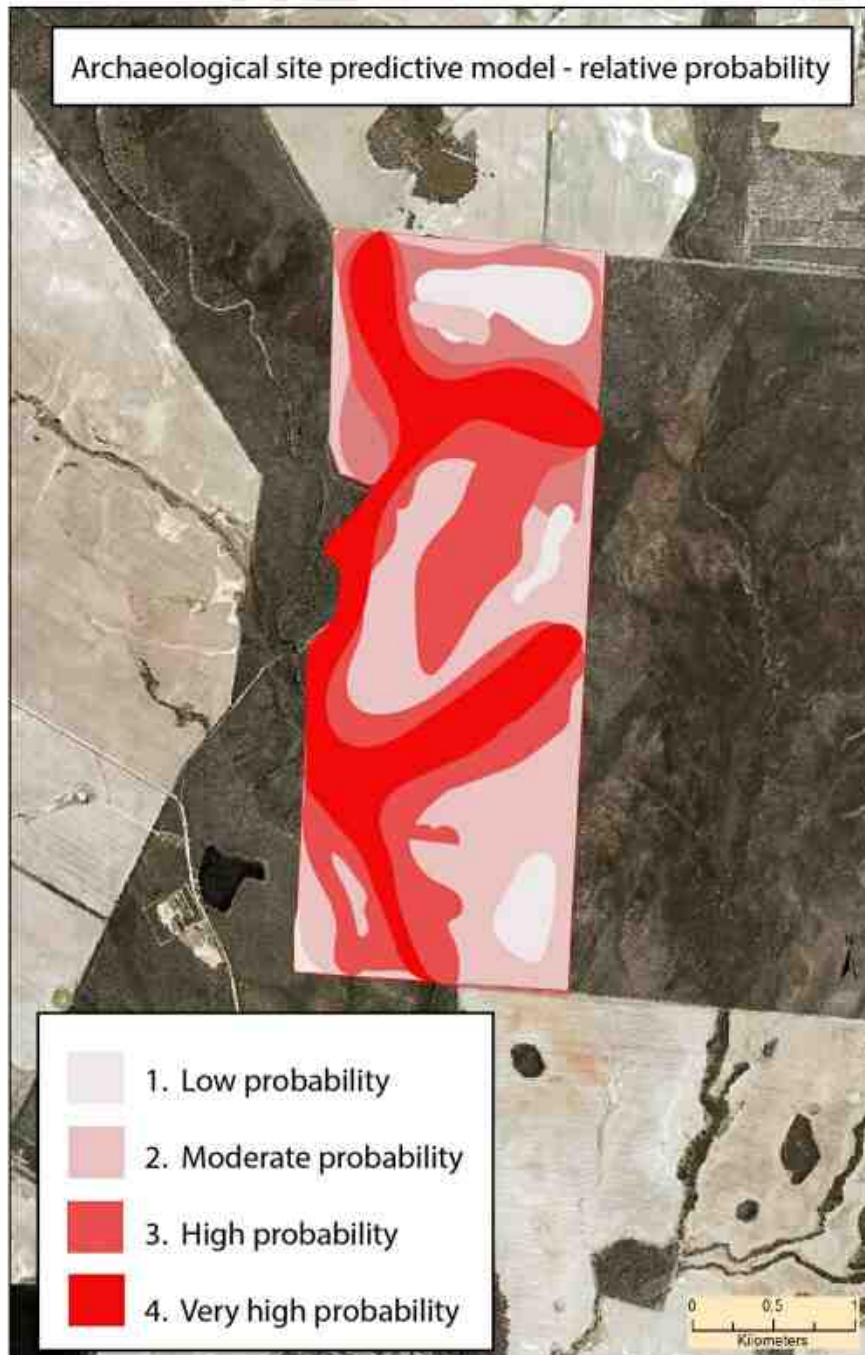


Figure 11. Map showing archaeological site predictive model.

2.4.1 Predictive Statements

- The majority of sites and cultural material will be located in close proximity to high, well-drained river terraces and tributaries, with well-drained sediments.
- The majority of sites will be small-to-medium artefact scatters.

- A base camp is likely to be in this area linking an array of smaller sites and features as part of an integrated settlement and subsistence system.
- Cultural values will be attributed to the waterways and rocky outcrops.

3.0 METHODOLOGY

3.1 Ethnographic Assessment Methodology

3.1.1 Aims

The aims of the ethnographic assessment were:

1. Undertake an ethnographic survey in accordance with the Government Standard Heritage Agreement.
2. Ensure the Traditional Owners had all the information they required to make an informed set of decisions and recommendations about the proposed works under the principle of *free prior* and *informed* consent as defined in the United Nations Declaration on the Rights of Indigenous People – Article 32
3. Identify cultural values within the area of potential effect (APE) as part of a site identification survey model
4. Undertake a cultural significance assessment as defined by the Burra Charter 2013 (Australia ICOMOS 2013)
5. Assess whether Sections 5 or 6 of the *Aboriginal Heritage Act* applies to any places within the APE
6. Identify potential impacts to cultural values
7. Identify solutions to mitigate potential impacts

3.1.2 Survey Definitions

A site identification survey model was selected for this project because major ground disturbing works are being undertaken. Here is a description of a site identification survey methodology:

During Site Identification Surveys, the recording of Aboriginal sites is undertaken to a sufficient level of detail to allow a Statement of Significance to be provided for each Aboriginal site. The Statement of significance must meet DAA's requirements for section 18 purposes. The purpose of a Site Identification Survey is to provide the proponent with sufficient information on the nature, extent and significance of any identified Aboriginal site to satisfy the requirements of the ACMC when considering an application under section 18 of the AHA. Similar to Site Avoidance Surveys, the on-the ground methodology for anthropological Site Identification Surveys varies very little compared with other types of surveys, other than a need to inform the Aboriginal Consultants of the purpose of the survey. For archaeological Site Identification Surveys, the on-ground methodology must be rigorous enough to ensure that all possible values are recorded, as well as enough information to determine the importance and significance of any sites (YMAC 2015:29).

The Burra Charter outlines a process for managing places of cultural significance (Australia ICOMOS 2013):

6.1 The cultural significance of a place and other issues affecting its future are best understood by a sequence of collecting and analysing information before making decisions. Understanding cultural significance comes first, then development of policy and finally management of the place in accordance with the policy. This is the Burra Charter Process.

6.2 Policy for managing a place must be based on an understanding of its cultural significance.

6.3 Policy development should also include consideration of other factors affecting the future of a place such as the owner's needs, resources, external constraints and its physical condition.

6.4 In developing an effective policy, different ways to retain cultural significance and address other factors may need to be explored.

6.5 Changes in circumstances, or new information or perspectives, may require reiteration of part or all of the Burra Charter Process.

3.1.3 Survey Methodologies

This survey assessed the cultural significance of the place through one-on-one and group discussions and an on-ground assessment with a representative group of Traditional Owners. This information is combined with the results of an archaeological assessment and background research, to produce a cultural significance statement for the place(s) in accordance with Section 6.1 of the Burra Charter (Australia ICOMOS 2013). The report provides direct quotes from informants wherever possible as a primary data source.

The assessment considers the proponents 'needs' (Section 6.3) expressed in the form of the proposed scope of works, which represents a potential 'change in circumstances' for the place (section 6.5). It also considers the physical condition of the place and other external constraints (Section 6.3) as appropriate before developing management recommendations to form the basis of a 'policy for managing the place' (section 6.2).

The survey began with a whole-of-group discussion facilitated by Doc Reynolds at the ETNTAC office. The briefing meeting provided the group with a detailed description of the proposed works and the locations, including detailed maps and diagrams provided by MRC Graphite.

Following the briefing meeting, we travelled to the area of potential effect and conducted an on-ground inspection. During the day, one-on-one or small group discussions were held between Myles Mitchell and Traditional Owners. The one-on-one and small group meetings are very important because they provide an opportunity for all Traditional Owner representatives to have input into the assessment outside of the whole-of-group meetings. We also had a number of group discussions onsite, to discuss the proposed works and develop recommendations.



Figure 12. Ethnographic consultations.

At the request of MRC, a daily survey briefing related to the outcomes of each survey field day was prepared, as an informal field journal report (on file with MRC and ETNTAC).

As is best -practice and a preferred methodology of the Traditional Owners, the overlap between archaeological and ethnographic assessments provides the advantage of allowing detailed discussion about the archaeological results and how best to manage those cultural materials, in tandem with assessing ethnographic values. This helps to solidify the recommendations and discuss management of archaeological features and cultural values.



Figure 13. Integrated discussions.

The final recommendations were all agreed upon by the entire group and all participants were satisfied that they had been provided with the necessary information and had the opportunity to freely contribute their opinions on the final recommendations.

3.2 Archaeological Assessment Methodology

3.2.1 Aims

The aims of the archaeological assessment were:

1. Perform the archaeological studies sufficient to assess previously recorded sites and identify any new sites that may be located within the proposed area of potential affect.
2. Determine physical extent, context (cultural and geographic), and condition of the cultural resources.
3. Integrate the archaeological assessment results with ethnographic assessment to inform a discussion of management recommendations with the Traditional Owners.

3.2.2 Definitions

The archaeological assessment identified and assessed sites under a Site ID survey methodology as defined by the AHA and outlined above. The archaeological assessment focused on identification of material cultural remains that may be isolated finds (a single artefact), a feature (gnamma hole or lizard trap), or a site (artefact scatter). The survey methodology used pro-forma recording forms on field tablets, that link to major archaeological site types and categories (see Appendix C).

3.3.3 Survey Methodologies – Stage 1 and Stage 2

The first round of survey was conducted with two qualified archaeologists and ALOs experienced in archaeological survey and accompanied by MRC representative Jordan Serve.

The second round of survey was conducted by a qualified archaeologist and an ALO. A safety induction was carried out prior to entering the site, and the team worked together to manage risks associated with such factors as exposure, dehydration, snakes, and sprains/soft tissue injuries. The team walked throughout the survey area, covering all vegetation zones and major landforms, paying particular attention to exposed areas of sand and open vegetation, as well as historic and new drill lines. It is estimated that ground surface visibility was approximately 20% across the survey area. In the thickest areas of vegetation, which is a large portion of the tenement, visibility was substantially lower than this.

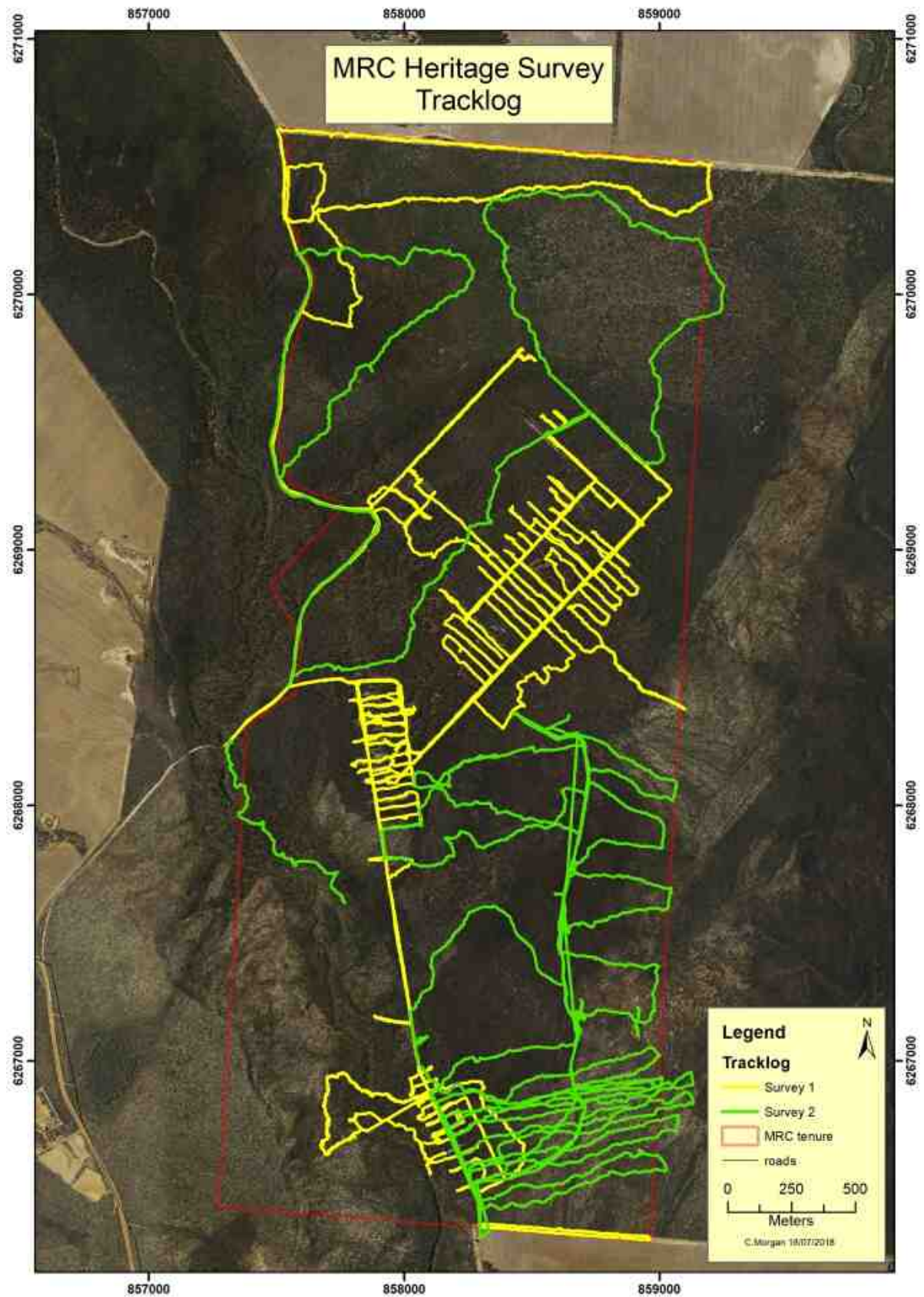


Figure 14. Map showing GPS Tracklogs of areas walked by archaeologists



Figure 15. Archaeological survey in exposed (left) and vegetated areas (right).
The team had developed a survey plan, summarised as follows:

- Day 1: Preliminary survey across the northern section to ascertain the nature of the ground conditions and key landforms. Survey of a sample creek-line to examine nature of the waterway terraces in this landscape and constraints related to vegetation and visibility. Systematic survey of historic and new drill lines commencing in the north-eastern sector.
- Day 2: Systematic survey of the historic and new drill lines and southern fenceline.
- Day 3: Systemic survey of the historic and new drill lines. Survey of exposed tracks and forays across the main waterway.
- Day 4: Archaeological discussion with the ethnographic survey team and site recording.

The survey documentation included recording of standard archaeological field data observations in field books and survey forms, linked to field tablets. The team also utilised topographic maps and aerial imagery pre-loaded on the tablets. The survey involved photographic coverage and collection of GPS points for different areas within the project area and at each feature and survey photo points (PP – see Figure 57). The ground surface visibility and other associated environmental observations were noted. The team referred to field maps and GPS units with the boundary and route waypoints uploaded for navigation and cross-checking.



Figure 16. Using a GPS, camera, tablet, pin flags and callipers to measure and record isolated artefacts and sites.

Due to extremely dense vegetation, and the nature of the APE, the survey targeted historic drill lines, new drill lines, fence-lines, and old tracks. These areas provided ‘windows of visibility’ into the archaeological landscape. In general, archaeological material was identified in cleared/exposed areas mostly within historic drill lines – thick vegetation restricted ground surface visibility over much of the survey corridor limiting the effectiveness of the archaeological survey in these areas. However, the team focused on those areas related to the mine site layout plan, especially the proposed open cut mine areas.



Figure 17. Archaeological material was identified in cleared/exposed areas mostly within historic drill lines.

At the request of MRC, the archaeological team provided daily survey briefings related to the conditions and outcomes of each survey field day, as an informal field journal report (on file with MRC and ETNTAC).

The archaeologists presented a preliminary assessment to the ethnographic Survey Participants at the ETNTAC offices on the 26th of April 2018. To further discuss the archaeological survey results and assist with management options, the archaeologists participated in the first half of the ethnographic survey on the 26th of April and departed before the closed session of Traditional Owner discussion (On Country) as part of the ethnographic assessment process.



Figure 18. Reviewing the results of the archaeological survey and discussing the project scope with the survey participants (left) and overlapping archaeological and ethnographic assessments on day 4 (right).

Stage 2 Archaeological Survey

At the request of the proponent, a second stage of archaeological survey was undertaken to survey the heavily vegetated areas of the tenement.

- Stage 2, Day 1: Stage 2 began in the south-east section of the tenement walking linear transects spaced 30m apart. Due to the thickness of the vegetation, it was very slow walking and difficult to maintain straight transects. At the end of the first day, we had not found any archaeological materials and it was clear that we were not going to cover the remaining extent of the survey area in the allotted time of four days if we maintained the 20m transect width, so we decided to widen the transects.
- Stage 2, Day 2: This day we surveyed through the central section of the tenement, which was substantially thicker vegetation so we adapted the survey strategy to widen the transects and follow the narrow accessible corridors. Even the most accessible corridors through this central section of the tenement were extremely difficult to walk through and visibility was close to zero. Multiple tiger snakes were encountered through one melaleuca and sedge grass vegetation zone within this central section, so it was decided that for safety reasons, that vegetation zone would be avoided. Nonetheless a good representative sample of the central area was surveyed.
- Stage 2, Day 3: This day was spent surveying the northern section of the tenement. Again, vegetation was thick and visibility was low. It was decided the most effective way to survey this section was to conduct arching transects which meant we could cover a wide area encompassing all the different vegetation zones and landforms, while utilizing the limited vehicle access points most efficiently. By the end of the day we felt we had achieved good representative coverage of the northern section.
- Stage 2, Day 4: The main plan for this day was to flag the cultural places and areas of high archaeological potential. We began with the river corridor. This served the dual purpose of conducting a walking transect through this section at the same time as flagging the river corridor. Progress was very slow and the transect ended up taking most of the day. After two near misses with tiger snakes after lunch, it was decided to abandon the remainder of the river corridor (the southern-most section) due to safety concerns. We spent the remainder of the afternoon flagging areas of high archaeological potential. Orange flagging tape was used for “amber” areas where monitoring and collection of artefacts is recommended. A combination of orange and green tape was used for flagging the agreed “no go” zones which are the river and the two rocky outcrops.

3.3 Recording Methodology

Once places were identified, the team used pin-flags to mark individual artefacts and features, as part of an intensive survey across the identified location. The pin flags provided an overall density and spatial structure to the site, and a site boundary was established based on the distribution of artefacts with a 20-30m buffer applied around the outside, identified artefacts. The intensive ground survey determined whether a full artefact analysis could take place, or a sampling methodology was required. From here a central point was established as a datum and GPS points and site overview photos were taken. At each identified artefact, the team mapped and measured the attributes, noting raw material types, artefact typologies, and technological attributes. A site description was written up while another team member took photographic documentation of formal artefact types.



Figure 19. Site recording.

The archaeologists visited with and reviewed the archaeological sites, where possible, with the Traditional Owners, to provide cultural context to the place. Based on the field assessment and discussion with Traditional Owners, each of the identified places are considered eligible as under Section 5(a) of the AHA as an Aboriginal site.



Figure 20. Assessing an archaeological site during the ethnographic assessment (Site MRC02).

3.4 Cultural Significance Assessment

This cultural significance assessment is based on the principles and criteria set out in the *Australia ICOMOS Burra Charter 2013* (Australia ICOMOS 2013) and the Western Australian *Aboriginal Heritage Act 1972*.

The International Council on Monuments and Sites (Australia ICOMOS) defines cultural significance in the following way:

The concept of cultural significance is used in Australian heritage practice and legislation to encompass all the cultural values and meanings that might be recognised in a place. Cultural significance is the sum of the qualities or values that a place has, including the five values— aesthetic, historic, scientific, social and spiritual—that are listed in Article 1.2 of the Burra Charter.

Through the processes of investigating the place and assessing each of these values, we can clearly describe why a place is important. This is the first step towards

ensuring that our decisions and actions do not diminish its significance. (Australia ICOMOS 2013:)

Assessing the cultural significance of a place means defining the reasons why a place is culturally important (Office of Environment and Heritage NSW 2011:7). This is done by assessing the place based on criteria.

This assessment uses two sets of criteria. The place must meet at least one of the four definitions of an Aboriginal heritage place to warrant protection under the *Aboriginal Heritage Act*. The five values outlined in the Burra Charter are used to form a more robust assessment that meets national and international standards (Appendix B – Significance Criteria). The criteria are:

- 1) The five values outlined in the Burra Charter (see Appendix B):
 - a. Social
 - b. Spiritual
 - c. Historic
 - d. Aesthetic
 - e. Scientific
- 2) The four definitions of an Aboriginal heritage place in Section 5 of the *Aboriginal Heritage Act*:
 - a. Place with Aboriginal objects.
 - b. Sacred, Ritual or ceremonial place.
 - c. Place of importance to the Aboriginal Heritage of the State.
 - d. Traditional or designated storage places for Aboriginal objects.

3.5 Constraints/Limitations

3.5.1 Ground surface visibility

Much of the tenement is densely vegetated and almost impenetrable in parts. Additionally, the tenement contains a thick layer of ground cover. The survey is therefore of limited effectiveness across the vast majority of the tenement. However, the exposures identified within the historic drill lines provide a survey sample that is adequate to characterise the archaeological signature of this area.

3.5.2 Sub-surface manifestations

Cultural resources may be hidden in such a way that only extensive excavations, use of remote sensing equipment (e.g., ground penetrating radar, magnetometer), or other technologies/methods not included in our scope of work will reveal them. Because archaeological materials, features, and other potentially significant cultural remains are commonly buried, they may not be identifiable from the surface or revealed in limited subsurface sampling. Several artefacts were observed in eroded, sub-surface contexts within tracks and eroded river terraces, and appear to be associated with run-off from historic drill lines.



Figure 21. A chert sidescraper eroding from a sub-surface context within an exposed river terrace (IF23).

3.6 Survey Confidence

We do not warrant that we have identified all potentially significant cultural resources present within the APE due to extremely dense vegetation, ground cover, and depositional (alluvial) environments. The survey confidence in terms of encountering the complete archaeological signature of this tenement is therefore low. The proposed open cut mine areas are also within existing disturbed areas and historic drill lines, and so these areas provided greater degree of visibility and exposure of cultural material, and so survey confidence is higher in these areas (see Figure 22). Conversely, the other site layout areas are proposed in undisturbed, densely vegetated areas, and were not able to be surveyed in any practical way. As such, the recommendations focus on mitigation of identified cultural places in the exposed areas, and monitoring of the densely vegetated areas (see below). The ethnographic and archaeological survey has identified six culturally-sensitive areas (see Figure 58 and Table 4), that relate broadly to the predictive model statements, and refined with the results of the survey.



Figure 22. Archaeological survey methodology targeted areas of exposure and planned open cut mine zones.

4.0 ARCHIVAL RESEARCH

4.1 Registered Heritage Places

There are no registered heritage places in the tenement. However, there are several registered sites in the general area, including the Oldfield River which is directly connected to the Munghlinup River (Table 2).

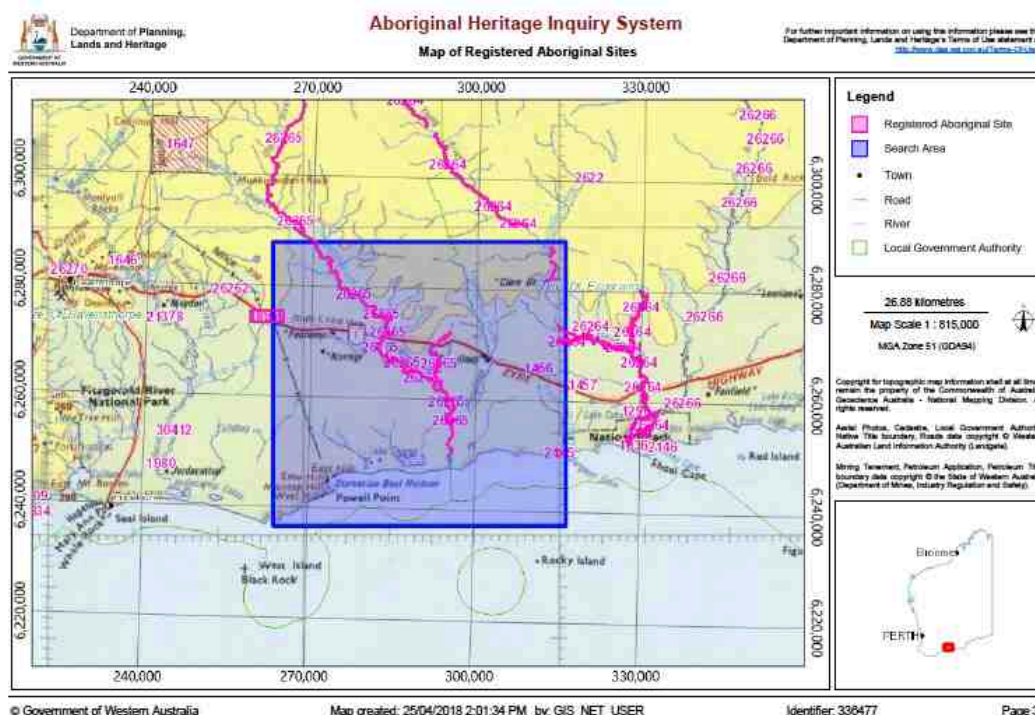


Figure 23. Map showing the search area on the Aboriginal Heritage Inquiry System.

Table 2. Previously registered/lodged sites on the Aboriginal Heritage Inquiry System.

PLACE_ID	NAME	STATUS	TYPE
1647	Coujinup Surface Scatter	Registered Site	Artefacts / Scatter
15151	Bandalup Burial	Lodged	Skeletal Material / Burial
21762	Bandalup Rockhole Scatter	Lodged	Artefacts / Scatter, Water Source
21763	Bandalup Rockhole	Lodged	Water Source
15149	Bandalup Rock Pool	Stored Data / Not a Site	Water Source
15150	Bandalup Rockhole	Stored Data / Not a Site	Water Source
21765	Paperbark Swamp	Lodged	Artefacts / Scatter, Camp, Water Source
26262	Bandalup Soak (artefact scatter)	Registered Site	Artefacts / Scatter
18950	Gnamma Hole	Registered Site	Artefacts / Scatter, Ceremonial, Historical, Man-Made Structure, Meeting Place, Water Source, Other: Lizard Trap/Gnamma Hole
26265	Oldfield River	Registered Site	Mythological
17273	Doyle Road Gnamma Hole	Lodged	Man-Made Structure, Quarry, Water Source
1455	Oldfield River	Registered Site	Artefacts / Scatter
22221	Munglinup Golf Course Artefact Scatter	Lodged	Artefacts / Scatter
29670	Bow River Camp	Lodged	Artefacts / Scatter, Camp
26264	Young River	Registered Site	Mythological
22244	Fuss Road Artefact Scatter	Lodged	Artefacts / Scatter
2145	Margaret Cove	Registered Site	Artefacts / Scatter
1456	Stuart Downs	Registered Site	Artefacts / Scatter

4.2 Previous Heritage Surveys

- *An Aboriginal Heritage Survey for Road Upgrades South Coast Highway SLK 290-415 and Hopetoun Ravensthorpe Road SLK 0-15 Western Australia – Brad Goode and Jaqueline Harris 2005*

This survey identified a number of archaeological and ethnographic sites. Of particular relevance to this report was the identification of all the rivers (Munglinup, Oldfield, Jerdacuttup, Young and Lort) as places of mythological significance that warrant protection under the *Aboriginal Heritage Act* 1972. The below excerpt makes specific reference to the Munglinup River being part of the Oldfield River. However, the registered heritage place (Oldfield River) that arose from this survey does not include the Munglinup River.

The next stop (Stop 11) was made at the Oldfield River crossing. The extent of this site crosses the highway between 351.48 – 352.33 SLK. Mr Doc Reynolds as spokesperson for the group stated that the Oldfield River system which included the Munglinup River and the Dallinup Creek which flowed to the Oldfield Inlet was of mythological significance to the Aboriginal community. Mr Reynolds advised that he could not reveal the nature of the mythological story at the time of the survey until he first consulted with senior elders in the Esperance region who were keepers of the story. Mr Reynolds advised that he send the consultant the details of the mythology at a later date by email. At the time of writing this report the consultant had not received this information. Mr Reynolds advised that the Oldfield River was also of domestic and contemporary significance as the pools along the southern side of the highway down to the Oldfield Inlet were important areas for bream fishing (Goode 2005: 31).

- *Report of an Aboriginal Cultural Heritage Survey of the State Barrier Fence Proposed Extension, Esperance Shire, Western Australia – Applied Archaeology Australia, 2015*

This survey followed a 700km linear transect from Jerdacuttup to Cape Arid and conducted archaeological and ethnographic studies along the entire route. The section relevant to this study identified the Oldfield River as a mythological place and some artefact scatters associated with the upper reaches of the Oldfield River.

- *Report of the Horizon Power Esperance Network Heritage Intersect Study, Western Australia: Work Area Clearance Assessment of Newly Identified Sites – Guilfoyle et al 2012*

This survey conducted assessments of heritage sites identified on the Horizon Power network. Of relevance to the study were the identification of the Oldfield/Munglinup River as a site of mythological significance and an artefact scatter just east of the River, near Rawlinson road, north of the current study area.

- *Report of a Cultural Heritage Survey along South Coast Highway, Shire of Esperance, Western Australia – Guilfoyle and Mitchell 2016*

This survey was conducted along the South Coast Highway between Munglinup and Esperance. The study identified the Munglinup River as a place of mythological importance associated with the Mungan (snake) creation story. The survey also identified extensive stone artefact scatters along the banks of the Munglinup River, just south of the current study area

5.0 FINDINGS

5.1 Archaeological Places in the Survey Area

The archaeological survey resulted in the identification of five (5) places and 34 isolated finds (Figure 24). In general, the places were near the main waterway and associated terraces, with a consistent background scatter of isolated finds within windows of visibility. Most of the tenement is very densely vegetated and therefore visibility is limited, inhibiting the ability for archaeological survey to identify all the cultural materials present. There is high potential for archaeological remains to be present within the densely vegetated areas. Vegetation density would have been significantly different during pre-European occupation periods because Aboriginal firing regimes would have reduced understory.

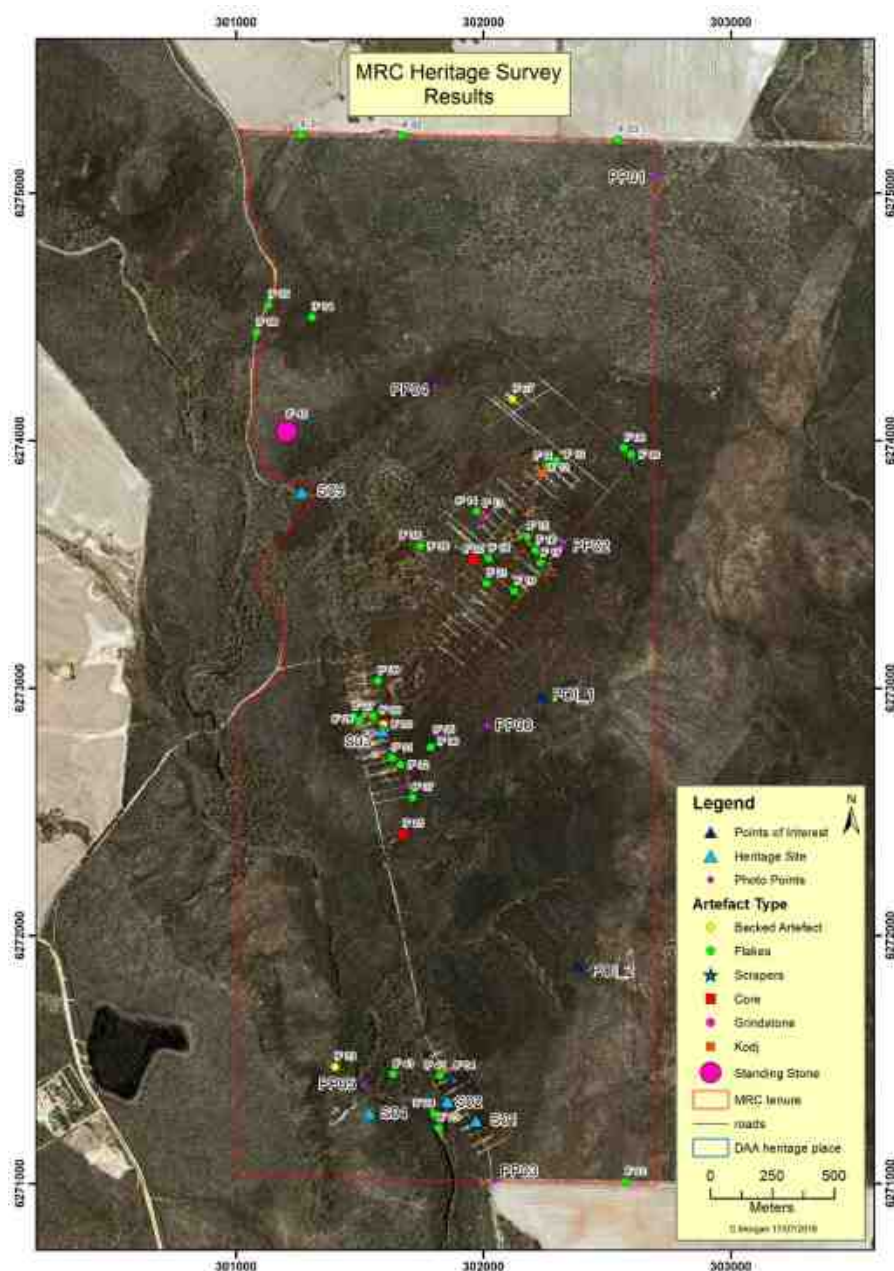


Figure 24. Archaeological survey results.

5.1.1 Archaeological Place Descriptions

5.1.1.1 MRC01

This is a moderately dense scatter of small crystal quartz, quartz flakes, and several brownish-red chert flakes, amongst a dense stand of *Eucalyptus platypus* ('spear trees') on the western terrace of the upper Munglinup River. The site is situated within a decomposing rocky ridge and sandy loam matrix, at the juncture of two soil zones.



Figure 25. Plan map and location of Site MRC01.

A total of 19 artefacts were observed in an area encompassing approximately 40m (n/s) and 60m (e/w). The observed assemblage is dominated by crystal quartz flake fragments and complete or broken flakes. Several pieces of quartz and one chert flake were observed. The artefacts were all exposed within narrow drill lines suggesting the site likely expands in all directions, currently obscured by dense vegetation and ground cover, and the artefacts have been previously disturbed (secondary deposition). For this reason, a management boundary has been established around the site, that does not reflect the spatial zoning of activity areas. Most artefacts are fragmented and broken, and this is likely a result of disturbances associated with the drill line activity.

Of interest is a distal flake fragment, crystal quartz, that has been shaped into a backed artefact (Figure 25). The site has two transversely broken flakes and a longitudinally broken flake, that may be a result of impacts from historic drilling. There is some potential for sub-surface cultural material in sectors of this site, within a depositional environment. Based on the above, the site is eligible under Section 5(a) of the AHA as an Aboriginal site.

5.1.1.2 MRC02

This is an expansive, small artefact scatter of fine-grained silcrete and chert flakes, with a relatively high proportion of retouched implements (utilized flakes). The site is also located on an upper terrace of the Munghlinup River, in a diverse soil system and the juxtaposition of two microenvironments (Figure 27).



Figure 26. Fine-grained chert and silcrete artefacts observed within MRC02.

The site is situated within a deep sandy terrace just east of the river and so has high sub-surface potential. The artefacts are exposed in a historic drill line running east to west towards the river. A total of 20 artefacts were observed in an area encompassing approximately 60m (n/s) and 60m (e/w). The artefacts were all exposed within disturbed areas, suggesting the site likely expands in all directions, currently obscured by dense vegetation and ground cover, and the artefacts have been previously disturbed (secondary deposition). For this reason, a management boundary has been established around the site, that does not reflect the spatial zoning of activity areas.

The assemblage consists mostly of a high proportion of silcrete flakes, with some chert, crystal quartz, quartz debitage, and one chalcedony flake fragment. This site has a relatively even count of raw materials and artefact types. Flake fragments make up most of the artefact

types, and it is likely that some fragmentation has occurred because of historic drilling and other impacts. At the time of archaeological site recording, the anthropologist and Traditional Owners met on site to review the recording process and discuss some key cultural questions about the place (see Figure 20), and the cultural connections and values attributed to this place were documented (see below). Based on the above, the site is eligible under Section 5(a) of the AHA as an Aboriginal site.



Figure 27. Plan map and location of MRC02.

5.1.1.3 MRC03

This is a small artefact scatter of quartz, crystal quartz and chert flakes and cores, and contains ochre sources, of interest to the Traditional Owners. The site is located on a rocky, east to west lying, laterite crest, slightly decomposing (Figure 29). The soil was sandy loam with exposed laterite throughout and the surrounding vegetation was dominated by ‘spear trees’ (*E.platypus*), with underlying shrub.



Figure 28. View of MRC03 (left) and quartz flakes.

A total of 28 artefacts were observed within a cleared drill line and encompassing an area approximately 50m (n/s) and 70m (e/w). The artefacts were either quartz (46%), chert (32%) or crystal quartz (21%), with a high proportion of core fragments (28%). Of interest is the presence of four backed artefacts within this exposed (small) assemblage.

The presence of a high number of core fragments and backed artefacts suggest that this location may represent activities associated with gearing up, in the preparation of composite weapons and tools. It may represent components of a larger site complex, and so one activity area within a continuous occupation zone along this terrace.

The artefacts were all exposed within narrow drill lines suggesting the site likely expands in all directions, currently obscured by dense vegetation and ground cover, and the artefacts have been previously disturbed (secondary deposition). For this reason, a management boundary has been established around the site, that does not reflect the spatial zoning of activity areas.

Several artefacts were observed, partially buried, indicating a sub-surface manifestation of this site is likely. There are areas of deep sandy loam deposition, and potential for stratified cultural deposits. Based on the above, the site is eligible under Section 5(a) of the AHA as an Aboriginal site.



Figure 29. Plan map and location of MRC03.

5.1.1.4 MRC04

There is a small and expansive artefact scatter on the western side of the Munghlinup River, within a sandy terrace below a thick outcrop of laterite, rising to the ridges that are located along the western boundary of the tenement (Figure 31).

A total of 25 artefacts were observed in an area encompassing approximately 80m (n/s by 65m (e/w). Most identified artefacts are quartz core fragments, with some small quartz broken flakes and some chert and crystal quartz fragments. A backed artefact was also observed within this site. The assemblage conforms to all other sites located in this area, and associated with the waterway, characterised by small flaked pieces, core fragments, and a presence of formal implements (microliths).

The artefacts were identified in a small clearing, and it is expected that additional cultural material is present in this vicinity, currently obscured by very dense vegetation and ground cover. The observed artefacts include crystal quartz and quartz flakes and microliths. It is likely the scatter extends in all directions and there is a high potential for subsurface cultural deposits, based on an assessment of the local geomorphology. Based on the above, the site is eligible under Section 5(a) of the AHA as an Aboriginal site.



Figure 30. Localized exposures revealing MRC04.



Figure 31. Plan map and location of MRC04.

5.1.1.5 MRC05 Mungan Wilgie Koort

This is a significant cultural place, dominated by a prominent (laterite) rocky hill at the junction of an ephemeral creek and on the eastern terrace of the Munghlinup River. This site extends inside and outside of the tenement. This site is extensive and dense. Large nodules of chert cores, small implement and waste flakes from the debris in the manufacture and maintenance of implements, formal tools, hammerstones and grindstones were identified. It is best understood as a wide diversity and range of implement types and raw materials, likely indicating a more sedentary (base) camp. Artefacts were identified within the existing track that bisects the site, and in sub-surface context in eroded rills.



Figure 32. Snakes, sub-surface artefacts, ochre, ephemeral creek and artefacts within MRC05.

The archaeologists and anthropologist worked to record this place, encountering three snakes in 15 minutes. From previous experience, this was considered a cultural sign. Although the Elders wanted to have the site recorded before a cultural discussion on the site scheduled for the next day (Friday), the archaeologists thought it was best to contribute assessment of the site with the Traditional Owners present (this decision was later verified as correct cultural practice). Further data analysis is required at this site before a full archaeological assessment and evaluation can be carried out. However, the place is being registered as a site for its combined archaeological and cultural values (discussed below).

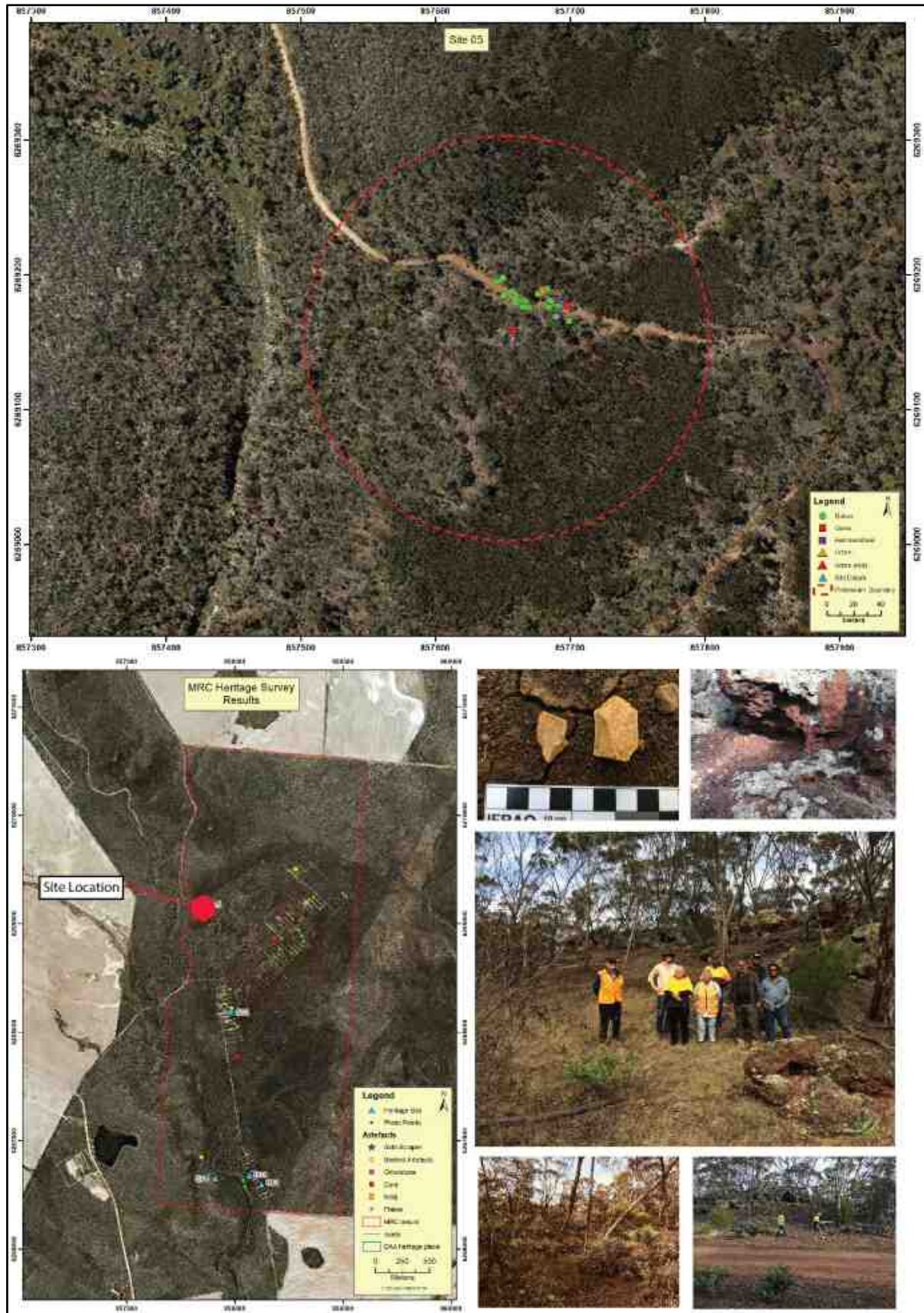


Figure 33. Plan map and location of Site MRC05 (Mungan Wilgie Koort).

5.1.1.5 Archaeological Places - Summary

The four small stone artefact scatters have a similar structure and organisation, with a dominance of quartz and crystal quartz, and dominated by small, fragments associated with tool manufacture and maintenance. A regular occurrence of backed artefacts indicates a concern with the manufacture of composite, hafted implements and weapons. MRC 02 is somewhat divergent with a dominance of silcrete flakes and MRC 03 has a high number of retouched and backed artefacts. MRC 05 (not compared here) is unlike any other of these small sites, with a focus on chert nodules and much higher densities of artefacts, and with detailed ethnographic associations, likely represents the major base camp of this area. The identified places are considered eligible under Section 5(a) of the AHA as Aboriginal sites.

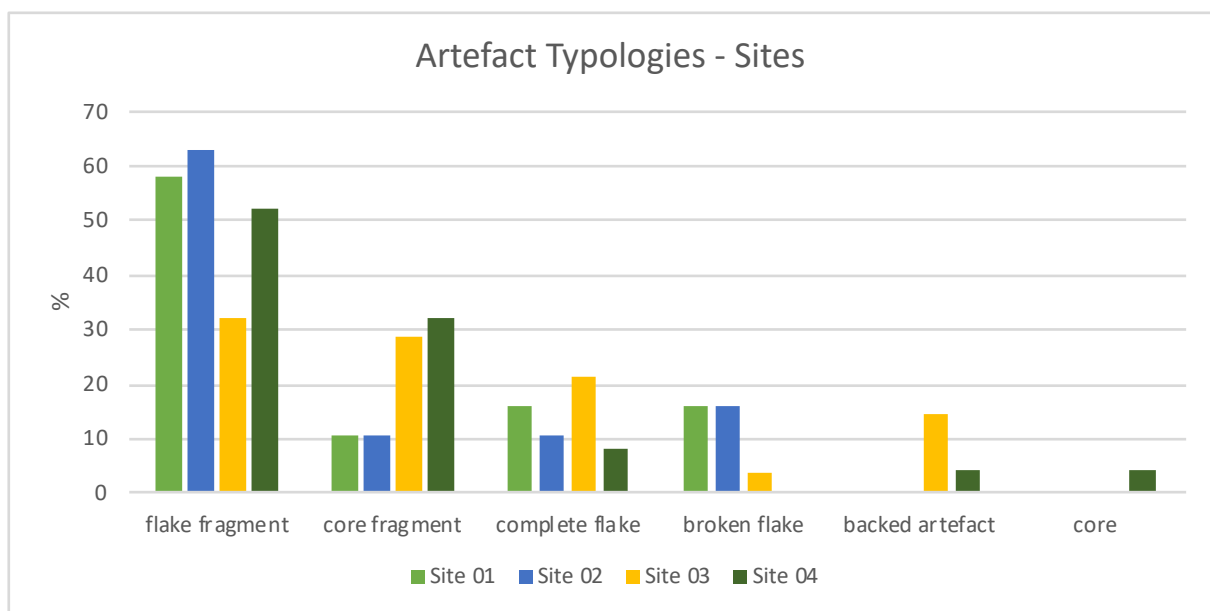


Figure 34. Artefact typologies across the four artefact scatters

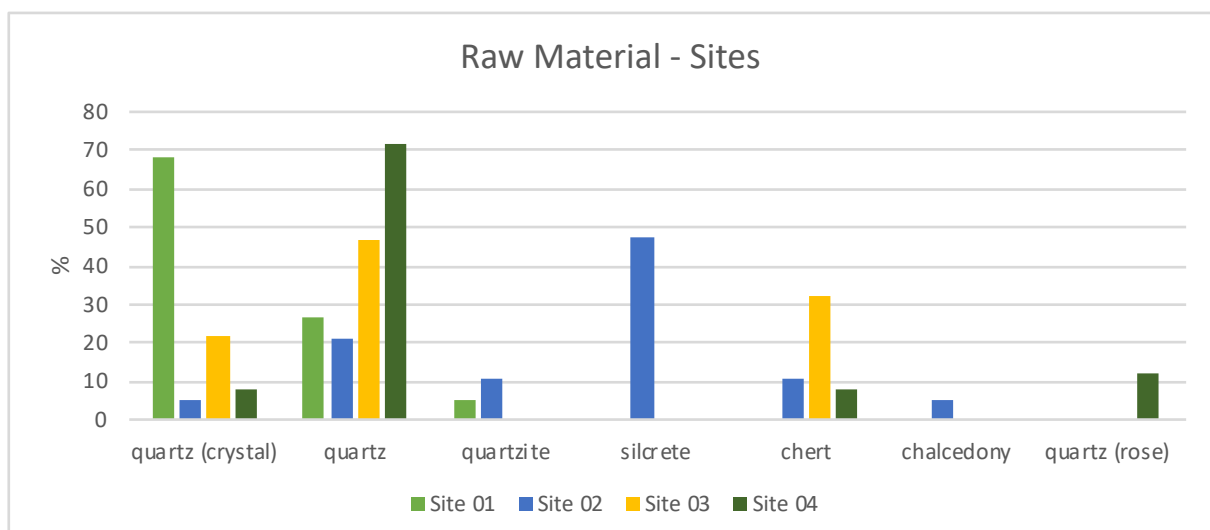


Figure 35. Raw material types across the four artefact scatters.

5.1.2 Isolated Finds

A total of 41 isolated finds were identified across the survey area, consisting predominantly of amorphous debitage (see Appendix C), and three formal implements. The survey resulted in several interesting finds including a small (palm-sized) grinding stone, a ground-edge *kodj* (axe), and a backed artefact that was likely hafted to a wooden implement known as a *taarp knife*.



Figure 36. A shaped grindstone with a polished, pitted surface (IF13).



Figure 37. Ground edge kodj located on site (left) and a hafted (flaked) kodj (IF12) with balga resin – example from the WA Museum.



Figure 38. A distinctive, backed quartz artefact (top left, bottom left) located on site (IF7) – (right) hafted tarp knife with balga resin collected near Albany and held at the Australian Museum.

The survey also resulted in the identification of a spectacular, quartz unifacial point (Figure 39). This formal tool type is quite rare in southwestern Australia and is another interesting component of the range of formal implement types and artefact distribution patterns observed in this local area.



Figure 39. Unifacial point.

ALO Donny Abdullah participating in the archaeological survey on Day 4, identified a formal chert scraper, that was likely hafted to the end of a club of shield.



Figure 40. Chert scraper held by Donny and its likely formal function within a traditional club.

In addition to these formal implements, numerous quartz artefacts were located and a chert flake fragment. These artefacts are related to the debris in the manufacture and/or maintenance of formal implements. Although they are not considered sites under the AHA, they contribute to understanding of past settlement and subsistence, and often also indicate that additional cultural material is likely to be found nearby (currently obscured by vegetation or sediments).

The dominant flake type is flake fragments (including five distal flake fragments and three medial flake fragments) and complete flakes (flakes displaying a platform, bulb of percussion, termination and intact lateral margins). Almost 90% of the isolated finds were made of quartz or crystal quartz.

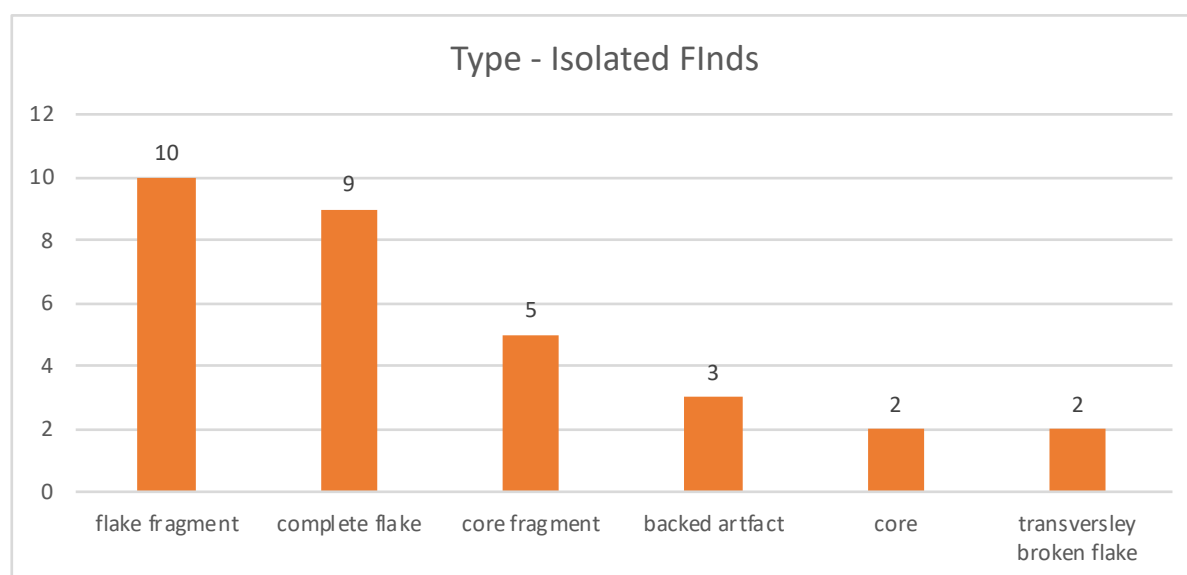


Figure 41. Flake typologies – isolated finds.

These formal implements and the associated scatter of flakes were all located in areas immediately above an ephemeral wash, with deeper, reddish-brown sands and clay loam. These preliminary results indicate that a wide range of activities were undertaken in this area,

and that a larger, base camp is likely nearby. It is also likely that groups targeted these upper washes and deeper, sandy profiles for gearing up activities, with less intensive occupation of the mallee scrub and laterite-capped profiles observed in the northern section of the tenement. Most of the finds were identified in cleared/exposed areas indicating that there is high potential for additional, currently obscured, cultural material to be located within the project area. In addition, several quartz artefacts were observed on localized wash zones on tracks, indicating that artefacts are likely to occur across the project area, and are regularly exposed or re-deposited following rains or other erosion impacts.



Figure 42. Artefacts exposed in a track (Site MRC05), (left) track/wash (IF5a/b) and (right) a partially buried core within an ephemeral creek (IF 25).

A further feature of interest is an embedded standing stone. It is not known for sure whether the standing stone is a cultural feature or just natural. The vertical nature of the stone suggests human placement but it is not conclusive. The Traditional Owners were asked about the stone

and shown pictures. They were not certain about it and wondered about the small size (H=280mm, W=260mm Th=40mm). This feature could be part of stone arrangement but it is very difficult to tell because the vegetation is so thick around it that other stones may be obscured. Stone arrangements are a relatively common archaeological feature in this region (Mitchell 2016). It is recommended that this location is zoned “amber” due to the high possibility that more cultural features exist around it, but are currently obscured by vegetation.



Figure 43. Left: Standing Stone close up. Right: Standing stone and density of surrounding vegetation



Figure 44. Left: Standing stone plan view. Right: Standing stone rear view

5.1.3 Artefact Assemblage Analysis

Of the total analysed assemblage (sites and isolated finds; n = 122), most artefact types identified were flake fragments (45%). A relatively high proportion of core fragments (20%) and complete flakes (18%), indicate perhaps a bi-modal concern for activities associated with ‘transported tool-kits’ and ‘curated’ assemblages. Almost 7% of the assemblages are crescent-shaped backed artefacts and 2.5% are cores.

Assemblages created as part of a transportable tool-kit that may have both tool manufacture/maintenance and core reduction but involved in immediate-return activities. These are often evidenced by small scatters but with a range of flake types. Wide and/or thick flakes may predominate (more suitable for longer use-life), and low retouch is expected.

A curated assemblage is characterized by relatively thin and often very small flakes that are infrequently cortical, have higher proportion of flakes with a PFA between or behind a ridge, and exhibit considerable investment in the preparation of the striking platform prior to flake detachment, and with moderate level of retouch.

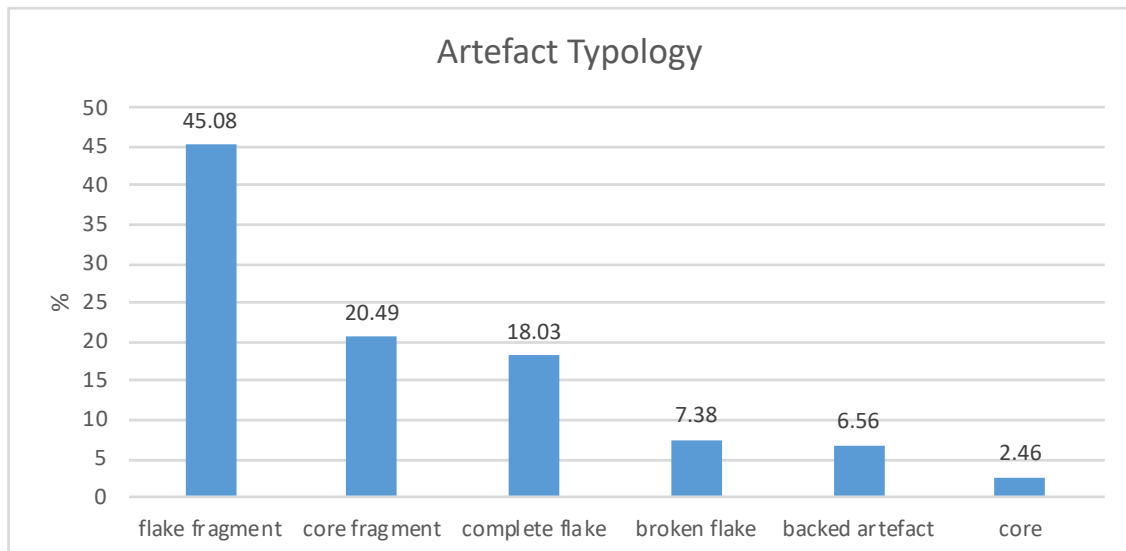


Figure 45. Proportion of artefact typologies across the project area (n=122).

This understanding of assemblage structure and organisation would indicate a relationship of more permanent base camps reflected by curated assemblages, presumably along the river terraces, and related to the identified sites), and transported tool-kits likely associated with more dispersive activities related to logistical forays (such as hunting parties) across the hinterland and laterite rises encompassing the project area. This model is further supported by the high number of backed artefacts and pre-forms located within the survey area, present both within site boundaries, but also as isolated finds – reflecting the ‘gearing up, curated assemblages at base camps and the use of these implements as part of a transported tool-kit away from base camps (sites).

In terms of lithic raw materials, most identified artefacts were comprised of quartz (44%), crystal quartz (28%), and chert (12%). Several artefacts of silcrete, quartzite and one chalcedony flake may indicate non-local sources acquired from seasonal movement and/or trade/exchange. It is assumed that local occurrences of quartz are within granite exposures near the waterway. The chert is likely sourced from localized sources within seams of Pallinup Siltstone.

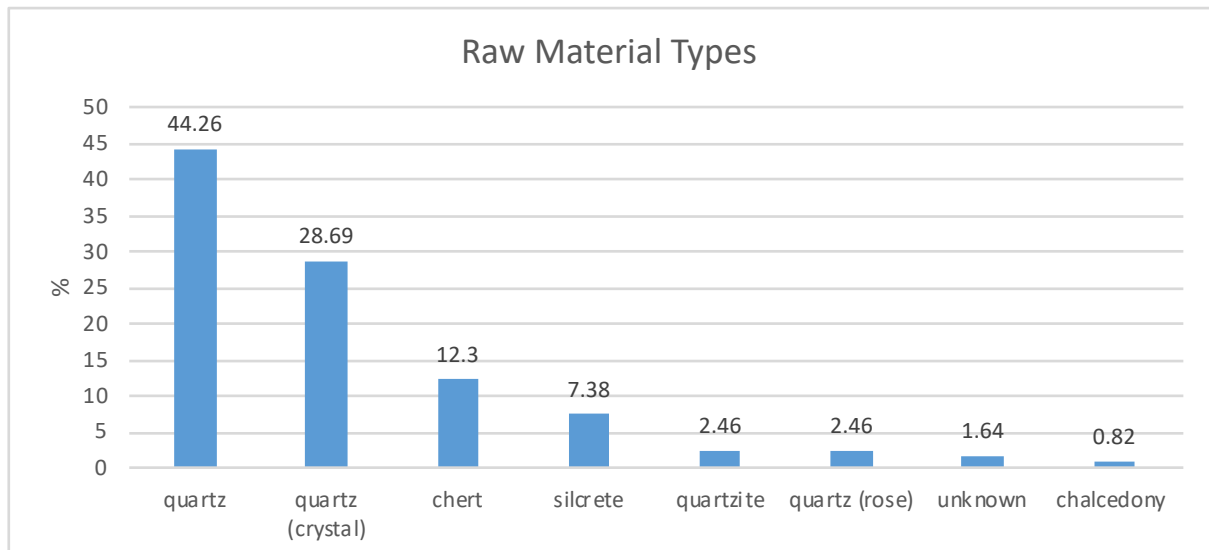


Figure 46. Raw material types within the project area.

Of interest is the backed, crescent-shaped artefacts found across the project area. These are formal tool types associated with the Australian Small Tool Tradition that is generally associated with the mid-to-late Holocene periods (~5,000 to 1,000 years ago). Research archaeologists have linked these implements to risk-reduction strategies and/or the conservation of raw material (Hiscock 2006).



Figure 47. Distinctive, crescent-shaped backed artefact associated with mid-to-late Holocene periods (left) and clump of Balga resin identified on survey that was used for hafting stone implements to wooden shafts.

The investment of time and energy into making these formal implements suggests they were valued as part of a composite implement for a range of hunting and harvesting activities. The technique of manufacture involves working a flake to a fine point on one side while blunting, or backing, the other side. The blunted side is then hafted onto a wooden shaft using balga (grass tree) resin, providing more surface area for the hafted edge, and then exposing the fine, sharp edge along the wooden shaft (Figure 38). The consistent form and function across wide areas suggest a shared style between groups.

5.2 Cultural Plants and Archaeological Patterning

The archaeological survey along the southern sector drill lines involved a brief investigation of a cluster of zamia palms, and previously identified as a culturally-sensitive area. The

archaeological team investigated the local area and did not identify any sites; however, a partially-buried quartz core was identified in the nearby ephemeral creek. The zamia palm cluster is of interest for researchers investigating models of human propagation and movement, in relation to archaeological site patterns in the Esperance region. This area was mapped and linked to management discussions as part of the ethnographic assessment.



Figure 48. Documenting cultural plants is a component of archaeological assessments.

5.3 Ochre

Throughout the survey area, nodules of ochre were identified. The archaeological team also investigated an area that was cleared without cultural monitors, following a request by Doc Reynolds. The team identified ochre nodules within this area, likely components of larger, subsurface ochre outcrop. Ochre is a significant cultural raw material and this area may be discussed during the upcoming ethnographic assessment, and the ochre outcrop may be afforded protection under Section 6 of the *Aboriginal Heritage Act*.⁴ With regard to this specific location, Doc Reynolds stated: “We know we have five earth colours (ochre) and we have four of them right here (red, brown, white, red).” Yellow nodules of ochre were also noted in different sectors of the tenement.

⁴ Section 6: This Act applies to all objects, whether natural or artificial and irrespective of where found or situated in the State, which are or have been of *sacred, ritual or ceremonial significance* to persons of Aboriginal descent.



Figure 49. Investigating ochre nodules and outcrops.

5.4 Archaeological Places and Material Nearby

The archaeological survey did not identify any cultural material outside the tenement; however, one place was identified that encompasses an area within and outside this boundary (MRC 05). It is expected that archaeological places are to be found in high densities nearby the project area, given the major waterway that runs north-south and the diversity of plant and animal life to be found here. The ethnographic and archaeological survey has identified six culturally-sensitive areas (see Figure 58 and Table 4).

5.5 Ethnographic Places, Values and Threats

The ethnographic survey resulted in the identification of a range of spiritual, social, ecological and cultural values associated with the area, including two interconnected heritage places – Munglinup River and the associated rocky outcrop (Site 05) which the Elders on this survey now refer to as Mungan Wilgie Koort. Both places warrant protection under Section 5 (b) of the *Aboriginal Heritage Act*, based on their association with the Mungan Nyitting Yarn (dreaming story) and a range of other heritage values.

Munglinup River is considered a place of *sacred* and *spiritual* importance because of its association with the Mungan Nyitting Yarn. Traditional Owner Doc Reynolds recalls being told about the mythical associations between the Mungan (snake) and the Munglinup River when he was a child. His family were camping around the area for extended periods while his dad and uncles were cutting fence posts out of jam trees (*Acacia acuminata*). They camped close to the river in a big half tank, turned on its side. Henry Dabb, also a child at the time (1960s), was camped nearby with his father Samuel Dabb a little further south towards the highway, on the other side of the Munglinup River.

The mythological significance of the Munglinup River has been identified in previous studies (Goode 2005: 31; Guilfoyle and Mitchell 2016: 61. See *Previous Heritage Reports* section for details). In Noongar cultural understanding of the place, the rocky outcrop is directly connected to the river because it sits atop one of its tributaries. However, for management purposes, we have prepared two separate significance statements and submitted HIS forms for each place. There are management recommendations for both places.

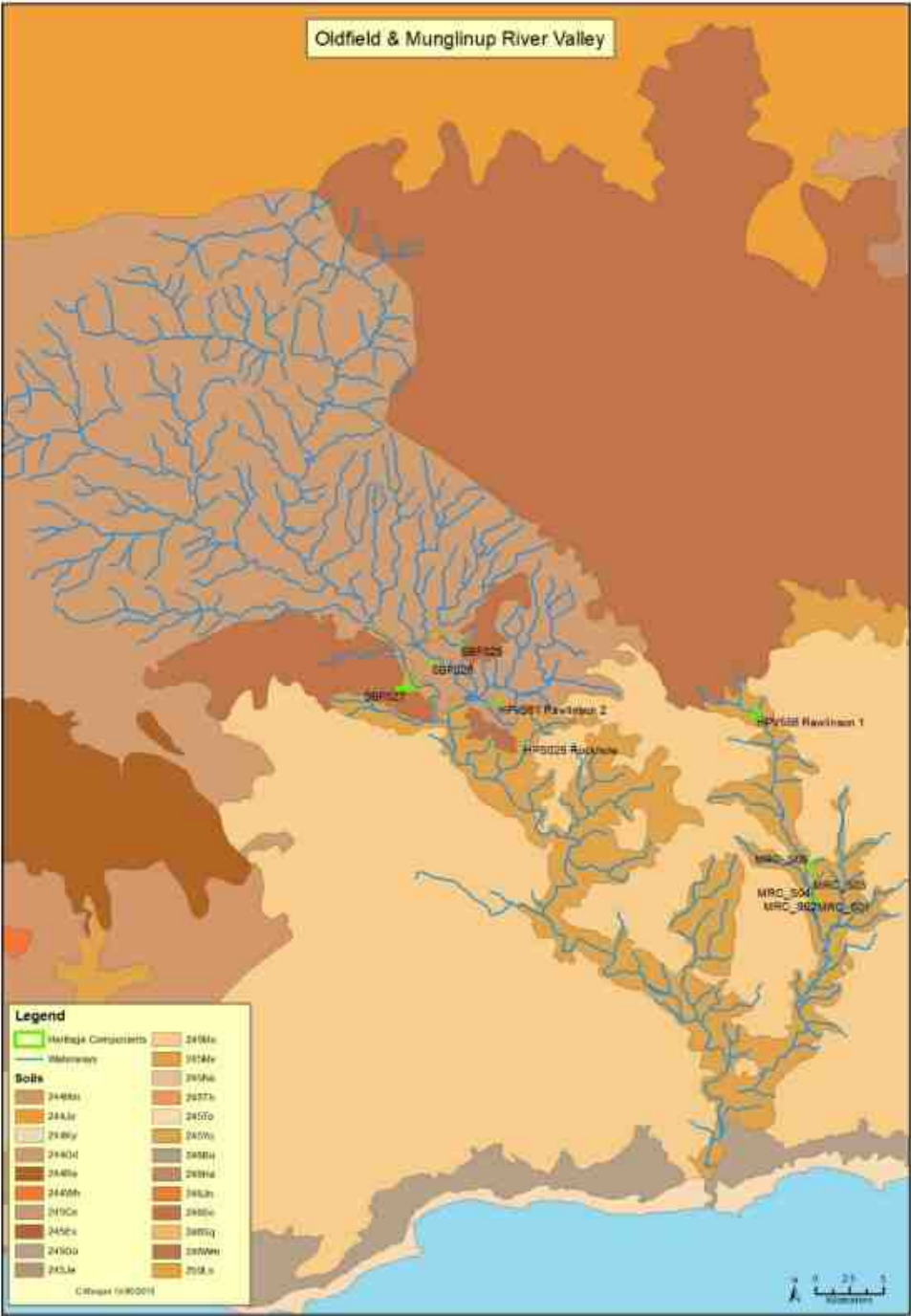


Figure 50. The Munglinup and Oldfield River integrated catchment and ethnographic place. A HIS form for the Munglinup River has been prepared and submitted to DPLH, which connects with the boundary of the existing Oldfield River registration. A separate HIS form has been completed for Mungan Wilgie Koort.

A range of cultural values were spoken about associated threats. These discussions are documented in the *Values and Threats* section below.

5.5.1 Munglinup River Significance Statement

Munglinup River (including tributaries) and the interconnected Oldfield River, Oldfield Estuary and Dallinup Creek are of high cultural significance, based on the spiritual and social values that Esperance Nyungar people associate with the waterway. This interconnected set of waterways would be considered a site under section 5B of the AHA, based on its spiritual significance and a range of other values (see below). The spiritual significance attached to the river directly reflects the importance of the river in past Aboriginal subsistence systems and its importance for *regional ecology*. Esperance Noongar culture attaches powerful spiritual beliefs to waterways which carry a set of binding principles for the management of the waterway. As a result, Esperance Noongar people inherit the responsibility to uphold these principles and care for the waterway.

Travel Route

From traditional times the river was an important travel route between the coast and the inland areas. Tjaltjraak people would spend most of the year in the coastal districts of the Esperance sandplain and would then travel inland annually during the winter months to take advantage of the bush foods that were available for harvest during the late winter and early spring time. The coastal bush foods were more readily available during the late spring and summer. There was not an exact time for the annual migration to and from the inland, as it depended on the specific seasons each year. As certain plants would blossom and change, the Tjaltjraak would know it was time to move. The rivers are still important travel routes for Esperance Tjaltjraak because access to so much of their traditional lands is not available to them due to private agricultural landholdings, the rivers provide one way of accessing their country, by boat or by foot, walking along the banks or during dry periods.



Figure 51. Munglinup River.

Sacred/Spiritual Significance

Munglinup River is considered a place of *sacred* and *spiritual* importance because of its association with the Mungan Nyitting Yarn. Traditional Owner Doc Reynolds recalls being told about the mythical associations between the Mungan (snake) and the Munglinup River

when he was a child. His family were camping around the area for extended periods while his dad and uncles were cutting fence posts out of jam trees (*Acacia acuminata*). They camped close to the river in a big half tank, turned on its side. Henry Dabb, also a child at the time (1960s), was camped nearby with his father Samuel Dabb a little further south towards the highway, on the other side of the Munglinup River.

Doc recalls that his father Ted Reynolds (dec.) was working with Ned Dimer (dec.) at the time.

“I remember him [Ned Dimer] talking about the old Mungan, the old ‘Joe Blake’, so you kind of got it from those old fellas. They were talking about it in the story - oh he’s old Mungan, he created this place, they would say watch out for that Mungan you fellas, this is his place here so you leave him alone.” – Doc Reynolds

Doc also recalls talking to the late Eddie Dimer (Ned Dimer’s son) in 2005 about it and Eddie also spoke about the Mungan with reference to the river.

“And even when I was talking to the son of old Ned Dimer, Eddy Dimer he also spoke about the Mungan here which corroborated what his old man was saying”.
- Doc Reynolds

Diane Clinch (Ned Dimer’s daughter) says the many tiger snakes seen during this survey are spiritual custodians of the place.

“The snakes are looking after this place – since the Old People left here. Looking after it.” – Diane Clinch

Senior Elders Veronica Williams-Bennell and Graham Tucker also confirmed that they were told as children that the name Munglinup was about the high density of snakes.

Social Significance

The Munglinup River (and associated Oldfield Estuary) have social significance to Esperance Noongar people as places to hunt, fish and gather bush resources and to teach cultural practices to younger generations (including caring for country). It has social significance for the current Elders of the Reynolds, Dabb and Rogers families because of the memories they associate with living and working along the river as children. The Reynolds and Dabb families camped adjacent to the mining tenement cutting fence posts during the 1960s. Henry Dabb and Doc Reynolds were children at the time and remember staying their family camps well. They share these stories with their younger generations.

Researcher Len Collard is conducting research into the origins and meanings of Noongar place names. He has hypothesised that the name Munglinup may be interpreted as a meeting place (<http://www.boodjar.sis.uwa.edu.au/boodjar-placenames/Munglinup>) described as follows:

Means that in this area kin groups get together shoulder to shoulder at a type of fair where trading and exchange of goods and people occurs and that the young people

meet their future in-laws (<http://www.boodjar.sis.uwa.edu.au/boodjar-placenames/Munglinup>).

This adds another potential layer of social significance to the Munglinup River. Further research about the possibility of past gatherings like that described above would be well worthwhile.

River Corridors, River Catchments

These consultations involved discussion on the inter-connected, regional landscape associated with the health of river corridors and catchments. This means also that people place equal significance to the main river channels and the associated tributaries. In the project area, the ethnographic consultations focused on the ephemeral tributaries that truncate the MRC tenement. The Survey participants were concerned to ensure management of these zones, as they relate to the health and protection of the interconnected landscape – the catchment. These zones also have a high likelihood for cultural materials and objects, as they are known as important camping, hunting and movement corridors. This also includes the ridges that represent the origin of the tributaries that feed into the river.



Figure 52. The tributaries and ridges related to the river catchment were a focus of the ethnographic consultations and concerns.

Caring for Country – Rivers

A traditional Tjaltjraak land management practice associated with the rivers is to open a channel through the sandbar between the river/estuary and the ocean. This is generally done at the end of winter when the estuary is full to overflowing. During very wet years, the sandbar may break of its own volition, however this seldom occurs. The Tjaltjraak people break the sandbar as a way of ‘cleaning out country’. Doc Reynolds likened the act of opening up the sandbar to the traditional use of fire:

“Its our way of clearing out the country and creating fresh life. We flush it out and it cleans the whole system for the fish and everything. Just like when we light the bush up to clean the bush out and create new growth. Its part of our ways of caring for country. Especially now days with all the use of chemical and fertilizers on the farms we really need to flush our river systems out.”



Figure 53. Traditional sand bar opening in 2015 – Oldfield Estuary.

Another reason that the Tjaltjraak would open the rivers up during traditional times, and during the historical period, is to aid with fishing. River and estuarine fish are an important part of Tjaltjraak subsistence and have been since traditional times. Opening the sandbar is a way to replenish fish stocks in the estuaries/rivers, as fish such as bream and mullet may transfer between the ocean and the estuary. It was also a way to trap fish in smaller pools upstream. This is because a sudden drop in water levels caused by the opening of the sandbar creates isolated pools where there was previously a free flow of water. This makes it easy to spear and catch fish in the pools.

Place with Aboriginal Objects

There are numerous Aboriginal objects, mainly stone artefact scatters, which have been identified along the Munghlinup River on this survey and during previous surveys (Guilfoyle and Mitchell 2016: 61). The artefact scatters attest to the use of the river in past Aboriginal movement patterns.

5.5.2 Mungan Wilgie Koort Significance Statement

Mungan Wilgie Koort is a rocky outcrop associated with an upper tributary of the Munghlinup River. There is an extensive artefact scatter and evidence that may be consistent with ochre quarrying. Esperance Noongar Elders believe it to have spiritual significance associated with the many tiger snakes inhabiting the place, which they understand to be spiritual custodians. The presence of ochre adds additional ceremonial values because ochre is used in ceremonial activities.



Figure 54. Mungan Wilgie Koort.

Spiritual Significance

The spiritual significance is explained below in a description of the assessment process. The Elders interpreted spiritual meaning for the place on the basis of animal activities. This kind of landscape interpretation is a part of contemporary cultural practice, especially in places where Noongar people have not visited for a generation or longer.

The team visited MRC 05 (Mungan Wilgie Koort) and David Guilfoyle (DG) provided a summary to the Survey Participants (SP) regarding the archaeological assessment the previous afternoon. DG discussed the extensive artefact scatter around the rocky outcrop, the density of chert nodules and cores, and the exposure of artefacts across the track, in erosion channels, and through the bushland on the other side. The ochre source and possible ochre quarrying identified in the rock shelters and overhangs was also discussed. DG recounted the story of the archaeologists encountering three snakes ('mungan') within 20 minutes during their assessment, at which time Diane Clinch turned to DG and stated:

"The snakes are looking after this place – since the Old People left here. Looking after it."

DG understood this as a layered and complex understanding of connections to place, past and present, that additionally describes the spiritual presence of the place, as well as a lesson. Diane gave DG a direct, thoughtful and knowing gaze, with a half-smile at the end, that DG interpreted as making sure that DG had listened and heard her words. The lesson is that sacred places such as this are looked after by spirits when Traditional Owners are not there, and this may be in the form of the Mungan (also the Traditional name of this waterway. Munmlinup). That is why the archaeologists encountered snakes, but during the ethnographic assessment, with the TOs present, no snakes were encountered. Her statement is also a reminder of the history of dispossession of the Traditional Owners from their lands and special places, but hints that this is just a temporary displacement, during which the Mungan are Custodians, until such time as the Traditional Owners return.

Doc suggested the group have a look around, but his suggestion was met with laughter. The team walked a little around, and no one was keen to explore the ochre source up close, so it was pointed out from down below.

Later the team gathered to discuss management and protection of this place (see recommendations) and it was unanimously noted that this area was to be a 'no-go' zone, but does require some further assessment, study, and protection measures, prior to this undertaking.

The Survey participants also discussed the name of this place – Mungan Wilgie Koort (snake ochre rock)

Place with Aboriginal Objects

There is an extensive artefact scatter and evidence that may be consistent with ochre quarrying (see archaeology findings: MRC 05).

5.5.3 Values, Threats and Impacts

A range of cultural and ecological values and associated threats and impacts relating to the broader project area were spoken about during the survey and these are documented in this section. These points are directly relevant to the proposed scope of work and to the management recommendations.

Senior Elders Graham Tucker, Diane Clinch and Veronica Williams-Bennell were discussing the proposed mining operation and its potential impacts on cultural and ecological values. This conversation demonstrates the emotional impacts of cultural places and waterways being destroyed or altered. Here is a transcription of the conversation.

There is evidence of occupation here, which is a big thing for me. I want that noted. – Graham Tucker

We feel every time sites get destroyed we feel sad, and there is too much of it. – Graham Tucker

And all the development takes precedent over our cultural sites. – Veronica Williams Bennell

Its shocking, I hate it. – Graham Tucker

With all this mines and pastoral leases etc. we are going to lose so much of our cultural materials. Our kids in the future might not ever see that sort of thing. – Veronica Williams Bennell

All for the sake of money, its all about money. – Graham Tucker

The things that worry me too are the water running and the chemicals and things going into the river, and that destroys the fish and everything. – Graham Tucker
That [reference to the proposed tailings dam covering a tributary creek] will bugger the whole system up. It destroys the whole river, goes right into the whole thing. It flows into the Oldfield River and down into the Inlet. – Graham Tucker

...and it will kill all our fish. – Diane Clinch

... and then the pelicans will eat the fish and they will die too. – Veronica Williams-Bennell

That's [impacts to river ecosystem] more important than the bloody sites at the moment. – Graham Tucker

The following discussion with Graham Tucker took place at site MRC02

The artefacts tell us people were here making tools and they would have had to stop here a little while, not too long. – Graham Tucker

If you did a dig [archaeological excavation] here you would find more. – Graham Tucker

Would you like to see a dig happen here? – Myles Mitchell

Dig yes, because I am of the opinion that there are more artefacts here. It would definitely be worth doing a dig because they are going to mine here. I would like to prove that there are artefacts under here. It gives us more evidence. – Graham Tucker

Graham said the artefact scatter is directly associated with the adjacent Munglinup River because it was a resource rich landscape node and travel route for people. Graham made note of the large stand of spear trees growing at this location.

They would have made good spears here. They have the toolmaking equipment and the appropriate trees to make spears. – Graham Tucker

5.4 Comparisons of Findings with Previous Surveys Nearby

The findings conform with those from the main nearby survey carried out by Brad Goode and Associates that led to the registration of the Oldfield River on the DPLH database. The ethnographic assessment carried out for this project reiterated the cultural significance of the waterway, in relation to both ancestral and historical connections, as well as ongoing values related to caring for country.

The archaeological assessment conforms broadly to previous, regional surveys, that define high archaeological density in resource-rich, riverine terraces and deep sandy profiles, and an almost continuous background scatter representing logistical forays from base camps. The identification of five places from this survey conforms to the predictive models and expectations based on generalized archaeological distribution patterns, as they are located along a major waterway and within an associated terrace in generally well-drained, deep sandy profiles. It is noted that limited, formal assessment survey work has been carried out in this area.

6.0 CONCLUSIONS

The diversity of cultural places, values, archaeological places and features, cultural plants, and raw materials, including ochre, attest to the integrated cultural landscape that this tenement is encompassed within. Areas of geological and botanical diversity, as this area is, are often co-located with significant cultural landscapes, as this area is. The survey results conform to expectations related to both the cultural value of waterways (Songlines), historical associations, and generalized archaeological models of site patterning. Despite limitations in survey methods due to vegetation, ground cover and depositional environments, a dense array of cultural places, features and artefacts were identified, and it is expected that additional cultural material will be located throughout the tenement following ground disturbances.

It is apparent that the five places that were identified and the associated background scatter of isolated finds, and all largely exposed within narrow drill lines, suggests that we are observing several activity areas and camping places that are part of a single occupation zone along this waterway and associated terraces and hinterland (rises). This type of settlement model is well documented in regional archaeological models and ethnographic understandings of settlement structure ('estate and range').

Three of the places are located within proposed open cut mine areas and there is a high potential for sub-surface cultural deposits. A range of formal tools and raw materials suggests unique occupation zone associated with the river; and in tandem with the diverse geology and botanical systems. Large areas remain mostly unsurveyed due to impenetrable bushland and erosion and future clearing is likely to expose additional artefacts and places.

Thus, there are a levels and layers of significance and formation processes at play here that must be considered and require some layers of management. In this way, the cultural values and places should be considered as an integrated landscape and placed within a heritage management plan framework.

6.1 Munglinup - The Waterway

The Munglinup River that truncates the project area is the major cultural place and provides for a lot of structure to the observed archaeological patterning. The place is of documented cultural significance and artefact density increases near the major waterway system in this area. A clear management zone is required to ensure protection from any direct impacts, and monitoring of any indirect impacts from this undertaking.



Figure 55. The waterway defines much of the cultural landscape.

6.2 Mungan Wilgie Koort - The Central Cultural Place

This place is of major cultural significance at a spiritual, social, and archaeological level. The Traditional Owners know this place as an important spiritual place and though the main component lies just outside the tenement, there are concerns related to access; such as widening of the existing track that passes through the place. Further study and analysis of this place will contribute to greater understanding as to the antiquity of human occupation in this area, changes over time, and subsistence and settlement patterns.

6.3 The Archaeological Places

Not including Mungan Wilgie Koort (that is assessed primarily for its ethnographic values), there are four archaeological places located within the tenement. It is expected that more places exist but are currently obscured by dense vegetation. The key management consideration for these areas relate to their location within areas planned for open-cut mining, and so are likely to be destroyed. These places are quite similar in structure and organization and detail aspects of the settlement patterns related to this wider area, and the range of activities being undertaken. The local geomorphology suggests that there is a high potential for stratified, sub-surface cultural deposits. These artefact scatters are of cultural values as direct evidence of activities undertaken by the Traditional Owners' ancestors and may yield information important to our understanding of prehistory.

A process of archaeological management is required in this tenement. Along the waterway edge, there is bank erosion caused from run-off associated with the nearby drill lines that run in a south-westerly direction toward the river (see Section 3.5.2). In this area, several artefacts were observed eroding from the river terrace/banks, including a large chert flake that has evidence of lateral margin retouch (possible side scraper, Figure 21). In addition, the access tracks are forming large erosion gullies and rills, and several artefacts were observed in sub-surface contexts. For these reasons, a process of ongoing management and monitoring is recommended.

6.4. Significant Cultural Artefacts

In addition to the identified cultural places and archaeological places, several important isolated finds were identified – including a kobj (axe), a grinding stone, a unifacial point, and several backed artefacts. These formal implements are somewhat rare and is unusual for a collection of these implements to be located in a small area. All these implements hold cultural value and are of major research interest, through the study of morphology and use-wear and residue analysis. The Traditional Owners recommend a salvage and curation plan is developed and implemented.

6.5 Cultural Plants

A cluster of cultural plants (zamia) were identified in a cleared area. These plants are of cultural value and the human use of these plants is a feature of the Esperance archaeological and cultural record. The major type-site documenting human history of the Esperance region – Cheetup Cave – discussed in the background section above, is listed on the National register of Historic Places, partly because it is the oldest evidence of human processing of this food source to release toxins that need to be leached out.

6.6 Ochre

Significant ochre sources have been identified across the tenement and within the rocky outcrop associated with Mungan Wilgie Koort. Ochre is of cultural significance and is afforded protection under the AHA (Section 6) if identified by Traditional Owners as such, with or without evidence of direct utilization of the ochre itself.

7.0 RECOMMENDATIONS

It is recommended that the proposed works may proceed as planned, on the condition that any heritage clearance given is subject to compliance with the conditions imposed by the heritage survey team and the subsequent recommendations, and in line with the obligations under the *Aboriginal Heritage Act* (1972, as amended).

7.1 Munmlinup River

1. **It is recommended** that MRC and ETNTAC jointly establish a buffer zone around the Munmlinup River to ensure the waterways to ensure the development minimizes impacts on the waterways.
2. **It is recommended** that MRC work with ETNTAC to minimise impacts of potentially dirty surface run-off in the Munmlinup River by designing the operational surface water management system to ensure that releases of water from site via nominated points can be tested and controlled.
3. **It is recommended** that MRC implement a monitoring program for the Munmlinup River to demonstrate that the project is not negatively impacting the river water quality and riverbank fringing vegetation. The monitoring system should be designed with input from ETNTAC and results of the monitoring be shared with ETNTAC.

7.2. Mungan Wilgie Koort

4. **It is recommended** MRC and ETNTAC establish a ‘no-go zone’ around heritage place MRC 05 and that MRC include this information in the site induction for all staff.
5. **It is recommended** that MRC establish a new track in place of the existing one which truncates MRC 05, and work with ETNTAC and Shire of Esperance to rehabilitate the existing track.

7.3 Archaeological Management

6. **It is recommended** that MRC and ETNTAC ensure that procedures and protocols for the salvage and curation of artefacts within the development envelope is addressed within the heritage management plan (see recommendation 11)

7. **It is recommended** that MRC obtain all relevant approvals under the *Aboriginal Heritage Act* for the disturbance/recovery of archaeological material located within the Munghlinup Graphite Project development envelope and work with ETNTAC to ensure that all salvage and recovery of objects is done in a culturally appropriate way.

7.5 Cultural Monitors

8. **It is recommended** that the use of cultural monitors is outlined in the heritage management plan to enable the recovery of exposed artefacts and culturally important plants. Monitors should be used in areas identified as culturally sensitive.

7.6 Cultural Awareness and Heritage Identification Training

9. **It is recommended** that MRC and ETNTAC develop and implement a cultural awareness and education plan. The education plan should include cultural awareness training for management and key decision makers as well as training for staff involved in clearing activities, that enables them to identify culturally sensitive materials and plants.
10. **It is recommended** MRC work with ETNTAC to look for opportunities to incorporate traditional names into the project features.

7.7 Heritage Management Plan

11. **It is recommended** that MRC and ETNTAC work together to develop a heritage management plan for the project that assists with observing and implementing these management recommendations, including legislative requirements, cultural protocols, cultural monitoring plan, salvage archaeology and curation plans.
12. In the event that MRC seeks to amend or to not uphold any of these recommendations, **it is recommended** that they notify ETNTAC in writing before commencing the program of works.

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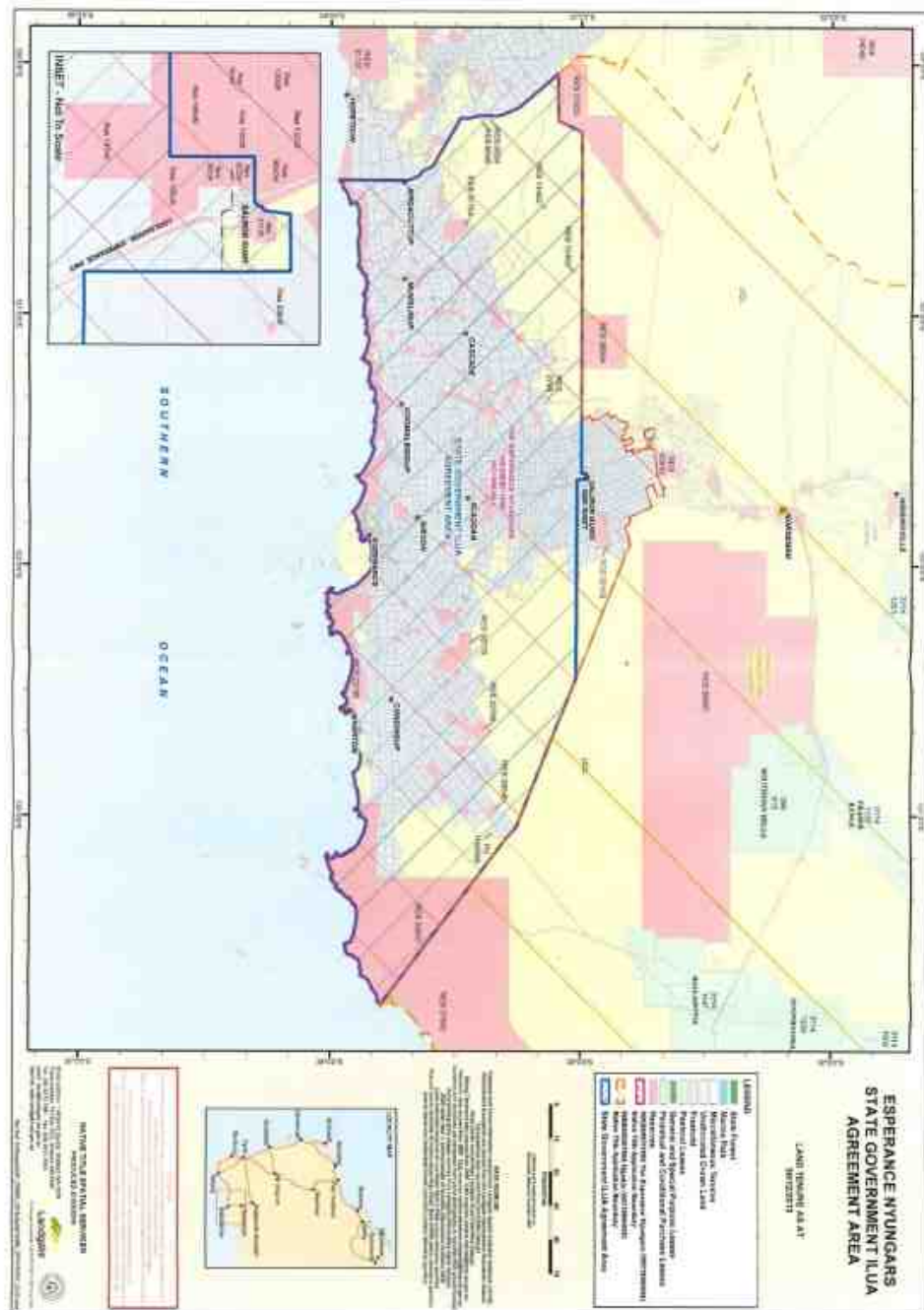
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APPENDIX A – MAP OF ESPERANCE NYUNGAR NATIVE TITLE CLAIM AND ILUA

Map obtained from National Native Title Tribunal website – Accessed 25 August 2016:

http://www.nntt.gov.au/searchRegApps/NativeTitleRegisters/ILUA%20Register/2014/WI2014.006/WI2014_006%20Schedule%20of%20Map%20of%20agreement%20area.pdf



APPENDIX B – SIGNIFICANCE CRITERIA

Table 3. Definition of criteria used in cultural significance assessment

Criterion	Definition
Social	Social value refers to the associations that a place has for a community or cultural group and the social or cultural meanings that it holds for them.
Spiritual	Spiritual value refers to the intangible values and meanings embodied in or evoked by a place which give it importance in the spiritual identity, or the traditional knowledge, art and practices of a cultural group. Spiritual value may also be reflected in the intensity of aesthetic and emotional responses or community associations and be expressed through cultural practices and related places. The qualities of the place may inspire a strong and/or spontaneous emotional or metaphysical response in people, expanding their understanding of their place, purpose and obligations in the world, particularly in relation to the spiritual realm.
Historic	Historic value is intended to encompass all aspects of history—for example, the history of aesthetics, art and architecture, science, spirituality and society. It therefore often underlies other values. A place may have historic value because it has influenced, or has been influenced by, an historic event, phase, movement or activity, person or group of people. It may be the site of an important event. For any place the significance will be greater where the evidence of the association or event survives at the place, or where the setting is substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of such change or absence of evidence.
Scientific	Scientific value refers to the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archaeological techniques. The relative scientific value of a place is likely to depend on the importance of the information or data involved, on its rarity, quality or representativeness, and its potential to contribute further important information about the place itself or a type or class of place or to address important research questions. To establish potential, it may be necessary to carry out Australia ICOMOS Incorporated Page 4 Practice Note Version 1: November 2013 some form of testing or sampling. For example, in the case of an archaeological site, this could be established by a test excavation.
Aesthetic	Aesthetic value refers to the sensory and perceptual experience of a place—that is, how we respond to visual and non-visual aspects such as sounds, smells and other factors having a strong impact on human thoughts, feelings and attitudes. Aesthetic qualities may include the concept of beauty and formal aesthetic ideals. Expressions of aesthetics are culturally influenced.
Place with Aboriginal Objects	Any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present.
Sacred Ritual or Ceremonial Place	any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;
Significance to the State	Any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the State;
Storage Place	Any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.

APPENDIX C – ISOLATED FINDS: MAP AND PLATES

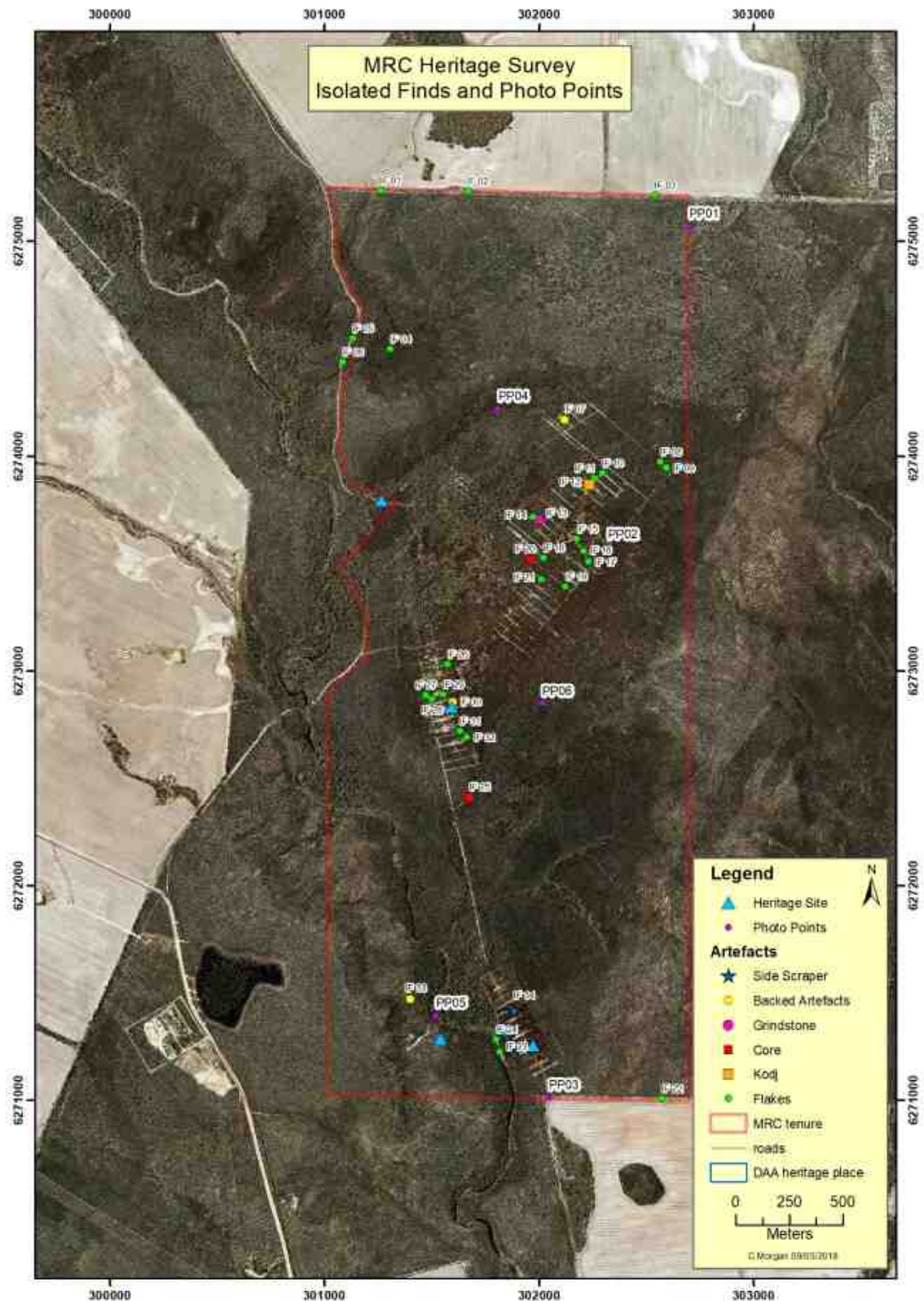


Figure 56. Map showing the location and reference number for the isolated finds and photo points.

IF 01



IF 02



IF 03



IF 05



IF 07



IF 08



IF 09



IF 11



IF 12



IF 13



IF 17



IF 19



IF 20



IF 21



IF 22



IF 24



IF 25



IF 26



IF 28



IF 30



IF 31



IF 33



IF 34



PP 01



PP 02



PP 03



PP 04



PP 05



PP 06



Figure 57. Photo points.

APPENDIX D – CULTURALLY-SENSITIVE AREAS



Figure 58. Culturally-sensitive areas identified within the tenement (see also Table 4).

Table 4. Description of culturally-sensitive areas (see also Figure 58).

CSA #	Key components	Recommendations
1	Ephemeral tributary of the Munmlinup River in dense vegetation	The area is not targeted for any ground disturbance at this stage. If this zone is to be subject to ground disturbance in the future, it is recommended that cultural monitors are engaged.
2	Ephemeral tributary of the Munmlinup River in dense vegetation that connects with the significant cultural place – Mungan Wilgie Koort (MRC 05)	It is recommended that during any ground disturbance within this zone cultural monitors are engaged. There is a high potential for cultural material to be exposed. The area surrounding MRC 05, although not subject to direct mining activity at this stage, may be impacted by vehicle access and road maintenance works. If so, it should be subject to a Section 18 permit with conditions for test excavations and cultural monitors during the subsequent and initial open mine excavations.
3	Open woodland area that has a sparse but consistent number of isolated artefacts.	It is recommended that during any ground disturbance within this zone cultural monitors are engaged.
4	A small artefact scatter and ochre source has been identified in this zone (MRC 03) with a high likelihood that additional artefacts will be exposed during ground clearing/disturbance.	As this area is within a planned open cut mine, this area should be subject to a Section 18 permit to disturb a heritage site with conditions for salvage of artefacts (as requested by Traditional Owners), test excavations, and cultural monitors during the subsequent and initial open mine excavations.
5	This is the corridor of the Munmlinup River that truncates the mining tenement, with associated tributaries, and includes MRC 04 and several isolated artefacts.	It is recommended that during any ground disturbance within this zone cultural monitors are engaged. There is a high potential for cultural material to be exposed.
6	This zone includes two artefact scatters (MRC 01 and 02) with a high likelihood that additional artefacts will be exposed during ground clearing/disturbance.	As this area is within a planned open cut mine, this area should be subject to a Section 18 permit to disturb a heritage site with conditions for salvage of artefacts (as requested by Traditional Owners), test excavations, and cultural monitors during the subsequent and initial open mine excavations.

APPENDIX C – HIS FORM: MUNGLINUP RIVER

Heritage Information Submission



Department of Planning,
Lands and Heritage

This form must be sent before 28/08/2019 13:44:33. After this date it will expire and a new form will need to be downloaded.

When should I consider submitting a Form?

Complete and submit this Form if you wish to provide information about a place which you consider to be an [Aboriginal Site](#) under the [Aboriginal Heritage Act 1972](#) (the Act). The Form can also be used to provide information about a registered Aboriginal Site or other heritage place (which includes places awaiting assessment) that is additional to information already held by the Department of Planning, Lands and Heritage (DPLH).

How can I make sure I provide the right information?

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- record all relevant information on the Form. Do not refer to attachments such as survey reports. Note that there is no requirement to include a survey report with the Form.
- all questions must be answered unless otherwise stated.
- refer to the document [Act](#) to assist with interpreting the Act and completing the Form.
- visit [Site Search](#) to see if DPLH already has information about this place. It is recommended that searches be made for both 'Registered Sites' and 'Other Heritage Places' (this includes places awaiting assessment).
- attach shapefiles and maps, if possible. Shapefiles are the preferred option.
- contact the Department of Planning, Lands and Heritage if you require further information by emailing submissions@daa.wa.gov.au or phoning (08) 6551 7950.

You may be asked to provide additional information during the assessment process. Note that you and other knowledge holders that you identify may be asked to provide additional information about the place (such as its condition) if it is alleged to have been damaged by someone else at a later date.

What happens when I submit a Form?

Once a Form is submitted, the information is assessed and a decision is made in relation to the applicability of the Act to the place. If the decision is that the Act applies to the place, then relevant information will be recorded on the Register of Aboriginal Sites.

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It should be noted that the Act does not require Aboriginal people to disclose information or otherwise act contrary to Aboriginal customary law or tradition. Secret information is not usually required to establish that an area is an Aboriginal Site. Information regarding an Aboriginal place which has been nominated by the knowledge holders as culturally sensitive on the Form must nevertheless be considered as part of the decision making process in order to fulfil statutory duty. The Form however provides for arrangements to be made for a summary of that information to be available to other interested parties.

Recorder Details

Given name

David

Family name

Guilfoyle

Organisation name (if applicable)

Applied Archaeology International

Position (if applicable)

Managing Director

Please enter either a landline phone or a mobile number (including area code for local numbers)

Phone number

0458266522

Mobile number

Fax number (optional)

E-mail address

dg@appliedarchaeologyinternational.com

Address

291 Belmont Avenue

Suburb/Town

Cloverdale

State

WA

Postcode

6105

Are you an Aboriginal person who holds cultural knowledge about this place?

☐ Yes

☒ No

Location of Place

Provide as much information as possible about where the place is located to enable it to be accurately mapped on DPLH's mapping system. You may wish to contact DPLH on (08) 6551 7950 or email submissions@daa.wa.gov.au to discuss the required information.

Select a boundary that accurately reflects the extent of the cultural material (preferably the smallest boundary possible with no buffers).

Do you have a shapefiles (preferred), coordinate data and maps to attach (GDA94 referenced is preferred)?

☒ Yes

☐ No

What is the datum of the shapefiles, coordinate data and maps if not GDA94 referenced?

You will be asked to attach these after you click the Send Application button at the end of this Form.

Are you able to list at least one coordinate (spatial reference) for the location?

☒ Yes

☐ No

Are the coordinates:

- ☒ projected (easting/northing) - this is preferred
☐ geographic (latitude/longitude in decimal degrees)

Map Grid of Australia (MGA) Zone

- ☐ 49
☐ 50
☐ 51
☒ 52

List these coordinates and what the coordinate(s) represents (eg central point of the place, boundary points). If you are unable to attach a shapefile or map, include boundary coordinates to ensure that DPLH accurately maps the location of the place.

857500mE 6270000mN

18/500 characters

Description of boundary of the place.

The Munglinup River and its tributaries that includes an area 50m wide from the approximately centre-line of waterway

117/1000 characters

Why did you select this boundary (i.e. what methodology did you use to arrive at this boundary)?

Criteria established via consultation with Traditional Owners and from previous ethnographic consultations:

"Mr Doc Reynolds as spokesperson for the [Traditional Owners] stated that the Oldfield River System which included the Munglinup River and the Dallinup Creek which flowed to the Oldfield Inlet was of mythological significance to the Esperance Noongar community. Mr Reynolds advised that the Oldfield River was also of domestic and contemporary significance as the pools along the southern side of the highway down to the Oldfield Inlet were important areas for Bream fishing. In Mr Reynolds opinion, an arbitrary distance does not adequately define Aboriginal spiritual notions of the significance in regards to flowing water. It was said that where the waters flow represented the serpent's path and as such defined the areas significance. The river valley was defined as of importance as a path where people traveled hunting, fishing and camping" (Brad Goode and Associates, 2005).

997/1000 characters

Name(s) that this place is known by?

Munglinup River

15/500 characters

Does this information relate to an existing place on DPLH's records?

- ☒ Yes
☐ No
☐ Unsure

What is its ID number on DPLH's Aboriginal Heritage Inquiry System?

Site ID 26265

What is the tenement ID for the location (if known)?

Are you submitting this form as part of another submission e.g. Section 18 Notice or Section 16 Application?

☐ Yes

☒ No

Type of Site: Evidence And Justification

A place is by definition an Aboriginal site by operation of the Act, section 5, that is if it meets the requirements of any paragraph of section 5. In the following section "Evidence and Justification" the questions have been designed to elicit the information required to satisfy each paragraph.

You may complete one or more of Item A, Item B, Item C or Item D.

- ☐ **ITEM A: PLACE WITH ABORIGINAL OBJECTS** (Act, section 5 (a))
- ☒ **ITEM B: SACRED RITUAL OR CEREMONIAL SITE** (Act, section 5(b))
- ☐ **ITEM C: SITES OF IMPORTANCE TO THE CULTURAL HERITAGE OF THE STATE** (Act section 5 (c))
- ☐ **ITEM D: TRADITIONAL OR DESIGNATED STORAGE PLACES** (ACT, SECTION 5 (d))

ITEM B: SACRED RITUAL OR CEREMONIAL SITE (Act, section 5(b))

PART 1: THE PLACE

Is the place a

- ☒ A sacred site
- ☐ A ritual site
- ☐ A ceremonial site
- ☐ None of the above

Provide full details:

The river and its tributaries are associated with a creation belief systems related to the interconnected Oldfield River (Site ID 26265), Oldfield Estuary, and Dallinup Creek; that are of high cultural significance, based on the spiritual and social values that Esperance Nyungar people associate with this catchment and waterways. The spiritual significance attached to the river directly reflects the importance of the river in past Aboriginal subsistence systems and its importance for regional ecology. Esperance Noongar culture attaches powerful spiritual beliefs to waterways which carry a set of binding principles for the management of the waterway. As a result, Esperance Noongar people inherit the responsibility to uphold these principles and care for the waterway. water course. In Mr Reynolds opinion, an arbitrary distance does not adequately define Aboriginal spiritual notions of the significance in regards to flowing water. It was said that where the waters flow represented the serpent's path and as such defined the areas significance. The river valley was defined as of importance as a path where people traveled hunting, fishing and camping. The archaeological record of sites along the river valley shows this prehistoric domestic use."

1267/10000 characters

PART 2: IMPORTANCE AND SPECIAL SIGNIFICANCE

To which persons of Aboriginal descent is the place of importance and special significance?

Esperance Nyungars/Traditional Owners

37/10000 characters

Why is the site of importance and special significance?

From traditional times the river was an important travel route between the coast and the inland areas. Tjaltjraak people would spend most of the year in the coastal districts of the Esperance sandplain and would then travel inland annually during the winter months to take advantage of the bush foods that were available for harvest during the late winter and early spring time. The coastal bush foods were more readily available during the late spring and summer. There was not an exact time for the annual migration to and from the inland, as it depended on the specific seasons each year. As certain plants would blossom and change, the Tjaltjraak would know it was time to move. The rivers are still important travel routes for Esperance Tjaltjraak because access to so much of their traditional lands is not available to them due to private agricultural landholdings, the rivers provide one way of accessing their country, by boat or by foot, walking along the banks or during dry periods.

Sacred/Spiritual Significance

Munglinup River is considered a place of sacred and spiritual importance because of its association with the Mungan Nyitting Yarn. Traditional Owner Doc Reynolds recalls being told about the mythical associations between the Mungan (snake) and the Munglinup River when he was a child. His family were camping around the area for extended periods while his dad and uncles were cutting fence posts out of jam trees (*Acacia acuminata*). They camped close to the river in a big half tank, turned on its side. Henry Dabb, also a child at the time (1960s), was camped nearby with his father Samuel Dabb a little further south towards the highway, on the other side of the Munglinup River.

Doc recalls that his father Ted Reynolds (dec.) was working with Ned Dimer (dec.) at the time.

"I remember him [Ned Dimer] talking about the old Mungan, the old 'Joe Blake', so you kind of got it from those old fellas. They were talking about it in the story - oh he's old Mungan, he created this place, they would say watch out for that Mungan you fellas, this is his place here so you leave him alone." – Doc Reynolds

Doc also recalls talking to the late Eddie Dimer (Ned Dimer's son) in 2005 about it and Eddie also spoke about the Mungan with reference to the river.

"And even when I was talking to the son of old Ned Dimer, Eddy Dimer he also spoke about the Mungan here which corroborated what his old man was saying". – Doc Reynolds

Diane Clinch (Ned Dimer's daughter) says the many tiger snakes seen during this survey are spiritual custodians of the place.

"The snakes are looking after this place – since the Old People left here. Looking after it." – Diane Clinch

Senior Elders Veronica Williams-Bennell and Graham Tucker also confirmed that they were told as children that the name Munglinup was about the high density of snakes.

Social Significance

The Munglinup River (and associated Oldfield Estuary) have social significance to Esperance Noongar people as places to hunt, fish and gather bush resources and to teach cultural practices to younger generations (including caring for country). It has social significance for the current Elders of the Reynolds, Dabb and Rogers families because of the memories they associate with living and working along the river as children. The

Reynolds and Dabb families camped adjacent to the mining tenement cutting fence posts during the 1960s. Henry Dabb and Doc Reynolds were children at the time and remember staying their family camps well. They share these stories with their younger generations.

River Corridors, River Catchments

These consultations involved discussion on the inter-connected, regional landscape associated with the health of river corridors and catchments. This means also that people place equal significance to the main river channels and the associated tributaries. In the project area, the ethnographic consultations focused on the ephemeral tributaries that truncate the MRC tenement. The Survey participants were concerned to ensure management of these zones, as they relate to the health and protection of the interconnected landscape – the catchment. These zones also have a high likelihood for cultural materials and objects, as they are known as important camping, hunting and movement corridors. This also includes the ridges that represent the origin of the tributaries that feed into the river. Numerous stone artefact scatters, which have been identified along the Munglinup River on this survey and during previous surveys, attest to the use of the river in past Aboriginal movement patterns and are linked to the waterway as nodes within the cultural place.

Caring for Country – Rivers

A traditional Tjaltjraak land management practice associated with the rivers is to open a channel through the sandbar between the river/estuary and the ocean. This is generally done at the end of winter when the estuary is full to overflowing. During very wet years, the sandbar may break of its own volition, however this seldom occurs. The Tjaltjraak people break the sandbar as a way of 'cleaning out country'. Doc Reynolds likened the act of opening up the sandbar to the traditional use of fire:

"Its our way of clearing out the country and creating fresh life. We flush it out and it cleans the whole system for the fish and everything. Just like when we light the bush up to clean the bush out and create new growth. Its part of our ways of caring for country. Especially now days with all the use of chemical and fertilizers on the farms we really need to flush our river systems out."

Another reason that the Tjaltjraak would open the rivers up during traditional times, and during the historical period, is to aid with fishing. River and estuarine fish are an important part of Tjaltjraak subsistence and have been since traditional times. Opening the sandbar is a way to replenish fish stocks in the estuaries/rivers, as fish such as bream and mullet may transfer between the ocean and the estuary. It was also a way to trap fish in smaller pools upstream. This is because a sudden drop in water levels caused by the opening of the sandbar creates isolated pools where there was previously a free flow of water. This makes it easy to spear and catch fish in the pools.

6308/10000 characters

ITEM E: OTHER RELEVANT INFORMATION

PART 1: SECTION 39(2)

Under Section 39(2) in evaluating the importance of places the ACMC shall have regard to the matters below.

Provide any further information referred to in Section 39(2) of the Act, if not provided above:

Any existing use or significance attributed under relevant Aboriginal custom.

The diversity of cultural places, values, archaeological sites and features, cultural plants, and raw materials, including ochre, attest to the integrated cultural landscape. Areas of geological and botanical diversity, as this area is, are often co-located with significant cultural landscapes, as this area is. This place relates to both the cultural value of waterways (Songlines), historical associations, and numerous, inter-connected archaeological features and sites.

478/10000 characters

PART 2: SECTION 39(3)

Under Section 39(3) associated sacred beliefs, and ritual or ceremonial usage shall be regarded as the primary considerations to be taken into account in the evaluation of any place for the purpose of the Act. Provide any further information referred to in Section 39(3) of the Act, if not provided above:

As above

8/10000 characters

Any former or reputed use or significance which may be attributed upon the basis of tradition, historical association or Aboriginal sentiment.

he spirituality reflects important ecological and cultural realities and enshrines them in mythological beliefs. These mythological beliefs then become doctrines for human behavior, often enforced through Aboriginal lore. This is true of the rivers in Esperance Tjaltjraak country, which serve as vital movement corridors for people and animals and are thus afforded spiritual significance as song lines – that imply movement in a spiritual as well as practical sense.

469/10000 characters

Any potential anthropological, archaeological or ethnographic interest

These artefact scatters and isolated finds are of heritage value, and they provide physical evidence of the broader heritage values. Doc Reynolds spoke to the anthropologist about what the archaeological materials mean on a cultural basis of 'proving' to the mainstream heritage system what the Traditional Owners already know and feel:

Doc Reynolds: You see, we come here and actually find clear evidence - some type of physical evidence - to correlate the cultural ethnographic evidence....we have to prove that we've lived in this area or come through this area. So you've got these things here [stone artefacts] that are pretty littered all the way through our country - that we physically gotta come and find them. We know they are there and we know the history, we know that people walked through here so they would have left evidence of this, walking through country. And as you said, how many of these have we found; you know, and we've only touched the surface.

The archaeological sites associated with this waterway are contributing components of the inter-connected landscape. These nodes are significant as formal analysis of the assemblage and setting can add to the current database of regional settlement and subsistence patterns including information about past land use and movement within this specific environmental zone. Although the individual site locations, that are manifest predominately in disturbed/exposed areas across the low dunes, may not be deemed of high archaeological significance when examined as discrete, individual entities, the collective archaeological patterning across this wider area is of interest and highly informative. The pattern and inter-relationships between these areas, that can only be fully determined with more fine-grained analysis, is significant, as it pertains to aspects of the integrated settlement/subsistence strategy of the people that lived in this area and embraced the opportunities and limitations of the natural environment. Although the sites may not be considered distinctive (rare) types within this region, they offer research potential and may be conserved as representative site types for this area, facilitating comparative analysis, and providing information for practical conservation and management.

2286/10000 characters

Aesthetic values

Granites, alluvial terraces, riparian vegetation complexes, tranquil waterways

78/10000 characters

Describe the Site Condition, Culturally Sensitive Information

Site Condition

Provide details regarding the current condition of the site, particularly if has been damaged or disturbed.

Land clearing and associated sediment loss, as well as runoff from chemicals and fertilisers, weeds and feral animals, poor water quality, all negatively impact upon the cultural landscape defined by the waterway and its tributaries, as well as the cultural features, cultural plants and cultural animals. The Traditional Owners are concerned about the overall health of their cultural waterway and associated landforms. If an integrated plan and response is not developed, and the waterway is not understood as a significant cultural landscape from a planning and management perspective, we will see the ongoing degradation of the ecological, biodiversity, and cultural heritage values.

689/10000 characters

Culturally Sensitive Information

Is there any information that is culturally sensitive?

- ☒ Yes
☐ No

Provide details of the information that is culturally sensitive and should be kept confidential and the reasons why (optional).

It is understood the previous ethnographic consultations and more recent consultations are given to heritage consultants for purposes of registering the place with DPLH and that the information is not to be used publicly without written consent of the informants.

264/5000 characters

Provide a summary of the above information that can be provided to the public as part of the State's Register of Places and Objects.

A cultural waterway with multiple and overlapping layers of ancestral, historical social and cultural significance.

115/1000 characters

Is the place:

- ☐ Male only
☐ Female only
☒ No gender restrictions

Knowledge Holders

Are there any people or groups who will be able to provide additional information if required?

Note: you may or may not have consulted with them.

- ☒ Yes
☐ No

Knowledge Holder 1

Given name

Doc

Family name

Reynolds

Organisation or group (if applicable)

Kepa Kurl

Optionally please enter the contact details of this knowledge holder.

Phone number

0418913414

Mobile number

Fax number

E-mail address

doc@kepakurl.com.au

Address

PO Box 1754

Suburb/Town

Esperance

State

WA

Postcode

6450

Is the person an Aboriginal person who holds cultural knowledge about the place?

- ☒ Yes
☐ No

What is their relationship to place and/or specialist expertise?

Traditional Owner

17/250 characters

Did you gather information from this person?

- ☒ Yes
☐ No

Date information provided.
26/04/2018

Information provided.
Cultural information regarding the river and its tributaries

60/250 characters

Add Knowledge Holder

Other Views

Are there any Aboriginal people or appropriately qualified experts known or believed to hold other views in respect of any information provided by the Informant?

- ☐ Yes
- ☒ I am not aware of any other views

Declarant Declaration

To the best of my knowledge, I declare that the statements made in this form are true and correct at the time of lodgement.

☒ I agree

Declarant given name

David

Declarant family name

Guilfoyle

Date

27/08/2018

Lodgement

Send Application

Each form you download can only be submitted once. For each application you submit, you will need to download a new copy of the [form](#).

Note: This form must be sent before 28/08/2019 13:44:33. After this date it will expire and a new form will need to be downloaded and completed.

Validate

APPENDIX D – HIS MAP: MUNGLINUP RIVER



APPENDIX E – HIS FORM: MUNGAN WILGIE KOORT

Heritage Information Submission



Department of Planning,
Lands and Heritage

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- refer to the document [Act](#) to assist with interpreting the Act and completing the Form.
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- attach shapefiles and maps, if possible. Shapefiles are the preferred option.
- contact the Department of Planning, Lands and Heritage if you require further information by emailing submissions@daa.wa.gov.au or phoning (08) 6551 7950.

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Recorder Details

Given name

David

Family name

Guilfoyle

Organisation name (if applicable)

Applied Archaeology International

Position (if applicable)

Managing Director

Please enter either a landline phone or a mobile number (including area code for local numbers)

Phone number

0458266522

Mobile number

0458 266 522

Fax number (optional)

E-mail address

dg@appliedarchaeologyinternational.com

Address

291 Belmont Avenue

Suburb/Town

Cloverdale

State

WA

Postcode

6105

Are you an Aboriginal person who holds cultural knowledge about this place?

☐ Yes

☒ No

Location of Place

Provide as much information as possible about where the place is located to enable it to be accurately mapped on DPLH's mapping system. You may wish to contact DPLH on (08) 6551 7950 or email submissions@daa.wa.gov.au to discuss the required information.

Select a boundary that accurately reflects the extent of the cultural material (preferably the smallest boundary possible with no buffers).

Do you have a shapefiles (preferred), coordinate data and maps to attach (GDA94 referenced is preferred)?

☒ Yes

☐ No

What is the datum of the shapefiles, coordinate data and maps if not GDA94 referenced?

You will be asked to attach these after you click the Send Application button at the end of this Form.

Are you able to list at least one coordinate (spatial reference) for the location?

☒ Yes

☐ No

Are the coordinates:

- ☒ projected (easting/northing) - this is preferred
☐ geographic (latitude/longitude in decimal degrees)

Map Grid of Australia (MGA) Zone

- ☐ 49
☐ 50
☒ 51
☐ 52

List these coordinates and what the coordinate(s) represents (eg central point of the place, boundary points). If you are unable to attach a shapefile or map, include boundary coordinates to ensure that DPLH accurately maps the location of the place.

301265mE 6273794mN - Central point of the place

47/500 characters

Description of boundary of the place.

The boundary represents the observed extent of the associated scatter of artifacts and formal implements that connect to this central cultural place represented by a prominent, rocky outcrop/landform.

201/1000 characters

Why did you select this boundary (i.e. what methodology did you use to arrive at this boundary)?

The boundary was mapped by a pedestrian survey around the central place and noting the spatial extent of associated artifacts. Due to low ground surface visibility and other survey constraints, a generalized buffer was established to assist with management and upon the request of the Traditional Owners.

307/1000 characters

Name(s) that this place is known by?

Mungan Wilgie Koort

19/500 characters

Does this information relate to an existing place on DPLH's records?

- ☐ Yes
☒ No
☐ Unsure

What is the tenement ID for the location (if known)?

ML74/246

Are you submitting this form as part of another submission e.g. Section 18 Notice or Section 16 Application?

- ☒ Yes

☐ No

Ensure that you record the Receipt ID when you submit this Form as you will be required to state it on the Section 18 Notice or Section 16 Application.

Type of Site: Evidence And Justification

A place is by definition an Aboriginal site by operation of the Act, section 5, that is if it meets the requirements of any paragraph of section 5. In the following section "Evidence and Justification" the questions have been designed to elicit the information required to satisfy each paragraph.

You may complete one or more of Item A, Item B, Item C or Item D.

- ☒ **ITEM A: PLACE WITH ABORIGINAL OBJECTS** (Act, section 5 (a))
- ☒ **ITEM B: SACRED RITUAL OR CEREMONIAL SITE** (Act, section 5(b))
- ☐ **ITEM C: SITES OF IMPORTANCE TO THE CULTURAL HERITAGE OF THE STATE** (Act section 5 (c))
- ☐ **ITEM D: TRADITIONAL OR DESIGNATED STORAGE PLACES** (ACT, SECTION 5 (d))

ITEM A: PLACE WITH ABORIGINAL OBJECTS (Act, section 5 (a))

PART 1: THE PLACE

To whom is the place of importance and significance?

The Esperance Nyungars

22/10000 characters

Why is the place of importance and significance?

Mungan Wilgie Koort is a rocky outcrop associated with an upper tributary of the Munglinup River. There is an extensive artefact scatter and evidence that may be consistent with ochre quarrying. Esperance Noongar Elders believe it to have spiritual significance associated with the many tiger snakes inhabiting the place, which they understand to be spiritual custodians. The presence of ochre adds additional ceremonial values because ochre is used in ceremonial activities. The spiritual significance is explained below in a description of the site assessment process.

Elder Diane Clinch stated (in response to the archaeologists information that several snakes were seen on the rocky outcrop): "The snakes are looking after this place – since the Old People left here. Looking after it."

This is understood as a layered and complex understanding of connections to place, past and present, that additionally describes the spiritual presence of the place, as well as a lesson. The lesson is that sacred places such as this are looked after by spirits when Traditional Owners are not there, and this may be in the form of the Mungan (also the Traditional name of this waterway, Munglinup). That is why the archaeologists encountered snakes, but during the ethnographic assessment, with the Traditional Owners present, no snakes were encountered. Her statement is also a reminder of the history of dispossession of the Traditional Owners from their lands and special places, but hints that this is just a temporary displacement, during which the Mungan are Custodians, until such time as the Traditional Owners return.

The Survey participants also discussed the name of this place – Mungan Wilgie Koort (snake ochre rock).

"There is evidence of occupation here, which is a big thing for me. I want that noted" Elder, Graham Tucker

1846/10000 characters

PART 2: THE OBJECTS

Is there one or more Aboriginal Objects left at this place by persons of Aboriginal descent?

☒ Yes

☐ No

Is/Are the Object(s):

☒ natural

☒ artificial

How is the purpose of the Objects connected with the traditional cultural life of the Aboriginal peoples Past or Present?

Are/Were the Objects:

☒ used for that purpose

☒ made for use for that purpose

☒ adapted for use for that purpose

Any further details?

In association with this significant cultural place, that is dominated by a prominent (laterite) rocky hill at the junction of an ephemeral creek and on the eastern terrace of the Munghlinup River, the site extends as an extensive and dense artifact scatter. Large nodules of chert cores, small implement and waste flakes from the debris in the manufacture and maintenance of implements, formal tools, hammerstones and grindstones were identified. It is best understood as a wide diversity and range of implement types and raw materials, likely indicating a more sedentary (base) camp. Artifacts were identified within the existing track that bisects the site, and in sub-surface context in eroded rills. In addition, significant ochre sources have been identified across the tenement and within the rocky outcrop associated with Mungan Wilgie Koort (Site MRC 05). Ochre is of cultural significance and is afforded protection under the AHA (Section 6) if identified by Traditional Owners as such, with or without evidence of direct utilization of the ochre itself.

1069/10000 characters

ITEM B: SACRED RITUAL OR CEREMONIAL SITE (Act, section 5(b))

PART 1: THE PLACE

Is the place a

☒ A sacred site

☐ A ritual site

☐ A ceremonial site

☐ None of the above

Provide full details:

The Elders interpreted spiritual meaning for the place on the basis of animal activities. This kind of landscape interpretation is a part of contemporary cultural practice, especially in places where Noongar people have not visited for a generation or longer. The presence of mungan (snakes) within this rocky outcrop provides a spiritual link to the place and the associated waterway, which relates to cultural connections with the mungan (snake) - that is, the Munglinup River.

479/10000 characters

PART 2: IMPORTANCE AND SPECIAL SIGNIFICANCE

To which persons of Aboriginal descent is the place of importance and special significance?

Esperance Nyungars, Traditional Owners, Native Title holders.

62/10000 characters

Why is the site of importance and special significance?

This site is of major cultural significance at a spiritual, social, and archaeological level. The Traditional Owners know this place as an important spiritual place and want to see it protected. The place represents the actions and movement of the Traditional Owners' ancestors and that remain present here, as Custodians. The place represents a strategic settlement where domestic and cultural activities took place, at the junction of a tributary and the main waterway of the cultural waterway - Munglinup River. Mungan Wilgie Koort is the name given to the rocky outcrop. Esperance Nyungar Elders believe it to have spiritual significance associated with the many tiger snakes inhabiting the place, which they understand to be spiritual custodians. The presence of ochre adds additional ceremonial values because ochre is used in ceremonial activities.

861/10000 characters

ITEM C: SITES OF IMPORTANCE TO THE CULTURAL HERITAGE OF THE STATE (Act section 5 (c))

PART 1: THE PLACE

Is or was the Place associated with Aboriginal people?

- ☐ Yes
☐ No

ITEM D: TRADITIONAL OR DESIGNATED STORAGE PLACES (ACT, SECTION 5 (d))

PART 1: THE PLACE

Is the place:

- ☐ One where Objects are traditionally stored and if so provide details including: Relevant current Aboriginal traditions, custodian of the objects and Details of current use. Please state whether the objects are still located at the place.
- ☐ One to which, under the provisions of the Act, Objects have been taken or removed and if so: By whom was the order made, Date of order, Attach a copy of the order.
- ☐ None of the above

ITEM E: OTHER RELEVANT INFORMATION

PART 1: SECTION 39(2)

Under Section 39(2) in evaluating the importance of places the ACMC shall have regard to the matters below.

Provide any further information referred to in Section 39(2) of the Act, if not provided above:

Any existing use or significance attributed under relevant Aboriginal custom.

The Traditional Owners connect this place to traditional gathering place where a range of activities were carried out, including ceremony, and in the the use and trade of ochre.

178/10000 characters

PART 2: SECTION 39(3)

Under Section 39(3) associated sacred beliefs, and ritual or ceremonial usage shall be regarded as the primary considerations to be taken into account in the evaluation of any place for the purpose of the Act.

Provide any further information referred to in Section 39(3) of the Act, if not provided above:

The place represents the sacred belief systems to the Creation of the landscape and waterway by the Mungan (snake).

117/10000 characters

Any former or reputed use or significance which may be attributed upon the basis of tradition, historical association or Aboriginal sentiment.

The area has historical connections as places where Nyungar people lived and worked, with a number of family camps located nearby. It has social significance for the current Elders of the Reynolds, Dabb and Rogers families because of the memories they associate with living and working along the river as children. The Reynolds and Dabb families camped adjacent to the mining tenement cutting fence posts during the 1960s. Henry Dabb and Doc Reynolds were children at the time and remember staying their family camps well. They share these stories with their younger generations.

581/10000 characters

Any potential anthropological, archaeological or ethnographic interest

the place is of immense anthropological and archaeological interest. For the latter, large nodules of chert cores, small implement and waste flakes from the debris in the manufacture and maintenance of implements, formal tools, hammer-stones and grindstones were identified. It is best understood as a wide diversity and range of implement types and raw materials, likely indicating a more sedentary (base) camp. Artifacts were identified within the existing track that bisects the site, and in sub-surface context in eroded rills. Thus, there is a very high potential for intact, stratified cultural deposits that may reveal detailed aspects of past human

antiquity, settlement and subsistence.

700/10000 characters

Aesthetic values

The place is a incredible landscape setting with very healthy vegetation systems, water, and animal life.

106/10000 characters

Describe the Site Condition, Culturally Sensitive Information

Site Condition

Provide details regarding the current condition of the site, particularly if has been damaged or disturbed.

The site is in good condition but with some impacts from a two-track that truncates a section of the site and has broken artifacts and exposed cultural deposits. There is some localized water erosion, associated with the track. During the ethnographic assessment, the team discussed management and protection of this place (see report) and it was unanimously noted that this area was to be a 'no-go' zone, but does require some further assessment, study, and protection measures.

482/10000 characters

Culturally Sensitive Information

Is there any information that is culturally sensitive?

☒ Yes

☐ No

Provide details of the information that is culturally sensitive and should be kept confidential and the reasons why (optional).

There are cultural stories associated with this place and waterway that are passed down through oral tradition.

112/5000 characters

Provide a summary of the above information that can be provided to the public as part of the State's Register of Places and Objects.

Cultural, social and archaeological place.

43/1000 characters

Is the place:

☐ Male only

☐ Female only

- No gender restrictions

Knowledge Holders

Are there any people or groups who will be able to provide additional information if required?

Note: you may or may not have consulted with them.

- ☒ Yes
- ☐ No

Knowledge Holder 1

Given name

Doc

Family name

Reynolds

Organisation or group (if applicable)

Esperance Tjaltjraak Native Title Aboriginal Corporation (ETNTAC)

Optionally please enter the contact details of this knowledge holder.

Phone number

0890720094

Mobile number

Fax number

E-mail address

admin@etntac.com.au

Address

18 Andrew Street

Suburb/Town

Esperance

State

WA

Postcode

6450

Is the person an Aboriginal person who holds cultural knowledge about the place?

- ☒ Yes
- ☐ No

What is their relationship to place and/or specialist expertise?

Custodian

9/250 characters

Did you gather information from this person?

- ☒ Yes
- ☐ No

Date information provided.

27/04/2018

Information provided.

Cutlural connections

20/250 characters

Other Views

Are there any Aboriginal people or appropriately qualified experts known or believed to hold other views in respect of any information provided by the Informant?

- ☐ Yes
- ☒ I am not aware of any other views

Declarant Declaration

To the best of my knowledge, I declare that the statements made in this form are true and correct at the time of lodgement.

☒ I agree

Declarant given name

David

Declarant family name

Guilfoyle

Date

17/06/2018

Submission Acknowledgement

Your application has been successfully sent. Please keep a copy of this acknowledgement for your records.

Date and time

18/06/2018 07:52:47 AWT

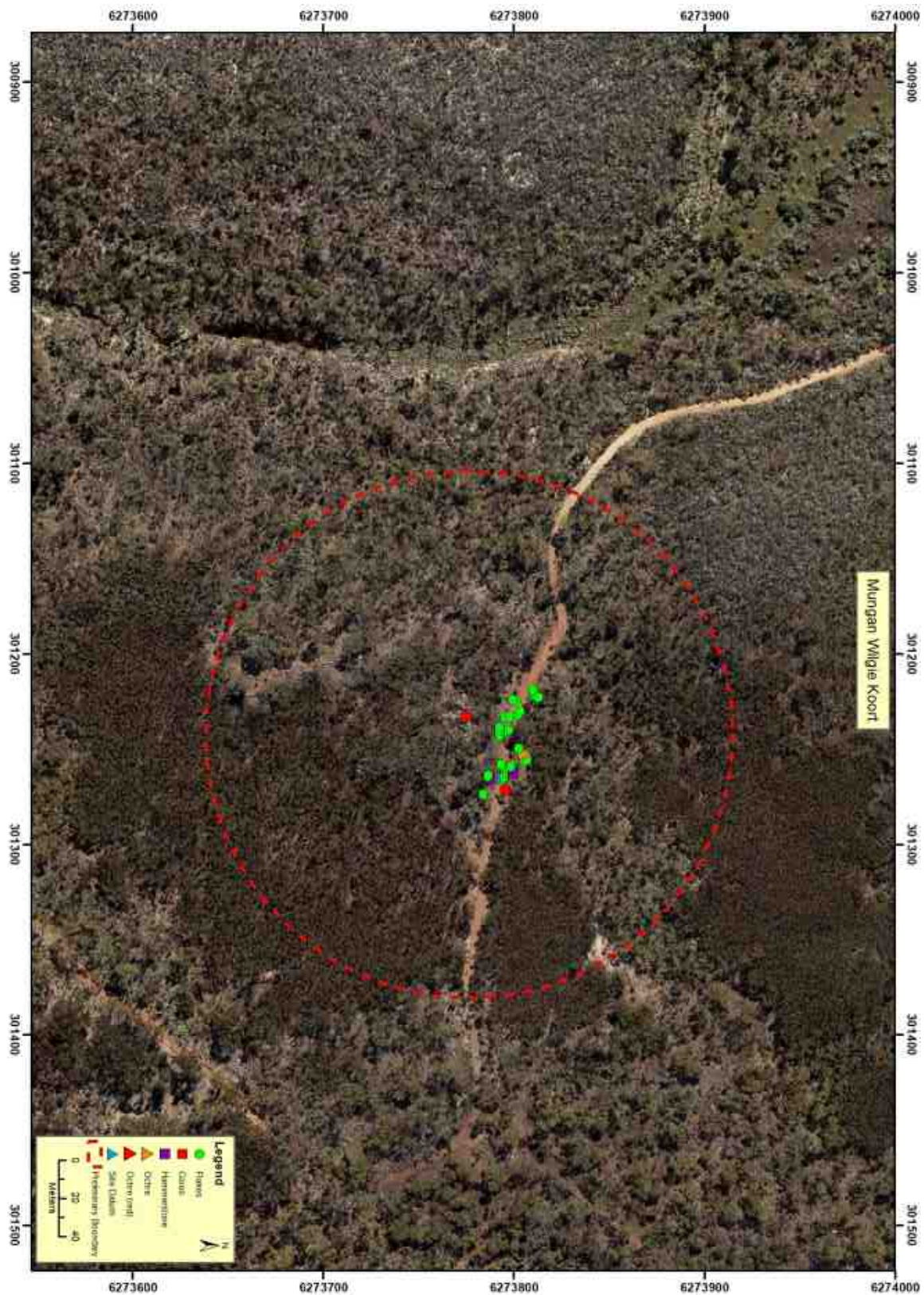
Form submission number

HIS-15120959-2987



To save or print a copy of the completed application and acknowledgement go to the "File" menu and select "Save as" or "Print".

APPENDIX E – HIS MAP: MUNGAN WILGIE KOORT



APPENDIX C-16: IBSA Data Packages

(Data Packages Provided Electronically)

APPENDIX D: EPBC PROTECTED MATTERS SEARCH



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: 20/09/18 12:42:39

[Summary](#)

[Details](#)

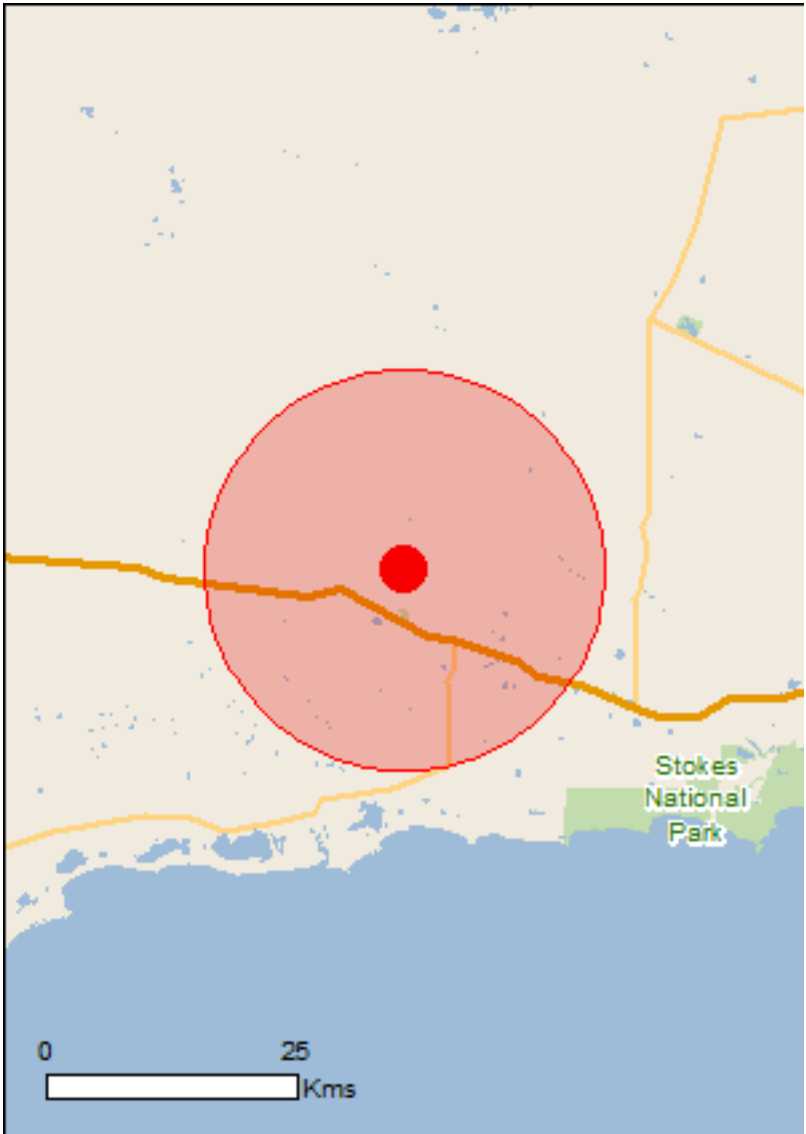
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are
©Commonwealth of Australia
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[Coordinates](#)

Buffer: 20.0Km



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:	2
Listed Threatened Species:	16
Listed Migratory Species:	12

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:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	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:	10
Regional Forest Agreements:	None
Invasive Species:	13
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities

[Resource Information]

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.

Name	Status	Type of Presence
Eucalypt Woodlands of the Western Australian Wheatbelt	Critically Endangered	Community may occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence area
Plants		
Anigozanthos bicolor subsp. minor Little Kangaroo Paw, Two-coloured Kangaroo Paw, Small Two-colour Kangaroo Paw [21241]	Endangered	Species or species habitat likely to occur within area
Conostylis lepidospermoides Sedge Conostylis [9254]	Endangered	Species or species habitat likely to occur within area
Eremophila denticulata subsp. denticulata Fitzgerald Eremophila [64569]	Vulnerable	Species or species habitat likely to occur within area
Eremophila lactea Milky Emu Bush [2416]	Endangered	Species or species habitat may occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Ricinocarpos trichophorus Barrens Wedding Bush [19931]	Endangered	Species or species habitat likely 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
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within

Name	Threatened	Type of Presence
Pandion haliaetus Osprey [952]		area Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land	[Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

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		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
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 likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]	Critically Endangered	within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to 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
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
East Naernup	WA
Lake Shaster	WA
Munglinup	WA
NTWA Bushland covenant (0015B)	WA
NTWA Bushland covenant (0019)	WA
NTWA Bushland covenant (0034)	WA
NTWA Bushland covenant (0035)	WA
NTWA Bushland covenant (0043)	WA
NTWA Bushland covenant (0047)	WA
Springdale	WA

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

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		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
Feral deer Feral deer species in Australia [85733]		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
Sus scrofa Pig [6]		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		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		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.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

-33.665 120.85972

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](#)
- [Department of Land and Resource Management, Northern Territory](#)
- [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, Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- [Australian Tropical Herbarium, Cairns](#)
- [eBird Australia](#)
- [Australian Government – Australian Antarctic Data Centre](#)
- [Museum and Art Gallery of the Northern Territory](#)
- [Australian Government National Environmental Science Program](#)
- [Australian Institute of Marine Science](#)
- [Reef Life Survey Australia](#)
- [American Museum of Natural History](#)
- [Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- 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.

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APPENDIX E: DIEBACK MANAGEMENT PLAN



MINERAL COMMODITIES LTD

MRC GRAPHITE DIEBACK MANAGEMENT PLAN

Prepared by Integrate Sustainability



Document Control

Version	Author	Date of Issue
Version 1	Integrate Sustainability Pty Ltd	September 2018
Version 2		
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Daniel Hastings
Business Development Manager
MRC Graphite Pty Ltd
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1. INTRODUCTION

1.1. Project Description and Background

The Munglinup Graphite Project is located 105km west of Esperance, 85km east of Ravensthorpe and 4km north of the town of Munglinup in the south coast region of Western Australia. Graphite within the project area has been identified, studied and historically mined on several occasions, by several companies, over the last 100 years. The Munglinup Graphite Project lies within Mining Lease M74/245 and includes the development of six graphite deposits as open pit mines (Halberts Main, Halberts South, Harris, McCarthy East, McCarthy West and Whites). Associated infrastructure including a waste rock landform, tailings storage facility, processing plant and run-of-mine / low-grade stockpile, workshops and administration buildings and roads (haul and LV) are proposed.

The Munglinup Graphite deposits have been held and explored by several companies, prospectors and groups over the last 100 years. The first exploration shafts were constructed before 1917 and mining records indicate that a small amount of graphite was extracted during the 1920's and likely used as part of the war effort. The small, shallow prospecting shafts which were targeted at that time are located over the known ore zones.

Since the 1970's several exploration companies have investigated the viability of the graphite deposits including Metals Exploration NL (1971-1972), Norseman Gold Mines (1979-1980), Pioneer Concrete (1985-1986) and Gwalia Minerals NL (1988-1997). In 1989 Gwalia Minerals declared a measured and indicated resource of 1,467,500 tonnes at 18.2% which was estimated in accordance with the AusIMM's 1989 Jorc Code. A feasibility study was produced in 1991 and an NOI was submitted for the development of an open pit mine. This work was never completed. In 1997 Gwalia released a statement that the Munglinup Graphite Project would not be brought into production until a proportion of the graphite output has been contracted for sale. In 2004 Gwalia Minerals went into administration and then receivership. (MRC Graphite, 2018c)

In 2007, Adelaide Prospecting Pty Ltd acquired the Munglinup Graphite Project from the administrator of Gwalia Minerals NL. In 2009 the project was sold to Graphite Australia. Exploration activities and metallurgical work was completed by Graphite Australia from 2011 to 2013 (Mineral Commodities Ltd, 2017). In 2014 Gold Terrace Pty Ltd acquired the tenure associated with the Munglinup Graphite Deposit. In November 2017 MRC Graphite entered into a joint venture agreement with Gold Terrace.

1.2. Purpose and Scope

Phytophthora Dieback is the common name for the root-rot disease in native plants caused by the pathogen *Phytophthora cinnamomi*. Prior to publication of the Best Practice Guidelines-Management of Phytophthora Dieback in Extractive Industries (DWG, 2005), most documents relating to the management of Phytophthora Dieback have only referred to *Phytophthora cinnamomi*. This document uses the term *Phytophthora* Dieback (Dieback) to refer to *Phytophthora cinnamomi*, which is by far the most virulent and destructive of the *Phytophthora* species in Western Australia, but it also includes the other species of *Phytophthora* that have been recorded in the area such as *P. cryptogea*.

This *Phytophthora* Dieback Management Plan relates to the monitoring and management of Dieback at MRC's Munglinup graphite project site located on tenements M74/245 and includes exploration tenements E74/505 and E74/565. The purpose of this document is to communicate the responsible management of Dieback during the exploration, construction and operational phases. This Management Plan applies to all MRC staff, contractors, sub-contractors and suppliers.

1.3 Environmental Setting

The proposed Project is located within the Shire of Esperance approximately 500 kilometres (km) south-east of Perth, 105km east of Esperance and 4km north of the Munglinup town site on Mining Lease M74/245. The project area encompasses approximately 685 ha of intact native vegetation adjacent to the Munglinup River, with limited historical clearing associated with mining in the 1900's and exploration of Graphite deposits on low rises.

The Project exploration tenure is situated over a mixture of freehold land, crown reserves and gazetted easements. These areas are comprised of intact vegetation and cleared farming land which is a mixture of grazing and cropping.

1.3.1 Biogeographic Regions

The Interim Biogeographic Regionalisation for Australia (IBR) (Version 7) classifies Australia into bioregions of similar geology, landform, vegetation, fauna and climatic characterisations. The project is located in the Esperance Plains Bioregion which is comprised of two sub-regions; the Fitzgerald and Recherche, the project is located in the Recherche subregion (Figure 1) which covers 1,606,517 ha on the south coast of Western Australia.

The Recherche subregion is characterised by variable relief, comprising of Quaternary coastal sandplains and dunes overlaying Proterozoic gneiss and granite and more recent coastal limestone. Vegetation types are diverse and are comprised of Proteaceous scrub and Mallee heaths on sandplains, herbfields and heaths on granite and quartzite ranges and Eucalypt woodlands in gullies and on alluvial footslopes (S Comer, 2001).

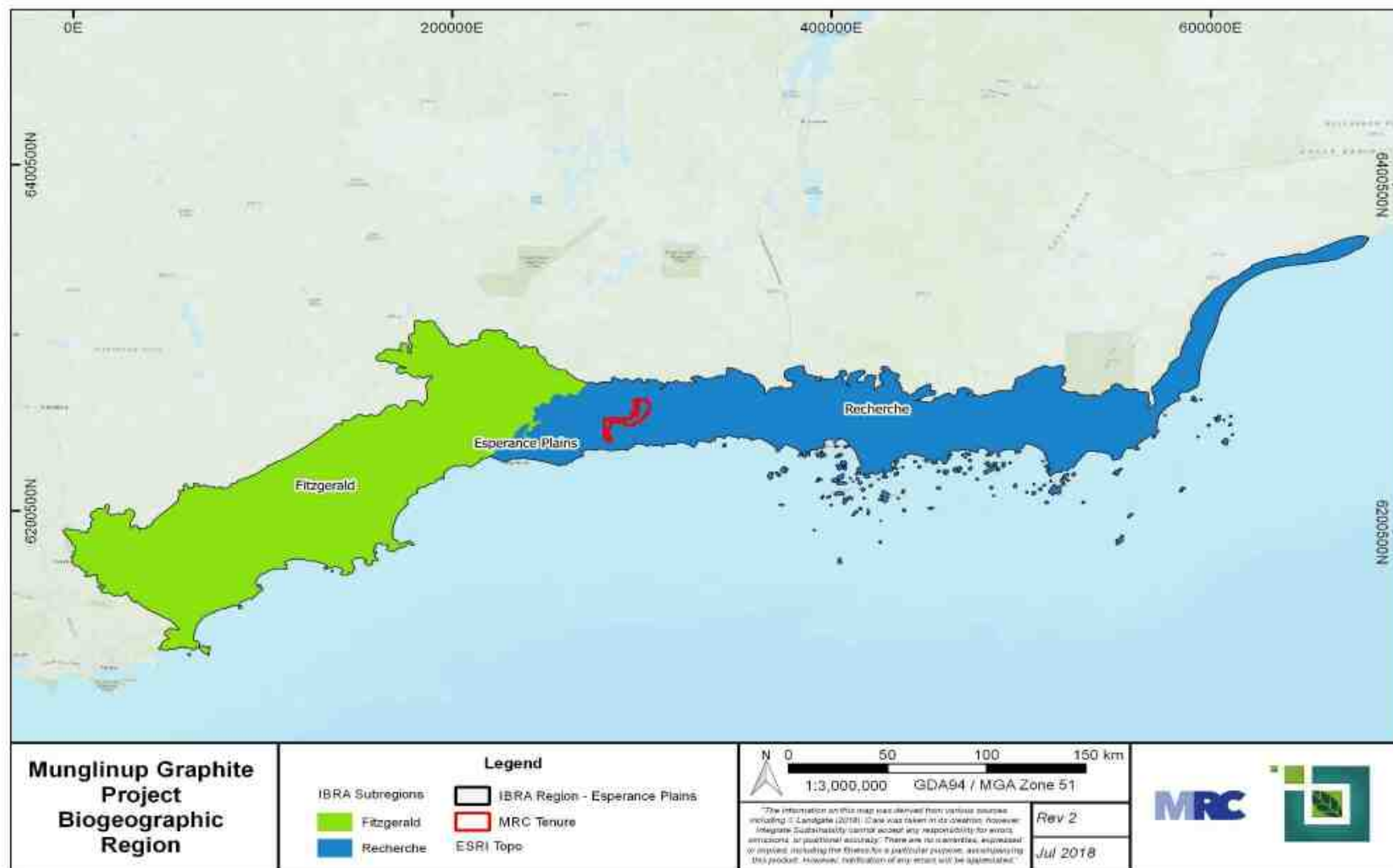


Figure 1 Biogeographic Regions

1.3.2 Climate

The Esperance Plains Bioregion experiences a temperate Mediterranean climate with warm hot summers, mild winters and annual rainfall between 400mm-700mm (S Comer, 2001) Figure 2.

At the Munglinup weather station, 5km south of the project area, the average rainfall (recorded between 2002 and 2018) is 456.5mm and the wettest period is from May to September, where approximately 50% of the mean annual rain falls (BOM, 2018). In terms of rainfall, the project area is in the vulnerable zone, where the disease is generally restricted to water-gaining parts of the landscape. Water-gaining areas are typically in the lowest parts of the landscape and include creeks, rivers and wetlands. The project area experiences occasional significant summer rainfall events, which would increase the likelihood of the disease establishing outside of water-gaining areas (Glevan Consulting, 2018).

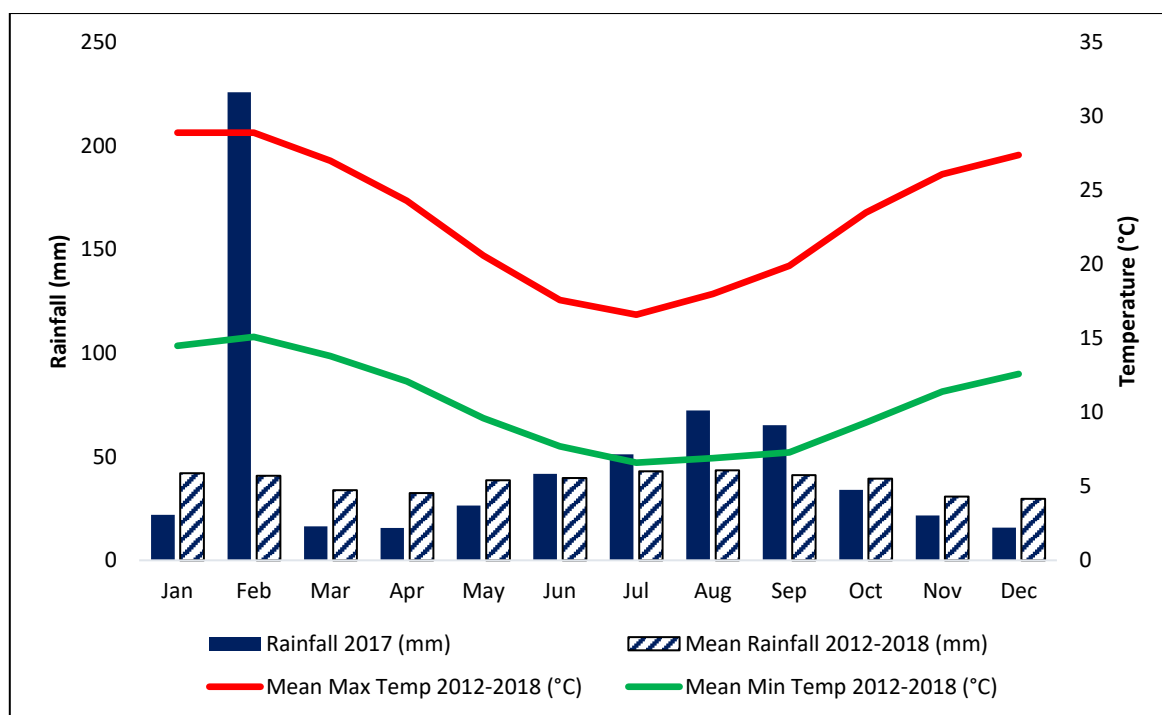


Figure 2. Munglinup Climate Data (2002-2018) (BOM, 2018)

1.3.3 Flora and Vegetation

The project area is dominated by Mallee shrubland and Eucalypt woodland, with occasional Proteaceous shrubland observed. The Mallee shrubland typically features a low overstorey of Mallee over a dense understorey of shrubs dominated by *Acacia* and *Melaleuca* species. The Eucalyptus woodland features an overstorey of Eucalypt trees, with a relatively sparse understorey of *Acacia* and *Melaleuca* shrubs, with occasional thickets. The Proteaceous shrubland is characterised by scattered Mallee over a relatively dense, proteaceous understorey (Glevan Consulting, 2018).

The Proteaceae Dominated Kwongan Shrublands Threatened Ecological Community (TEC) has also been identified in the project area. The TEC comprises 350 ha primarily located in the northern portion of the project area and in the south-western corner on the western side of the Munglinup River. However, the development envelope which is covered within this proposal includes only 46ha of the vegetation type associated with the Kwongan Shrubland TEC (Woodman Environmental, 2018).

1.4. *Phytophthora* Dieback

The pathogen *Phytophthora cinnamomi* is an agent of environmental disease found in vulnerable areas of Western Australia. Phytophthora Dieback is the common name for the observable disease result of interaction between the pathogen (*P. cinnamomi*) and the vegetation hosts (susceptible plant species within vulnerable areas).

P. cinnamomi is a microscopic water mould. It belongs to the class Oomycetes in the Kingdom Stramenopila. It is more closely related to brown algae than to true fungi. Oomycetes organisms occupy both saprophytic and pathogenic lifestyles however *P. cinnamomi* is considered parasitic. It behaves largely as a necrotrophic pathogen causing damage to the host plant's root tissues because of infection and invasion. The life cycle of *Phytophthora cinnamomi* is a continuous circle of infection, sporulation and further infection and is readily vectored by animals and human activity allowing for rapid invasion into new areas.

The pathogen consumes the host plant causing lesions (areas that appear rotten). This weakens or kills the plant by reducing or stopping the movement of water and nutrients within the plant. Once attacked susceptible hosts rarely recover (CALM, 2003).

The environmental conditions of the site significantly affect the pathogens ability to survive or flourish and spread over time. All land with an annual average rainfall of more than 400 millimetres and suitable soil composition is considered vulnerable to Phytophthora Dieback. This large area stretches approximately from Perth, Bunbury and Augusta in the west to Narrogin, Ravensthorpe and Esperance in the east, and as far north as Kalbarri.

Other *Phytophthora* species responsible for vegetation decline or death are also regularly encountered during Phytophthora Dieback assessments. Two species frequently recovered in soil and tissue samples taken in south west and southern coast of WA are *P. multivora* and *P. arenaria*.

It is not known whether *P. multivora* is indigenous or introduced. It is however, widespread on the coastal plain sands and has been associated with the deaths of several different native plant species. This pathogen is also typically much less virulent and destructive than *P. cinnamomi* in the natural environment. The project area is not considered to be a favourable environment for *P. multivora* and its presence is highly unlikely. The nearest recorded recovery of *P. multivora* to the study area was on Hammersley Drive, west of Hopetoun, approximately 85 km away (Glevan Consulting, 2018).

The plant host is a highly variable component of the disease development. Sites may range from having no susceptible host, to containing vegetation that is almost entirely susceptible. Within vulnerable areas, three main family groups are regarded as highly susceptible to Phytophthora Dieback disease, being:

- Proteaceae
- Ericaceae
- Xanthorrhoeaceae.

1.5. Current Status

Based on the field assessment conducted in April 2018, the Project Area can be grouped in to the following occurrence categories.

Vegetated Areas:

- **Infested** - Areas of vegetation, identified and assessed by an accredited disease interpreter, that show visible signs of infestation through the presence of associated susceptible plant deaths in a pattern consistent with Dieback. Evidence of the infestation may be supported by positive recoveries of Dieback via laboratory analysis.
- **Uninfested** - Areas of vegetation, identified and assessed by an accredited disease interpreter, that are free from the disease. Uninfested areas must contain susceptible species in numbers that would allow detection of the disease if it were present.
- **Uninterpretable** - Areas within the study area that cannot be determined to be infested or uninfested. Such areas may:
 - Consist of vegetation that does not contain susceptible species;
 - Have been recently burnt, removing all evidence of disease symptoms; or
 - Be recently disturbed areas or areas of non-native vegetation.
- **Temporarily Uninterpretable** - Areas that are sufficiently disturbed so that Phytophthora Dieback occurrence mapping is not possible at the time of inspection;
- **Not yet Resolved** - Areas where the interpretation process has not confidently determined the status of the vegetation.

Non-Vegetated Areas:

- **Excluded** - Areas devoid of vegetation are excluded from the assessment area

A desktop review using the DIDMS database indicates two infestations located on tenement E74/565, these infestations are in roadways that traverse the exploration tenement (Figure 3). Prior to undertaking exploration near these areas MRC will commission a dieback assessment to verify the extent of the occurrences.

The most recent survey conducted on the project site has identified that there are no Phytophthora Dieback infestations within the project area located on tenement M74/245. A total of 19.5 ha was observed to be uninfested, while the remaining 228 ha was mapped as uninterpretable due to an insufficient coverage of reliable indicator species. The only uninfested sections observed occurred on the roads and tracks used to access the project area (Figure 3).



Figure 3 Dieback Classification

2. POTENTIAL IMPACTS

The potential impacts associated with *Phytophthora* Dieback and that may arise or occur from exploration, construction and operational activities are:

- unauthorised entry into the *uninterpretable* or *uninfested* areas;
- inadequate hygiene practices; and
- increased activity associated with mining operations, road and pipeline construction following rain and in moist conditions.

The most likely disease vectors for the project will be the introduction of *Phytophthora* Dieback through equipment and machinery carrying contaminated mud and soil from other sites. To prevent introduction the access of vehicles and machinery will be controlled at the hygiene inspection points (Figure 4) where vehicles will go through a mandatory inspection and wash-down before being granted access between uninfested and uninterpretable areas. During the wetter months all vehicles and machinery will also be required to go through the hygiene inspection points to wash-down prior to entering uninfested areas from uninterpretable areas regardless of visual inspection.

Exploration

Exploration activities most likely to have a medium to high risk on the introduction of *Phytophthora* Dieback is from the mobilisation of contaminated equipment and the movement of equipment between infected, uninterpretable and clean areas. All vehicles and equipment must be “clean on entry” and staff and contractors to the site must be made aware of the *uninterpretable* and *uninfested* areas.

Construction

Activities during the construction phase that are most likely to cause the introduction or spread of *Phytophthora* Dieback include mobilisation of contaminate equipment, large scale clearing of vegetation and topsoil collection, and earthworks associated with the construction of roads and site infrastructure and commencement of mining. Maintenance activities such as grading, earth moving, topsoil stock piling and survey works also increase the risk of introducing the disease.

Operations

The risk of *Phytophthora* Dieback spread, or introduction is greatly reduced in the operational phase once all roads and infrastructure are established. The risk of dieback spread, or introduction can still occur when new equipment involved in clearing and rehabilitation is brought to site or changes in surface water management resulting in wet conditions suitable for dieback establishment or offsite contaminated run-off enters site.

3. RELEVANT LEGISLATION AND GUIDELINES

The following legislation and policy guidelines are relevant to Dieback management and have been used as guidance material for the Project:

- *Conservation and Land Management Act 1984* (WA);
- *Conservation and Land Management Regulations 2002* (WA);
- *Forest Management Regulations 1993* (WA);
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (WA);
- *Wildlife Conservation Act 1950* (WA);
- *Environmental Protection and Biodiversity Conservation Act 2000* (Cth);
- Policy Statement No 3, *Threat Abatement for Phytophthora cinnamomi and disease caused by it in Native Vegetation* (CALM, 2004a) – draft interim policy;
- *National Threat Abatement Plan for disease in natural ecosystems caused by Phytophthora cinnamomi* (Commonwealth of Australia, 2017);
- *National Background: Threat Abatement Plan for disease in natural ecosystems caused by Phytophthora cinnamomi* (Commonwealth of Australia, 2017);
- *Best Practice Guidelines for the Management of Phytophthora cinnamomi* (CALM, 2004b);
- *Phytophthora cinnamomi and Disease Caused by it, Volume 1 Management Guidelines*, Department of Environment and Conservation (2007);
- *Managing Phytophthora Dieback in Bushland – A Guide for Landholders and Community Conservation Groups*, Edition 3, Dieback Working Group (2005a); and
- *Management of Phytophthora Dieback in Extractive Industries*, Dieback Working Group (2005b).

4. MANAGEMENT OBJECTIVES AND PERFORMANCE INDICATORS

4.1 Management Objectives

The objective of the *Phytophthora* Dieback Management plan is to define, control and measure responsibilities and procedures for the management of the disease, by implementing best management practices to restrict the spread of dieback from infested and uninterpretable areas to uninfested areas. The overarching objectives are to:

- prevent new infestations;
- restrict the spread of known infestations;
- protect uninfested and uninterpretable areas that are protectable; and
- protect Critical Assets outside Protectable Areas from non-autonomous spread of the pathogen.

The management objectives in relation to Dieback are to:

- manage activities to prevent the introduction of Dieback on M74/245 and E74/505;
- restrict the spread of known infestations located on E74/565;
- ensure that the risk of spread of Dieback onto the site or from uninterpretable to uninfested areas is minimised over the Life of the Mine;
- ensure that appropriate hygiene measures limit the spread of Dieback during exploration, construction and operation activities;

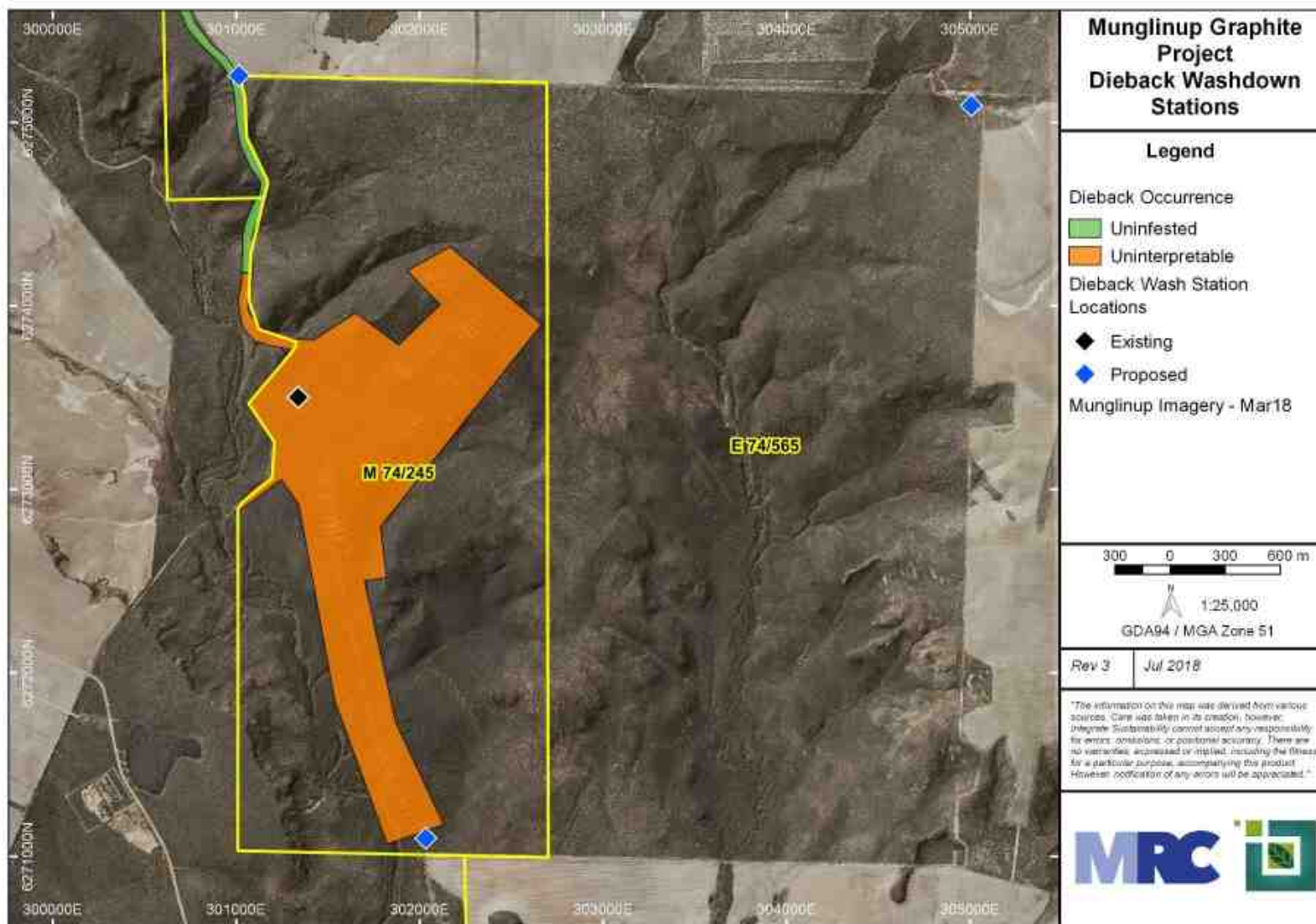


Figure 4 Proposed Dieback Hygiene Inspection Point and Washdown Areas

- define environmental roles, responsibilities and accountabilities of personnel in respect to the implementation of the Dieback Management Plan;
- provide adequate information and instruction to ensure personnel comply with this Management Plan and that a framework exists for the inclusion of additional requirements; and
- ensure that senior management and all personnel understand their environmental duty of care and have concern for the overall environmental effects of their performance by implementing, managing and continually reviewing this Management Plan.

4.2 Performance Indicators

Prevent and minimise the spread of known Dieback infestations on E 74/565 to uninterpretable and uninfested areas is minimised over the Life of the Mine

- compliance with prescribed management actions;
- clear evidence of no breaches of the management actions; and
- conduct assessments during optimal conditions throughout the exploration, construction and operation of the mine

Prevent the introduction of Dieback on M 74/245 and E 74/505 and ensure that the risk of spread of Dieback onto the site or from uninterpretable to uninfested areas is minimised over the Life of the Mine

- compliance with prescribed management actions;
- clear evidence of no breaches of the management actions; and
- conduct assessments during optimal conditions throughout the exploration, construction and operation of the mine

Ensure that appropriate hygiene measures limit the spread of Dieback during Project exploration, construction and operation

- conduct assessments during optimal conditions throughout the construction and operation of the mine;
- review vehicle clean down records; and
- maintenance service records are kept for all wash-down equipment.

Provide adequate information and instruction to ensure personnel comply with this Management Plan and that a framework exists for the inclusion of additional requirements

- no breaches of management plan instructions reported

Ensure that senior management and all personnel understand their environmental duty of care and have concern for the overall environmental effects of their performance by implementing, managing and continually reviewing this Management Plan

- evidence of management plan updates on a scheduled basis

Dieback management actions are contingent upon the stage of development. This plan refers to three stages:

- exploration – drilling activities, removal of vegetation, driving
- construction – removal of vegetation and topsoil from haul road, mining and laydown areas; preparation of haul road foundation and application of surfacing material; and

- operations – mining and haulage; road and infrastructure maintenance; surface water management.

Unexpected and/or unplanned access, water usage and movement through disease boundaries may occur in exceptional circumstances such as fire-fighting activities.

5. MANAGEMENT ACTIONS

No *Phytophthora* Dieback infestations have been recorded to date in the project site, although there are a significant number of known infestations throughout the local area.

Management controls have been developed to be consistent with best practice management techniques described in the following publications:

- *Management of Phytophthora cinnamomi for Biodiversity Conservations in Australia, Part 2 – National Best Practice Guidelines* 2005;
- *Phytophthora cinnamomi and Disease Caused by It* Volume 1 Management Guidelines, DEC 2007;
- *Management of Phytophthora Disease; Policy Statement 3*, DPaW (2014);
- *State Phytophthora Dieback Management and Investment Framework*, 2014; and
- *Management of Dieback Disease in Mineral Exploration*, DMP 2006.

Areas classified as uninterpretable will be assumed to contain Dieback and therefore the management objectives listed above are to prevent the spread of Dieback into the uninfested areas and to constrain the spread of the pathogen into the uninfested areas. These management actions have been identified in Table 1.

Table 1 Management Actions

Stage	Control	Description	Responsibility
Objective 1. Prevent the spread of known Dieback infestations on E 74/565			
Exploration Construction Operations	Planning	Consideration of <i>Phytophthora</i> Dieback issues in and ensuring that management controls are adhered to during construction and operations	Exploration Manager / Project Manager / General Manager
		All disease category boundaries will be assessed on an annual basis during monitoring by a qualified Dieback interpreter.	Environmental Advisor
Exploration Construction Operations	Hygiene	Vehicles and machinery that enter the infested areas will be required to perform a mandatory wash-down before entering any uninfested or uninterpretable areas	Exploration Manager / Project Manager / General Manager
Exploration	Hygiene	Wash-down stations will be made available for all vehicles/machinery for exploration activities	Exploration Manager
Objective 2. Prevent the introduction of Dieback on M74/245			
Exploration Construction Operations	Planning	Consideration of <i>Phytophthora</i> Dieback issues and ensuring that management controls are adhered to during construction and operations	Exploration Manager / Project Manager / General Manager
		All disease category boundaries will be assessed on an annual basis during monitoring by a qualified Dieback interpreter.	Environmental Advisor
Exploration Construction Operations	Hygiene	Vehicles that are unclean will be refused entry to site and will be directed to a wash-down area	Exploration Manager / Project Manager / General Manager
		All vehicles/machinery that have been working in other areas where dieback management may not be in place must be clean upon arrival to site	Exploration Manager / Project Manager / General Manager
		In wet conditions clean down of all vehicles/machinery will be required when entering uninfested areas from uninterpretable areas	Exploration Manager / Project

Stage	Control	Description	Responsibility
			Manager / General Manager
		All surface run-off from the quarantine inspection area and permitted wash-down facilities will be directed to a collection sump (or evaporation pond)	Exploration Manager / Project Manager / General Manager
Exploration	Hygiene	Wash-down stations will be made available for all vehicles/machinery for exploration activities	Exploration Manager
Exploration Construction	Import of Materials	Only soils, road base or vegetation from known <i>Phytophthora</i> -free areas are to be allowed on site. Import of these materials will be permitted provided the materials are classified as <i>Phytophthora</i> free. Haulage contractors associated with transporting soils, road base or vegetation to site must ensure their equipment to be <i>Phytophthora</i> free / clean on entry.	Exploration Manager / Project Manager
Exploration Construction Operations	Contractor Management	Compliance with this <i>Phytophthora</i> Dieback Management plan is to be included in contractual obligations of suppliers and contractors and will be audited for compliance	Exploration Manager / Project Manager / General Manager
Objective 3. Ensure that the risk of spread of Dieback onto the site or from uninterpretable to uninfested areas is minimised over the Life of the Mine.			
Exploration Construction Operations	Hygiene	In wet conditions clean down of all vehicles/machinery will be required when entering uninfested areas from uninterpretable areas	Exploration Manager / Project Manager / General Manager
		All vehicles /machinery will undergo visual inspection during dry periods when entering uninfested areas for uninterpretable areas	Exploration Manager / Project Manager / General Manager
		Vehicle movements are restricted to designated roads and exploration tracks. Access controls including warning signs and barrier fences will be erected in areas of significant vehicle use.	Project Manager / General Manager
		All off-road access must be approved by the nominated company representative (i.e. Mine Manager, Exploration Manager etc).	Exploration Manager / Project

Stage	Control	Description	Responsibility
			Manager / General Manager
Exploration Construction	Road Construction	Use only Phytophthora-Dieback free soils and gravel for road construction. Imported materials for road construction shall be classified as Phytophthora-free by a certified agency and be carted by a contractor who can demonstrate good Phytophthora Dieback hygiene	Exploration Manager / Project Manager
		Roads are constructed to ensure water does not pond on the surface, and drainage allows roads to dry out quickly with runoff collected in roadside sumps	Exploration Manager / Project Manager
Exploration Construction Operations	Review	All disease category boundaries will be assessed on an annual basis by a qualified Dieback interpreter	Environmental Advisor
Objective 4. Ensure that appropriate hygiene measures limit the spread of Dieback during Project explorations, construction and operation			
Exploration	Hygiene	Dieback wash-down procedures will be developed for sites from uninterpretable to uninfested areas	Environmental Advisor
		Dieback wash-down locations will be located in accordance with the Dieback survey recommendations and will be annually reviewed.	Exploration Manager / Environmental Advisor
Construction	Hygiene	Water used for construction will be from Dieback free sources only.	Project Manager
		Water required for construction and project activities in uninfested areas will be dosed with sodium hypochlorite (250ml per 400-500L). The concentration of this solution is 125 gm/L of available chlorine, as recommended in the Department of Mines and Petroleum (DMP) Guideline for Management of Dieback Disease in Mineral Exploration (DMP, 2006).	Project Manager
Exploration Construction Operations	Hygiene	Signage will be provided at wash-down stations to inform operators of correct wash-down and checking procedures.	Exploration Manager / Project Manager / General Manager
		Dieback hygiene measures, including standards for cleaning of all vehicles, machinery, equipment and personnel will be implemented as standard operating procedures	Exploration Manager / Project Manager / General Manager

Stage	Control	Description	Responsibility
Exploration Construction Operations	Monitoring	Conduct <i>Phytophthora</i> assessments during optimal conditions throughout the construction and operation of the mine (inhouse or by an external party)	Environmental Advisor
Exploration Construction Operations	Review	Review vehicle clean down records on a regular basis to ensure hygiene measures are being followed	Environmental Advisor
		Maintenance service records are kept for all wash-down equipment to show inspections are done on a regular basis	Environmental Advisor
Exploration Construction	Road Construction	Use only <i>Phytophthora</i> -Dieback free soils and gravel for road construction. Imported materials for road construction shall be certified as <i>Phytophthora</i> -free by a certified agency and be carted by a contractor who can demonstrate good <i>Phytophthora</i> Dieback hygiene	Exploration Manager
		Roads are constructed to ensure water does not pond on the surface, and drainage allows roads to dry out quickly with runoff collected in roadside sumps	Exploration Manager
Exploration Construction	Clearing	Clearing or disturbance of native vegetation will not proceed until the completion and sign off on the native vegetation clearing permit.	Exploration Manager
		Clearing for any purpose in the project area will conform with ground disturbance procedures specific to managing Dieback	Exploration Manager
Objective 5. Ensure that senior management and all personnel understand their environmental duty of care and have concern for the overall environmental effects of their performance by implementing, managing and continually reviewing this Management Plan			
Exploration Construction Operations	Review and Planning	Ensure that the <i>Phytophthora</i> Management plan is reviewed regularly, or as operations change	Environmental Advisor
Exploration Construction Operations	Training	Provide <i>Phytophthora</i> training through inductions and awareness programs for all employees, contractors, sub-contractors and visitors prior to site access.	Environmental Advisor
		Where applicable, personnel attend courses, workshops, seminars and other training to ensure current knowledge and best practice information is available to enable effective <i>Phytophthora</i> management	Exploration Manager / Project Manager / General Manager
Exploration Construction Operations	Contractors/Sub- contractors	Conditions will be included in contracts to ensure all contractors and sub-contractors adhere to applicable requirements of the <i>Dieback Management Plan</i>	Exploration Manager / Project Manager / General Manager

Stage	Control	Description	Responsibility
Objective 6. Provide adequate information and instruction to ensure personnel comply with this Management Plan and that a framework exists for the inclusion of additional requirements			
Exploration Construction Operations	Monitoring	Monitoring will be undertaken by a qualified Dieback interpreter before exploration, and then again before the construction phase, any changes will be noted and added to the Management Plan	Environmental Advisor
		Following construction, a full Dieback survey of operational areas will be conducted every three years by an accredited person with an annual re-check of all disease boundaries to review disease spread and hygiene washdown locations. If any infestations are found, appropriate mitigation strategies shall be developed in consultation with government guidelines	Environmental Advisor
Exploration Construction Operations	Review	The Dieback Management Plan will be reviewed annually, incorporating feedback from relevant staff, contractors, government agencies and surrounding landowners as well as updated information from Dieback surveys	Environmental Advisor

6. PERFORMANCE MONITORING

Monitoring is required to assess the effectiveness of *Phytophthora* Dieback management controls and will be conducted according to scheduled timetables and on an as-need basis depending on rainfall events and annual climate trends. Monitoring will be undertaken by DPaW registered *Phytophthora* Dieback Interpreters where required, with MRC Graphite personnel undertaking ongoing field surveillance throughout the year (Table 2).

An initial dieback survey of the project areas vegetation was conducted in April 2018 by Glevan Consulting to identify any presence of *Phytophthora* Dieback at the drill lines and the access tracks. Further assessment will be conducted by Glevan Consulting later in 2018.

Table 2 *Phytophthora* Dieback Management Program

Parameter	Frequency	Purpose	Responsibility
Phytophthora Dieback Assessment	Annually or Opportunistically	To undertake an assessment of High and Moderate risk areas within project tenement(s) and to determine if the disease status of uninterpretable areas has changed	Environmental Advisor to coordinate DPaW accredited Dieback Interpreters
Field Surveillance	Annually	To sample uninfested road and disturbed areas to determine if area remains uninfested or if demarcation is required	Environmental Advisor
Access Controls	Annually	To ensure compliance of hygiene stations and field demarcation signage with this Management Plan	Environmental Advisor
Spot Sampling	Opportunistically or after high rainfall events	To determine if <i>Phytophthora</i> species have been accidentally introduced into the project area	Environmental Advisor

7. REVIEW & REPORTING

7.1 Review

This management plan will be reviewed and revised as required, in consideration of the following:

- changes to the project or its operations;
- issues raised by stakeholders through the submission of the Annual Environmental Review;
- issues raised in response to any incident which results in a failure to meet any of the commitments to manage *Phytophthora* Dieback; and
- monitoring results which may indicate that a change in management strategy is required.

7.2 Reporting

Performance Reporting

An annual performance compliance report will be compiled for the project, it will provide detail against the performance indicators. The key management issues in Table 1 will be carried out with the purpose of achieving the environmental objectives.

Incident Reporting

Any non-compliance with this management plan will be reported to MRC Graphite's environmental advisor's and site management.

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APPENDIX F: THREATENED SPECIES AND COMMUNITY ENVIRONMENT MANAGEMENT PLAN (DRAFT)



MRC GRAPHITE PTY LTD



MUNGLINUP GRAPHITE THREATENED SPECIES AND COMMUNITY ENVIRONMENT MANAGEMENTAL PLAN

Prepared by Integrate Sustainability

Document Control

Version	Author	Date of Issue
Version 1	Integrate Sustainability Pty Ltd	
Version 2		
Version 3		
Version 4		

DRAFT

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Appendix 1	MRC Flora and Vegetation and Terrestrial Fauna Risk Assessment

Summary

This Munglinup Threatened Species and Community Environmental Management Plan (TSC Management Plan) is submitted to support environmental referrals under the *Environmental Protection Act 1986* and *Biodiversity and Conservation Act 1999* for the Munglinup Graphite Project (the Project) proposed by Mineral Commodities Limited (MRC). Table 1 presents a summary of this Management Plan including the completion criteria specific to the proposal against which the environmental objectives are measures.

Table 1 Purpose of the TSC Environmental Management Plan

Item	Description
Title of Proposal	Munglinup Graphite Project
Proponent Name	MRC Graphite Pty Ltd
Ministerial Statement Number	Not Applicable
Purpose of the Management Plan	This management plan is submitted to support referrals under the <i>Environmental Protection Act 1986</i> and <i>Environment Protection and Biodiversity Conservation Act 1999</i> . It also provides a framework for the protection and management of identified threatened communities, flora and fauna species.
Key Environmental Factors	Threatened Flora, Threatened Terrestrial Fauna and Proteaceae Dominated Kwongkan Shrublands Threatened Ecological Community.
Objective	To protect and manage; • <i>Anigozanthos bicolor subsp. minor</i> – Little Kangaroo Paw; • <i>Conostylis lepidospermoides</i> - Sedge Conostylis; • <i>Eremophila denticulata subsp. denticulate</i>; • <i>Rhizanthella johnstonii</i> - Underground Orchid; • Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia (Kwongkan TEC); • <i>Calyptrorhynchus latirostris</i> – Carnaby’s Black Cockatoo; and • <i>Isodon obesulus fusciventer</i> – Southern Brown Bandicoot / Quenda in line with the EP Act and EPBC Act, so that biological diversity and ecological integrity are maintained.

1. Context, Scope and Rationale

1.1. MRC Munglinup Graphite Project

The Munglinup Graphite Project (Project) is located 105km west of Esperance, 85km east of Ravensthorpe and 4km north of the town of Munglinup in the south coast region of Western Australia Figure 1. It is located on the Esperance side of the Esperance/Ravensthorpe boarder. The Project is located within the Esperance Plains IBRA region and the Recherche IBRA sub-region.

The Project lies within Mining Lease M74/245 and includes the development of six graphite deposits as open pit mines (Halberts Main, Halberts South, Harris, McCarthy East, McCarthy West and Whites) Figure 2. Associated infrastructure including a waste rock landform, tailings storage facility, processing plant and run-of-mine / low-grade stockpile, workshops and administration buildings as well as roads (haul and LV) are proposed. The Munglinup Graphite Project has a proposed maximum disturbance footprint of 350ha within a development envelope of 650ha. The majority of this will be new disturbance.

The purpose of this Management Plan is to ensure that the Project is managed to maintain local flora and vegetation, threatened ecological communities and terrestrial fauna biological diversity and ecological integrity, with a focus on:

- *Anigozanthos bicolor subsp. Minor*
- *Conostylis lepidospermoides* (Sedge Conostylis)
- *Eremophila denticulata subsp. Denticulate* (Native Fuchsia/Toothed Eremophila)
- *Rhizanthella johnstonii* (Underground Orchid)
- *Calyptorhynchus latirostris* – Carnaby's Black Cockatoo
- *Isoodon obesulus fusciventer* – Southern Brown Bandicoot / Quenda
- Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia (Kwongkan Shrublands)

such that the EPA objectives for flora and vegetation and terrestrial fauna are met, (EPA, 2016a; EPA, 2016b).

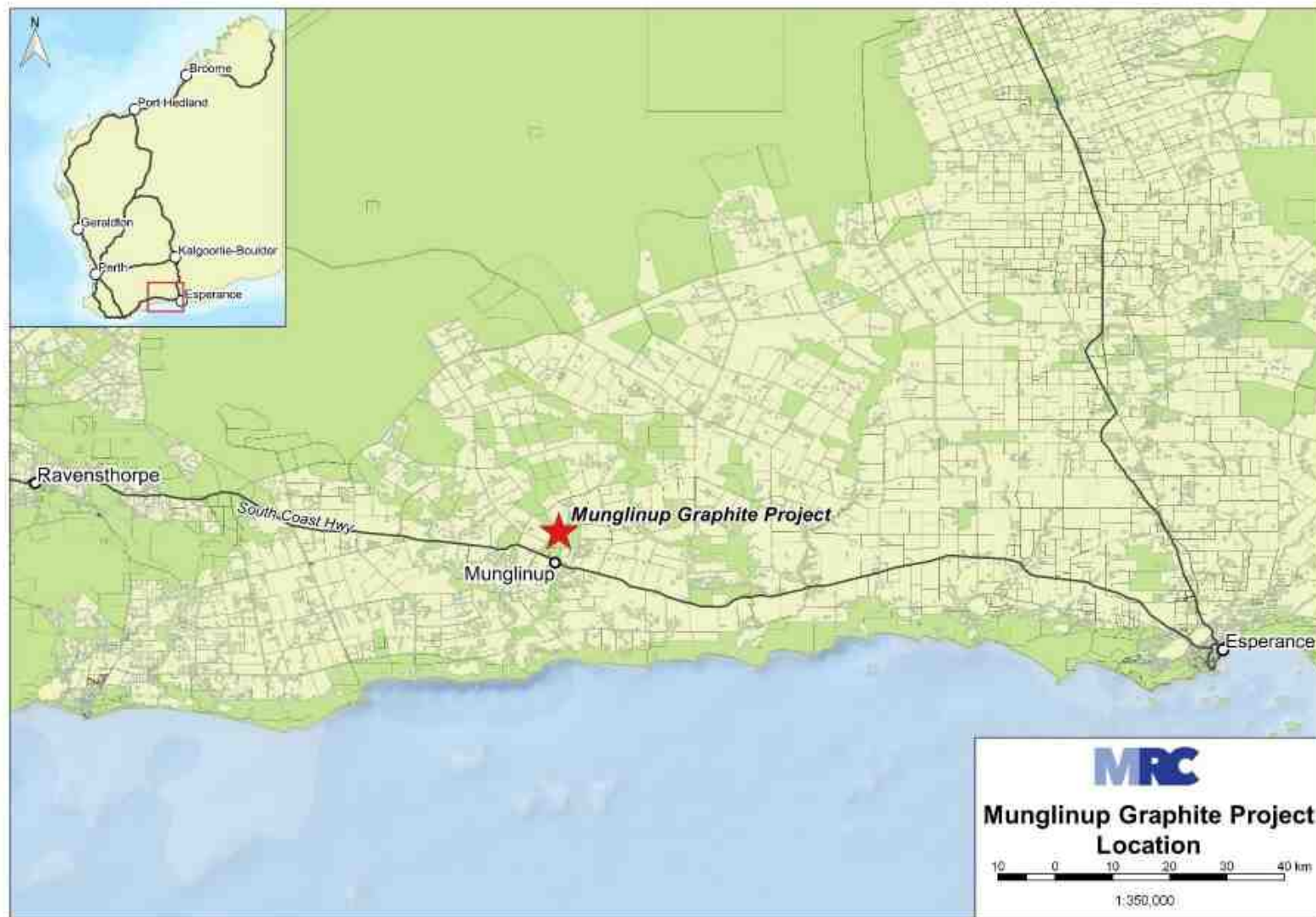


Figure 1 Munglinup Graphite project location



Figure 2 Project site layout

1.2. Conditional Requirements

No conditions currently exist for the Project. This management plan is being submitted to support the environmental referrals under the *Environmental Protection Act 1986* and *Biodiversity and Conservation Act 1999*. MRC has taken into consideration the environmental objectives set for threatened and protected flora, fauna and ecological communities, and are committed to implementing the Project in a manner that meets these objectives.

1.3. Key Environmental Factors: Flora and Vegetation

The EPA's objective for flora and vegetation is to protect flora and vegetation so that the biological diversity and ecological integrity are maintained.

Flora baseline assessments of the project area have identified the following threatened and Priority flora and ecological communities as either likely to be present or recorded during surveys:

Table 2 Threatened Flora and Vegetation of the Project

Species name / Ecological Community (common name)	Conservation Status	
	WA	EPBC
<i>Anigozanthos bicolor subsp. minor</i>	Threatened	Endangered
<i>Conostylis lepidospermoides</i> (Sedge Conostylis)	Threatened	Endangered
<i>Eremophila denticulata subsp. denticulata</i>	Threatened	Vulnerable
<i>Rhizanthella johnstonii</i> (Underground Orchid)	Threatened	Endangered
Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia (Kwongkan Shrublands)	Threatened*	Endangered

*Elements of the community are listed as threatened

The following aspects of the Project have been identified as having the potential to affect this factor but are not limited to the flora and vegetation listed in Table 2.

Table 3 Potential impacts of flora, vegetation and Kwongkan TEC

Aspect	Description
Clearing	Mining, exploration and survey may result in unintentional clearing of individual plants or populations during clearing or off-road activities.
Weed invasion	Mining activities may increase risk of weed invasion through clearing, new roads and tracks, additional vehicles and lack of hygiene procedures increasing competition for resources.
Introduction of <i>Phytophthora</i> dieback	Mining and exploration activities increasing the risk of dieback spread through clearing, new roads and tracks, additional vehicles.
Changed fire regimes	Mining activities can cause accidental fires, though the risk is low, unplanned fires can also be caused by road accidents, lightning or arson. Large unplanned bushfires are undesirable as they substantially change flora and vegetation on a large scale.
Changed hydrology	Operations can result in modified hydrology, resulting in deterioration of plant health through either inundation or reduce water supply.
Changed hydrogeology	The project will require groundwater abstraction, which can result in degradation of flora and vegetation where species are dependent on ground water.
Habitat fragmentation	Fragmentation of individual and populations from land clearing reduces potential for gene flow. Fragmentation potentially exacerbates other threats like fire, weed invasion and herbivory by feral species providing access onto habitats that were previously dense and difficult to transverse.
Increased feral fauna	Increased human activity can lead to an increase in feral herbivores which thrive in modified landscapes with additional water sources, food from rubbish tips and

Aspect	Description
	increased access along tracks and roads. Feral fauna, particularly herbivores such as deer and rabbits, have the potential to negatively impact flora and vegetation, with competition and land degradation by goats, sheep, rabbits, deer, red foxes, wild dogs and feral cats.
Generation of dust	Earth moving activities, vehicle movements on unsealed roads and processing activities have the potential to generate dust which can result in impacts to the health of flora and vegetation.
Dust suppression using hypersaline water	Use of hypersaline water in dust suppression on roads and other surfaces have the potential to impact flora and vegetation if it is not contained and flows to surrounding vegetation.
Spillages	Spillages of tailings and hypersaline water from pipelines can result in large scale vegetation death without the correct controls in place.

1.4. Key Environmental Factors: Terrestrial Fauna

The EPA'S objective for terrestrial fauna is to protect flora and vegetation so that the biological diversity and ecological integrity are maintained (EPA, 2016b).

The following aspects of the Project area have been identified as having the potential to impact terrestrial fauna, including those listed in Table 4.

Table 4 Threatened and priority terrestrial fauna of the Project

Species name	Conservation Status	
	WA	EPBC
<i>Calyptorhynchus latirostris</i> – Carnaby's Black Cockatoo	Threatened	Threatened
<i>Isoodon obesulus fusciventer</i> – Southern Brown Bandicoot / Quenda	P4	N/A
<i>Leipoa ocellata</i> – Malleefowl	Vulnerable	Vulnerable
<i>Macropus Irma</i> – Western Brush Wallaby	P4	N/A
<i>Falco peregrinus</i> – Peregrine Falcon	OS	N/A

Table 5 Potential impacts of terrestrial fauna

Aspect	Description
Clearing activities causing injury or death	Clearing of vegetation with heavy vehicles may cause direct mortality or injury to terrestrial fauna.
Vehicle strike causing injury or death	Species may be at risk of direct mortality or injury by project vehicles.
Entrapment	Terrestrial fauna may become trapped in containers, uncapped drill holes, trenches, excavations or water storage structures.
Habitat Loss	Terrestrial animals occur through the Project areas in all habitats, although there may be a reduction in numbers in areas that have been recently or excessively burnt. Clearing, including the creation of new gaps in an otherwise homogenous habitat area, is regarded as a current threat to the listed species.
Habitat Fragmentation	Fragmentation of fauna habitat from land clearing reduces the ability of individual Malleefowl and the Southern Brown Bandicoot to move freely for dispersed or temporary resources and reduces gene flow. Habitat fragmentation potentially exacerbates other threats, like predation by feral species, by providing access into habitats that were previously dense and difficult to traverse. These impacts are already present in the area due to roads and existing exploration tracks. Fauna are better able to persist in a modified landscape when vegetation patches are large and there are more links between patches.

Aspect	Description
Increased Disturbance to Fauna and Fauna Habitats	The Project has the potential to create a range of disturbance to the listed animal species; noise, dust, movement and light from heavy machinery, lighting and the presence of people or vehicles. Terrestrial fauna may avoid disturbance or experience increased stress, expending energy in avoidance behaviours.
Increased Feral Fauna	Increased human activity can lead to an increase in feral predators which thrive in modified landscapes with additional water sources, food from rubbish tips and increased access along tracks and roads. Feral fauna, particularly predators such as foxes, cats and wild dogs, have the potential to negatively impact the listed terrestrial fauna, with predation by feral cats and foxes both recognised as key threatening processes.
Changed Fire Regimes	Mining activities can cause accidental fires, though the risk is low. Unplanned fires can also be caused by road accidents, lightning or arson. Large, unplanned bushfires are undesirable as they substantially change fauna habitats on a large scale. The Malleefowl and the Southern Brown Bandicoot are negatively impacted by fire with direct mortality experienced as well as a reduction in habitat including a loss of leaf-litter essential for building mounds and burrows.

1.5. Rationale and approach – Flora and Vegetation

1.5.1. Surveys and Results: Flora and Vegetation

Flora baseline assessments of the project area (Table 6) have identified the following threatened and Priority flora and ecological communities as either likely to be present or recorded during surveys:

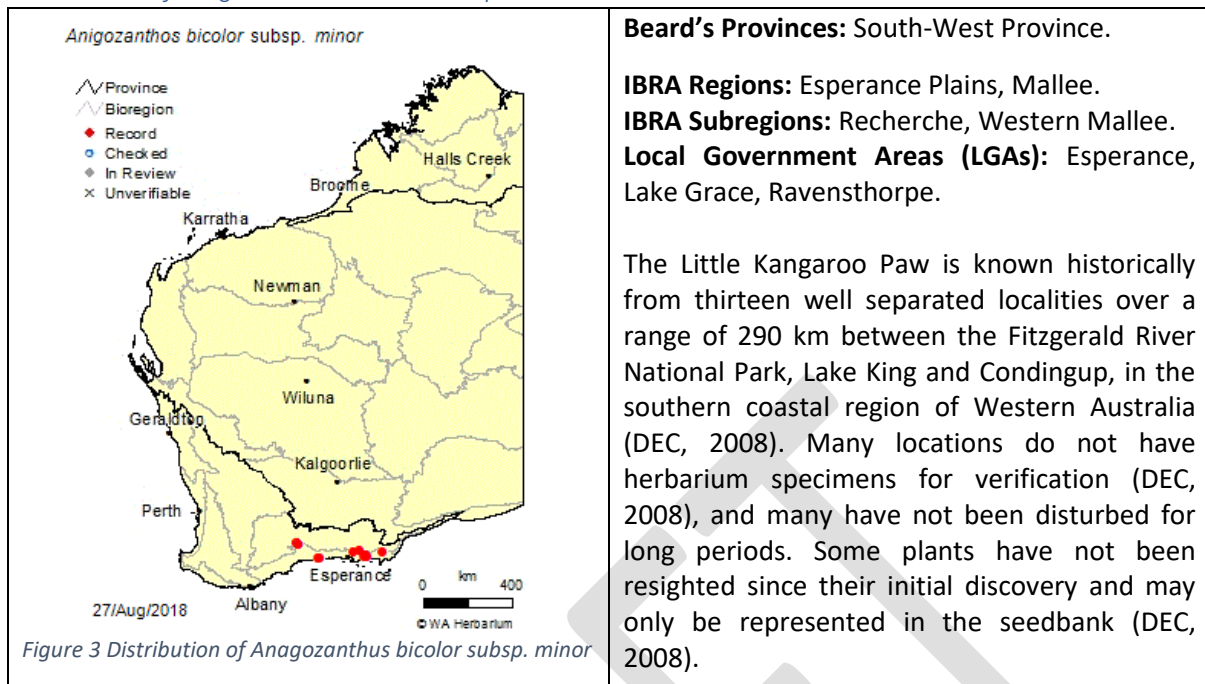
Table 6 Baseline flora and vegetation surveys of the Project

Survey Title	Survey Timing
Woodman Environmental - Munglinup Graphite Project Flora and Vegetation Assessment – Survey for TEC 'Proteaceae Dominated Kwongan Shrublands of the southeast coastal floristic province of Western Australia' and habitat for the Threatened taxon <i>Rhizanthella johnstonii</i>	August 2018
Woodman Environmental – Peer review of consultant report Level 2 Flora and Vegetation Assessment in the Munglinup Area	April 2018
Ecologia Environment – Munglinup Graphite Project Flora and Fauna Assessment	March 2015
Environmental Survey and Management – Environmental Assessment of ML 74/17a	April 1990

Descriptions of Flora and Vegetation

Biology of Anigozanthos bicolor subsp. minor

Anigozanthos bicolor subsp. minor is a small rhizomatous herb with flattened leaves 5-10 cm long and hairy flowers held on scapes 5-20 cm high. Each flower has a green perianth 30-45 mm long and a red ovary. The perianth is strongly constricted above the middle and is just 3-5 mm wide at the narrowest point. When flowering, *A. bicolor subsp. minor* usually has several flowering stems 5–20 cm tall with solitary flowers.

Distribution of Anigozanthos bicolor subsp. minor*Habitat of Anigozanthos bicolor subsp. minor*

The Little Kangaroo Paw prefers moist sandy soil in heath communities, however it has also been found in shallow soil near granite outcrops. A record of the species occurs for a wet, gravely clay site in which the plants were standing in water (DoEE, 2018). Associated native plants include *Adenanthos sp.*, *Allocasuarina sp.*, Showy Banksia (*Banksia speciosa*), Pincushions (*Borya sphaerocephala*), *Calothamnus sp.*, *Calytrix spp.*, *Chamelaucium sp.*, *Conostylis petrophiloides*, Common Donkey Orchid (*Diuris laxiflora*), White Marlock (*Eucalyptus x tetragona*), Yellow Mallee (*Eucalyptus incrassata*), Fine-leaved mallee (*E. perangusta*), *Leptospermum sp.*, *Lysinema sp.*, *Patersonia sp.*, *Verticordia sp.* and *Thryptomene sp.* (DEC, 2008).

*Occurrence of Anigozanthos bicolor subsp. minor*Table 7 *Anigozanthos bicolor subsp. minor* known occurrences (DEC, 2008)

Population Location	District	Tenure	Year	Number of Plants
Condungup	Esperance	Recreation Area	1982 1999 2003	1 700–800 0
North of Cascades	Esperance	Vacant Crow Land	1983 2003	5000+ 0
Dalyup (Population not confirmed)	Esperance	Nature Reserve	1988 1999	0 0
North-east of Gibson	Esperance	Private Property	1987 1999	40 0
Fitzgerald (Population not confirmed)	Albany	Road Reserve	1967 1999	Unknown 0
Twertup (Population not confirmed)	Albany	National Park	1967 1999	Unknown 0
Jerdacuttup -Stokes Inlet (Population not confirmed)	Esperance	National Park	1999	0

Population Location	District	Tenure	Year	Number of Plants
North-east of Gibson	Esperance	Road Reserve	1963 1999 2004	Herbarium record 2 0
North west of Ravensthorpe (Population not confirmed)	Albany	Road Reserve	1999	0
Pallarup	Great Southern		1935 1999	Herbarium record 0
West of Hopetoun (Population not confirmed)	Albany	Private Property		
North west of Ravensthorpe (Population not confirmed)	Albany	Private Property	1987	0 4
North west of Ravensthorpe (Population not confirmed)	Esperance	Private Property	1987	
West of Hopetoun	Esperance	Nature Reserve	2004	160
West of Hopetoun	Esperance	Nature Reserve	2004	67

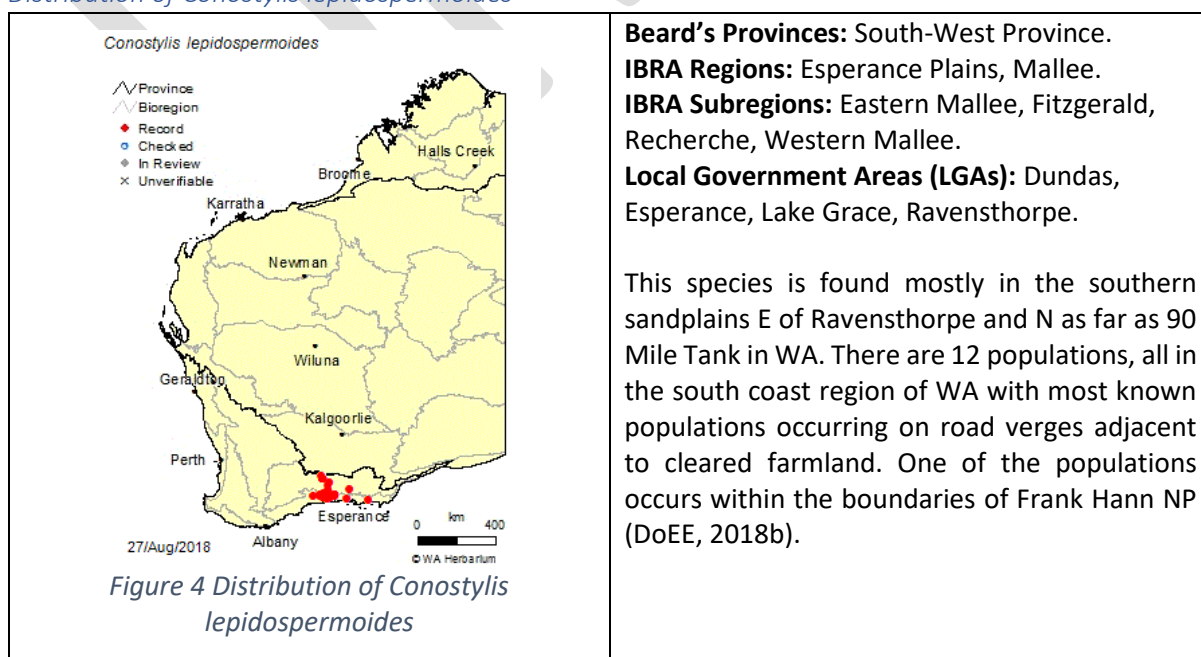
(DEC, 2008)

No occurrence of *Anigozanthos bicolor* subsp. minor was recorded during the 2018 woodman Environmental baseline survey.

Biology of *Conostylis lepidospermoides*

Conostylis lepidospermoides, Family Haemodoraceae, also known as Sedge Conostylis, is a rhizomatous, tufted, sedge-like perennial plant, growing up to 35 cm tall and 40 cm wide. The flat, yellow-green, narrow leaves are 20–35 cm long, and edged with two rows of short, dark bristles. A stem, which grows 1–4 cm long, can hold up to 6 flowers in a loose inflorescence. The stamens have large anthers up to 5 mm long and are inserted 5–7 mm above the ovary; the style is about 10 mm long. The floral whorl, up to 20 mm long, is deeply divided into 6–10 mm long lobes covered in long hairs. The distinctive flowers of this species are the largest among the genus. This species, however, is inconspicuous during non-flowering periods, due to its slender sedge-like leaves. Flowering occurs from September to October with a mixture of insect and bird pollinators.

Distribution of *Conostylis lepidospermoides*



Habitat of Conostylis lepidospermoides

Although Sedge Conostylis is widespread, most known populations are confined to verges adjacent to cleared farmland. This species occurs in flat or gently undulating plains, in yellow or grey sand over laterite or clay. It inhabits low heath and sedge communities with scattered emergent *Lambertia inermis*, *Banksia media*, *Eucalyptus tetragona* and other mallees.

Occurrence of Conostylis lepidospermoides

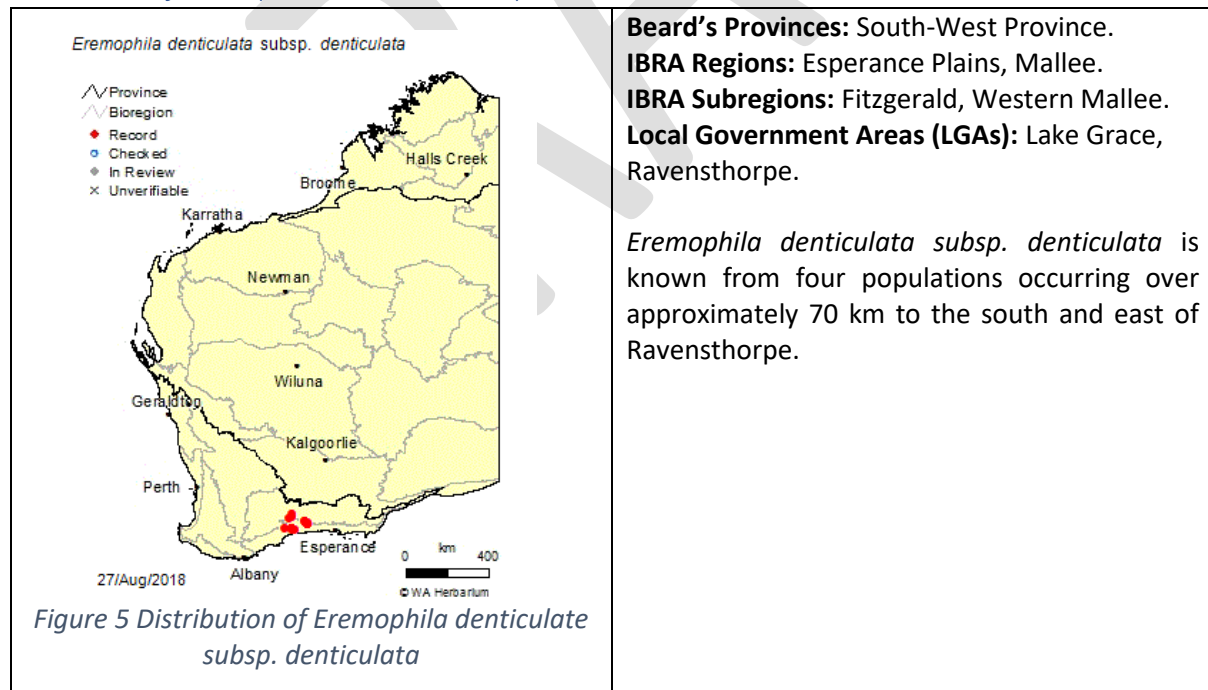
There are 17 known populations with nine occurring on road verges, three on private property, two on conservation estate, one on unallocated Crown land and two on unknown tenure. It is estimated that seven populations have 670 mature plants in the wild, with the largest population recorded in 1993 as having 500 plants on a road verge. The extent of occurrence is estimated to be 4400 km². The area of occupancy has been recorded for five populations at 0.18 km² in 1992–1993.

Preliminary findings from the Woodman Environmental survey recorded specimens of *C. lepidospermoides* within the development envelope and more specifically the TSF footprint.

Biology of Eremophila denticulata subsp. denticulata

Eremophila denticulata subsp. denticulata is an erect shrub 1.5 to 2.5m high with resinous stems. Leaves are also resinous and about 50mm long. Flower buds are orange-yellow. Flowers are tubular, carmine red on shaped stalks, with sepals 3.5–9 mm long and the lower corolla lobe lip reflexed. Flowering occurs from October through January. Fruit are 10–11 mm long and 8–9 mm wide, ovoid with 1–2 seeds.

Eremophila denticulata subsp. denticulata is known to be a short-lived disturbance opportunist with plants observed to germinate, flower and senesce after 10 years.

Distribution of Eremophila denticulata subsp. denticulata*Habitat of Eremophila denticulata subsp. denticulata*

This subspecies has been observed growing in alluvial soils along river banks and on plains of sandy clay loam over granite. The distribution of this subspecies is not known to overlap with any EPBC Act-

listed threatened ecological communities. (DoEE, 2008)

Occurrence of Eremophila denticulata subsp. denticulate

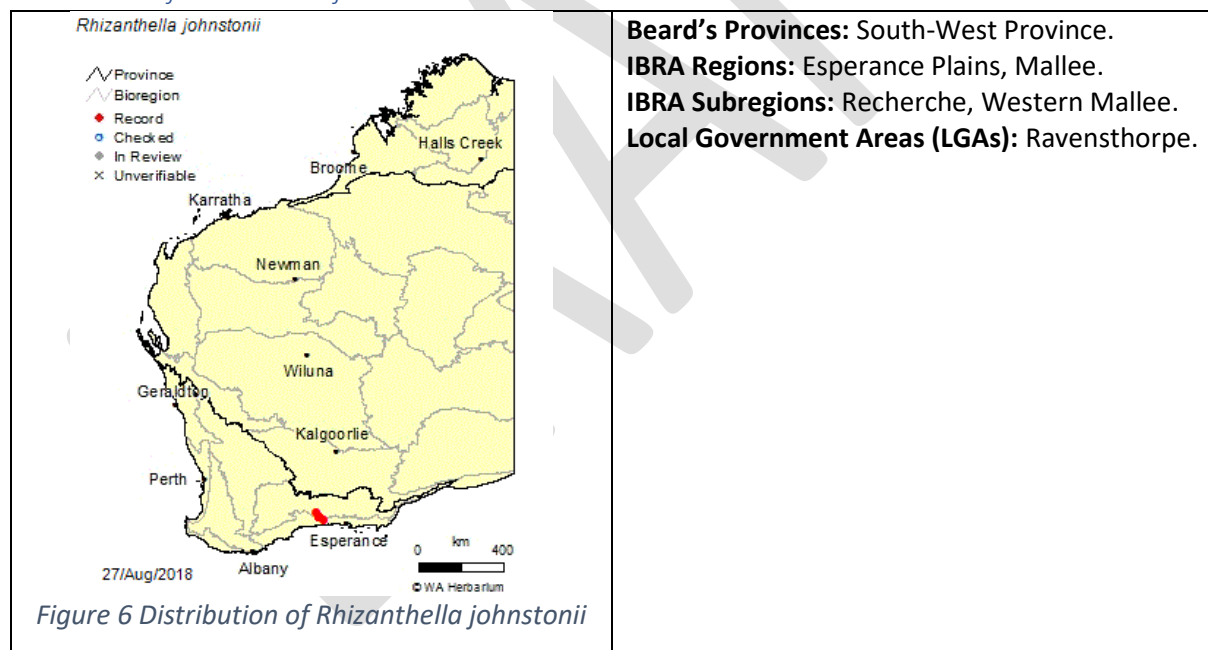
Three populations of Fitzgerald Eremophila exist to the north of Fitzgerald River National Park. A separate population at Cheadanup Nature Reserve, initially recorded in 1993 with numbers in excess of 2000 plants over 1.5 ha, has been resurveyed with a reduction in plant numbers to approximately 200 in 1995, to only 5 plants in 2002, and nil observed in 2005 following fire. However, three new populations were discovered in February 2008, on unallocated crown land just east of this location. (DEC, 2008a)

Biology of Rhizanthella johnstonii

Flowering of *Rhizanthella johnstonii* begins in late May, early June when each plant produces up to 100 small, inward facing, cream to reddish coloured flowers, surrounded by 6 to 12 large, cream or pinkish-cream bracts.

The bracts form a tulip-like head that curves over the flowers forming a small opening at the soil surface. A layer of leaf and bark litter covers this opening. The plants have a horizontal rhizome 6 to 12 cm below the ground level, which, like the rest of the plant, is succulent and produces a formalin-like odour when cut. Once pollinated each flower produces a berry-like indehiscent fleshy fruit containing 20 to 150 seeds.

Distribution of Rhizanthella johnstonii



Habitat of Rhizanthella johnstonii

In the Munglinup – Oldfield River area *Rhizanthella johnstonii* under patches of *Melaleuca uncinata* and *Melaleuca hamata*, with the wider habitat described as mallee heath. Plants occur under leaf and bark litter in thickets of *Melaleuca scalena*, *Melaleuca hamata* and *Melaleuca uncinata* (broombush species) with scattered emergent Eucalyptus and Acacia species on soil of either sandy-clay or sandy-loam (Woodman Environmental, 2018).

Occurrence of Rhizanthella johnstonii

In 2018 a targeted field assessment to define habitat for *R. johnstonii* confirmed that the vegetation community along the Munglinup River and other nearby drainage lines is consistent with vegetation that supports *R. johnstonii* (Woodman Environmental, 2018). This vegetation type consists of *Melaleuca hamata* as a significant mid-storey component with a well-developed leaf litter layer, consistent with published descriptions of *R. johnstonii* habitat (Woodman Environmental, 2018). This was mapped to extend across 17ha along the Munglinup River. Additional potential habitat has also been located along other drainage lines within MRC tenure and outside the development envelope covering 18ha (Woodman Environmental, 2018).

Table 8 *Rhizanthella johnstonii* known occurrences

Population Location	District	Tenure	Year	Number of Plants
Oldfield River	Munglinup	Unvested Crown Land	1982	4
			2002	2
			2004	26
			2010	1
Cheadanup Reserve, north-west of Munglinup	Munglinup	Nature Reserve	1981	6
			1982	4
			2002	0
			2004	23
			2008	25
North-west of Munglinup	Munglinup	Private	1979	15
			1981	10
			2002	2

Vegetation of Proteaceae Dominated Kwongan Shrublands of the southeast coastal floristic province of Western Australia

The vegetation of the TEC is typically plants from the family Proteaceae make up a large component of the flora, including plants from the genera *Adenanthos*, *Banksia*, *Grevillea*, *Hakea*, *Isopogon* and *Lambertia*. The actual Proteaceae species present in the ecological community is variable across its range.

Widespread and characteristic species within the ecological community include: *Banksia alliacea*, *B. armata* (prickly dryandra), *B. cirsioides*, *B. media* (southern plains banksia), *B. nutans* (nodding banksia), *B. obovata* (wedge-leaved dryandra), *B. sessilis* (parrot bush), *B. speciosa* (showy banksia), *B. tenuis*, *Hakea cucullata* (hood-leaved or scallop hakea), *H. corymbosa* (cauliflower hakea), *H. denticulate*, *H. drupacea*, *H. ferruginea*, *H. obliqua* (needles and corks), *H. pandanicaarpa*, *H. victoria* (royal hakea), *Lambertia inermis*, *Beaufortia empetrifolia* (Myrtaceae), *Xanthorrhoea platyphylla* (Xanthorrhoeaceae), *Melaleuca striata* (Myrtaceae) (DoEE, 2015).

Mallee eucalypt trees may be present at varying densities, but providing the vegetation is dominated by Proteaceae species, it is still classified as the ecological community.

Distribution of Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia.

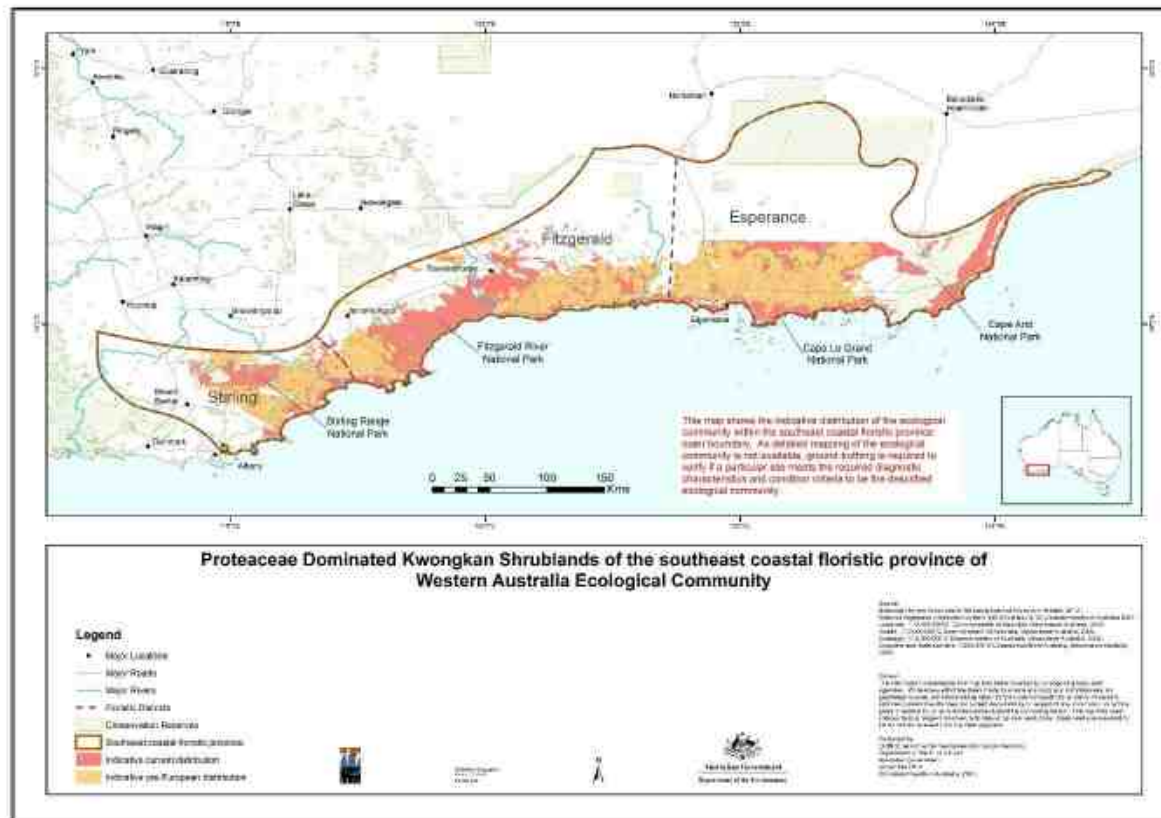


Figure 7 Distribution of Kwongkan TEC

Key diagnostic features of Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia

The field survey indicated that the TEC is represented by at least two distinct floristic units, one hosted on a lateritic gravel substrate and the other on sand over laterite (Woodman Environmental, 2018). These two units are dominated by Proteaceous species varying in dominance in a mosaic pattern that responds to varying levels of sand depth at surface (Woodman Environmental, 2018). Twenty two species of the Proteaceae family comprised significant components of the vegetation within the TEC (Woodman Environmental, 2018).

Key diagnostic features include:

- 1) Occurs within the Southeast Coastal Floristic Province.
- AND
- 2a) Characterised by Proteaceae species, having 30% or greater cover of Proteaceae species across all layers where these shrubs occur (crowns measured as if they are opaque),
- OR
- 2b) Two or more diagnostic Proteaceae species are present that are likely to form a significant vegetative component when regenerated. The use of diagnostic species is for situations in which the cover of Proteaceae species is reduced due to recent disturbance (e.g. fire) (Woodman Environmental, 2018).

Occurrence of Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia

The Kwongkan Shrubland TEC covers approximately 317ha within the Project area (Woodman Environmental, 2018). The ecological community typically occurs on sandplains, occupying lower and upper slopes and ridges, as well as uplands across its range, where rainfall ranges from approximately 400 to 800 millimetres a year. It typically occurs on:

- duplex soils and deep to shallow soils on the sandplains
- sandy soils to clay loam, gravelly loam and loam on quartzite (e.g. The Barrens, Stirlings and Russell Range)
- greenstone ranges (e.g. Ravensthorpe Range).

1.5.2. Key Assumptions and Uncertainties: Flora and Vegetation

The Project area has been subject to several baseline surveys into flora and vegetation including a targeted survey into the Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia and the Western Underground Orchid. It is assumed that the studies and management plans have been developed adequately.

Key Assumptions:

- The baseline surveys conducted (Table 6) provide sufficient information to confirm the presence or absence of the species listed in Table 2.
- Flora and vegetation surveys were completed in compliance with EPA requirements and MRC agreed upon scope of work.
- The level of survey was limited to the Project area, so it is considered there are likely to be more listed flora and vegetation species and TEC in close proximity.

Key Uncertainties:

- The distribution of the described flora species and the TEC outside of the project area are generally unknown.

1.6. Rationale and approach Terrestrial Fauna

1.6.1. Surveys and Results: Terrestrial Fauna

Terrestrial fauna baseline assessments of the project area (Table 9) have identified the following threatened and protected terrestrial fauna to be either likely present or identified during surveys:

Table 9 Baseline terrestrial fauna surveys of the Project

Survey Title	Survey Timing
Red Dog Environmental - Complimentary Fauna Assessment	July 2018
Biostat – Review and Gap Analysis of the fauna assessment for the Munglinup Graphite Project	March 2018
Biota – Munglinup Graphite Project Terrestrial Short – Range Endemic Fauna Pilot Study	May 2018
Ecologia Environment – Munglinup Graphite Project Flora and Fauna Assessment	Nov/Dec 2014

Descriptions of Terrestrial Fauna

Biology of Carnaby's Black Cockatoo

Carnaby's black-cockatoos are large, raucous black cockatoos with white patches on their cheeks and white bands on their tails. They have strong short bills designed to cope with the hard nuts and seeds that form their diet. There is little difference between the male and female birds apart from bill and eye ring colour. Males have red eye rings and black bills whereas females have grey eye rings and a lighter grey or bone-coloured bills (DoEE, 2018c).

Distribution of Carnaby's Black Cockatoo

Carnaby's black-cockatoos are found in southwest Australia from the Murchison River across to Esperance and inland to Coorow and Lake Cronin. They are commonly seen in some areas such as the coastal plain to the north of Perth and some areas of the northern Wheatbelt. Carnaby's black-cockatoos are locally extinct in others, such as in many parts of the central Wheatbelt (DoEE, 2018c).

Habitat of Carnaby's Black Cockatoo

In the Wheatbelt during the nesting season Carnaby's black-cockatoos occur in uncleared or remnant eucalypt woodlands, predominately salmon gum or white gum (wandoo). They feed in heathland called Kwongkan heath, on different types of banksia, grevillea, hakea and dryandra species. They also feed on seeds of eucalyptus species, and introduced species such as wild radish and pines (DoEE, 2018c). During the non-nesting season Carnaby's black-cockatoos predominantly occur in banksia woodlands, coastal and near-coastal scrub and forests and introduced pine trees of the coastal regions.

None of the habitats present provide breeding opportunities for this species; however, there is suitable foraging habitat in the form of the Proteaceous Shrubland habitat (Woodman Environmental, 2018b; Ecologia, 2015).

Occurrence of Carnaby's Black Cockatoo at the Project

There are 65 records for Carnaby's Black Cockatoos within the region with a significant number being recorded in the last 10 years. The Carnaby's Black Cockatoo was identified and recorded at the Project during the Red Dog Environmental survey in 2018. The Ecologia survey in 2015 did not record any occurrences. Carnaby's Black Cockatoo has been recorded in the Project area since completion of the field survey.

Biology of Southern Brown Bandicoot

Coarse dark grey or yellow brown fur above and creamy-white below and a short, tapered, dark brown tail. The ears are short and rounded. The tail is lightly furred and often shortened or missing altogether, probably as a result of fighting.

Distribution of Southern Brown Bandicoot

Widely distributed near the south west coast from Guilderton north of Perth to east of Esperance. Quenda have a patchy distribution through the Jarrah and Karri forest, the Swan Coastal Plain, and inland as far as Hyden. Quenda have been translocated to Julimar State Forest, Hills Forest near Mundaring, Tutanning Nature Reserve, Boyagin Nature Reserve, Dongolocking Nature Reserve, Leschenault Conservation Park, Karakamia Sanctuary, Paruna Sanctuary, Yalgorup National Park, Creery Wetlands, Avon Valley National Park, Nambung National Park, Francois Peron National Park and Thomson's Lake Nature Reserve

Habitat of Southern Brown Bandicoot

Scrubby, often swampy, vegetation with dense cover up to 1 m high, often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses. Quenda will thrive in more open habitat subject to introduced predator control. On the Swan Coastal Plain, Quenda are often associated with wetlands. Recorded. Secondary evidence in the form of diggings were recorded in the 2018 survey and the 2015 survey (Ecologia, 2015).

Suitable habitat for this species can be found in the major drainage line and low Melaleuca shrubland habitats identified by Ecologia (Ecologia, 2015).

Occurrence of Southern Brown Bandicoot at the Project

A site occurrence of the Southern Brown Bandicoot was recorded in 2015 Ecologia survey, along with secondary evidence of diggings recorded in both the 2015 and 2018 baseline surveys.

1.6.2. Key Assumptions and Uncertainties: Terrestrial Fauna

Key Assumptions:

- The Project area and greater regional area have been adequately surveyed for terrestrial fauna with three baseline fauna surveys being carried out between 2015 and 2018.
- Fauna surveys were completed in compliance with EPA and DoEE requirements.
- The surveys provide sufficient information to confirm the presence of the Carnaby's Black Cockatoo and the Southern Brown Bandicoot within the Project.
- The Project area includes favourable habitat conditions for the presence of the Carnaby's Black Cockatoo, Southern Brown Bandicoot, Malleefowl, and the Western Brush Wallaby.

Key Uncertainties:

- The extent of population areas outside of the Project area for each listed fauna species is generally unknown.

1.7. Management Approach

This EMP has been developed to address the key environmental factors of Threatened Flora and Vegetation and Threatened Terrestrial Fauna. The management approach taken in this management plan is risk-based and developed around the mitigation hierarchy of avoid, minimise, rehabilitate and offset to ensure impacts to the key environmental factors have been avoided or reduced to as low as reasonably practicable. Mitigation and management actions were identified and prioritised using information gained from baseline surveys and other regional and local information within the public domain.

1.7.1. Rational for Management Provisions

The management approach is informed by results of baseline surveys and the Project parameters. The Project will have an aim to minimise the Project footprint over the operations life with priority given to using area of existing disturbed areas and progressive rehabilitation.

Management and mitigation measures have been designed for the life of the mine, and as such, may require adaptive solutions in subsequent revisions.

2. EMP Provisions

This section identifies the provisions that MRC proposes to implement to ensure protection of the above-mentioned fauna, flora, vegetation and TEC. It identifies the environmental criteria that will be used to measure performance and monitoring that will be undertaken in relation to these environmental criteria. It also defines the response actions (trigger level and contingency actions) that will be undertaken if the environmental criteria are exceeded. Table 11 details the provisions of this EMP focusing on those listed in Table 10:

Table 10 Threatened and priority flora, vegetation and terrestrial fauna of the Project

Species name / Ecological Community (common name)	Conservation Status	
	WA	EPBC
<i>Anigozanthos bicolor subsp. minor</i>	Threatened	Endangered
<i>Conostylis lepidospermoides</i> (Sedge Conostylis)	Threatened	Endangered
<i>Eremophila denticulata subsp. denticulata</i>	Threatened	Vulnerable
<i>Rhizanthella johnstonii</i> (Underground Orchid)	Threatened	Endangered
Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia (Kwongkan Shrublands)	Threatened*	Endangered
<i>Calyptorhynchus latirostris</i> – Carnaby's Black Cockatoo	Threatened	Threatened
<i>Isodon obesulus fusciventer</i> – Southern Brown Bandicoot / Quenda	P4	N/A

2.1. Objectives

The objective of this Management Plan is to ensure the Project is managed to maintain local flora and vegetation and terrestrial fauna biological diversity and ecological integrity, with a focus on the species listed in Table 10, such that the EPA objective for flora and vegetation and terrestrial fauna is met (EPA, 2016a; EPA, 2016b)

2.2. Management Actions

Management objectives have been identified to address potential impacts detailed in Table 3 and Table 5 of this management plan. To meet the management objectives, a series of Project specific, risk-based management actions have been developed and prioritised based on risk to minimise potential impacts to flora and vegetation and terrestrial fauna. The management actions focus on proposed activities that have the highest likelihood of causing adverse impacts to:

- *Anigozanthos bicolor subsp. minor* – Little Kangaroo Paw;
- *Conostylis lepidospermoides* - Sedge Conostylis);
- *Eremophila denticulata subsp. denticulate*;
- *Rhizanthella johnstonii* - Underground Orchid;
- Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia (Kwongkan TEC);
- *Calyptorhynchus latirostris* – Carnaby's Black Cockatoo; and
- *Isodon obesulus fusciventer* – Southern Brown Bandicoot / Quenda

Management objectives, targets, actions and reporting are listed in Table 5. Risk assessment tables are provided as Appendix 1.

Flora and Vegetation

The risk rating remains high for one management objectives related to clearing:

- Habitat loss and fragmentation – the Project area contains some threatened TEC and flora species, so all populations surveyed and considered significant.

Terrestrial Fauna

The risk rating remains high for one management objectives related to clearing:

- Habitat loss and fragmentation – the Project area is home to some threatened species such as the Southern Brown Bandicoot. Any loss of nesting areas is considered significant. Clearing is regarded as one of the greatest threats to the terrestrial fauna.

2.3. Management Targets

Measurable management targets have been developed to ensure management actions are effective. If management targets are met, then impacts on the threatened flora and fauna listed in Table 10 will be minimised and the EPA's environmental objective for flora and vegetation will be achieved.

Habitat loss and fragmentation resulting from clearing is identified as the greatest potential to impact on the flora and vegetation and terrestrial fauna through the potential for direct loss of individuals and communities. This impact is anticipated to be minimised by limiting the amount of clearing and implementing progressive rehabilitation.

Management objectives, targets, actions and reporting are listed in Table 11.

Table 11 MRC EMP provisions

Management Objective	Management Targets	Management Actions	Timeframe/ Phase	Reporting
Flora and Vegetation				
Minimise the potential for clearing to cause significant damage, degradation or unlawful loss to the Kwongkan Shrubland TEC	Minimal unauthorised or accidental clearing of significant flora individuals or populations	- Avoid accidental clearing of the Kwongkan Shrubland TEC through implementation of an internal clearing permit procedure. - Where the Kwongkan Shrubland TEC has been recorded the following actions will be undertaken: - It will be avoided as far as practicable. - It will be incorporated into the mine plan. - Its identification and management will be incorporated into the environmental education package. - If areas containing the Kwongkan Shrubland TEC are cleared, the following actions will be undertaken to maximise rehabilitation: - Vegetation will be stockpiled separately and signed. - Topsoil will be stockpiled and preserved for rehabilitation. - Appropriate seed mix will be used to promote rehabilitation.	Planning, Construction, Operations anytime clearing is undertaken.	Pre-clearance surveys. Incident reporting. Internal clearing permits. Clearing register. TEC and Threatened Species Register. Annual Environmental Report
Avoid clearing or unlawful clearing of <i>R.johnstonii</i> habitat	Minimal unauthorised or accidental clearing of <i>R.johnstonii</i> habitat	- Where <i>R.johnstonii</i> habitat has been identified the following actions will be undertaken: - It will be avoided as far as practicable - The area will have signage erected - If <i>R.johnstonii</i> habitat is cleared, the following will be undertaken: - Vegetation will be stockpiled separately and signed - Topsoil will be stockpiled and preserved for rehabilitation	Planning, Construction, Operations - anytime clearing is undertaken	Pre-clearance surveys. Incident reporting. Internal clearing permits. Clearing register. Annual Environmental Report
Minimise the introduction of invasive weed species through the Project area.	Minimal new weeds introduced to site.	- Implementation of a Vehicle Hygiene Procedure which will include commentary on vehicles to be washed down prior to deployment to site, washdown bays on site, frequent use of washdowns. - Implementation of invasive species control, if deemed necessary. - Provide education and training to employees on weed management.	Construction, Operation, Rehabilitation and Closure	Washdown/vehicle hygiene certificates. Invasive species control reports. Annual Environmental

Management Objective	Management Targets	Management Actions	Timeframe/ Phase	Reporting
No introduction of Phytophthora Dieback to the Project area.	No introduction of Phytophthora Dieback into the Project area.	- Development and implementation of a Phytophthora Dieback Management Plan - Use of Dieback washdown stations for all vehicles and machinery entering and leaving the Site - Maintenance of Dieback Washdown Stations - Provide education and training to employees on Phytophthora Dieback and the use of washdown stations	Construction, Operation, Rehabilitation / Closure	Report. Washdown/vehicle hygiene certificates. Annual Environmental Report.
Minimise dust emissions across the Project area	Minimal death or decline in health due to dust.	- Dust will be reduced on site through stabilisation of topsoil stockpiles, implementation of speed limits on unsealed roads and application of dust suppression methods along roads and on stockpiles. - Conveyors will be incorporate dust control strategies to minimise dust - Watercarts or fixed spray sprinklers will be implemented to minimise dust off ROM Pad and stockpiles	Construction, Operation, Rehabilitation / Closure	Incident reports of speeding. Visual dust monitoring. Annual Environmental Report. Incident report of significant dust plumes. Quarterly and annual vegetation monitoring.
Minimise the risk to flora and vegetation from unauthorised off-road driving	Minimal damage or death attributed to off-road driving.	- Avoid accidental disturbance to conservation significant flora by enforcing strict traffic management rules such as: - keeping to designated tracks, - reduced speed limits, - prohibiting access to native vegetation areas except for monitoring purposes, - signed No-Go areas	Construction, Operation, Rehabilitation / Closure	Incident reports of speeding, un-authorised off-road driving. Incident reports of accidental damage/clearing of vegetation. Internal audits and inspections of vehicle speeds.

Management Objective	Management Targets	Management Actions	Timeframe/ Phase	Reporting
				Annual Environmental Report Quarterly and annual vegetation monitoring.
Minimise clearing which could cause fragmentation	No clearing outside approved clearing areas. Progressive rehabilitation undertaken.	- Design infrastructure and site layout to avoid listed threatened species, habitats and the Kwongkan Shrubland TEC. - Design site layout to account for vegetation corridors. - Internal clearing permit procedure to be developed and implemented (to include flagging of clearing areas, supervision of clearing by a suitably qualified environmental professional, reporting of unauthorised clearing). - Undertake progressive land clearing with the amount of active disturbance minimised. - Undertake progressive rehabilitation in accordance with the site Mine Closure Plan. - Where possible, direct placement of topsoil and vegetation will be respread over rehabilitated areas.	Planning, Construction, Operation	Clearing Register. Internal clearing permits. Survey data. Annual Environmental Report.
No increase in fire frequency or intensity	No fires attributed to mining and associated activities.	- Maintenance of fire breaks and implementation of fire management procedures (e.g. Hot Work Permit system, Fire-fighting training, Emergency Response Plan). - Firefighting equipment will be located on site and in vehicles. - Lightning protection equipment will be installed as part of Project design, where necessary. - Vehicles will not be permitted to leave access tracks or cleared areas. - MRC will work with DFES and DBCA to undertake prescribed burns if deemed necessary. - Staff training and awareness to include information on the prevention and management of fires.	Construction, Operations, Rehabilitation/ Closure.	Aerial photos. Incident reports.
Terrestrial Fauna				
Minimise the potential for clearing activities to cause death or	Minimal fauna deaths due to direct interaction with	- Avoid unauthorised clearing through implementation of an internal clearing permit procedure. - Avoid or minimise disturbance to Carnaby Cockatoo foraging habitat. - Minimise disturbance to Southern Brown Bandicoot habitat.	Planning, Construction, Operations - anytime clearing is undertaken	Internal audits /inspections of areas before and after clearing.

Management Objective	Management Targets	Management Actions	Timeframe/ Phase	Reporting
injury to terrestrial fauna including the Carnaby's Black Cockatoo and the Southern Brown Bandicoot	equipment and machinery. No unauthorized clearing of Southern Brown Bandicoot dens.			Incident reporting of fauna death, active den destruction, unauthorised clearing and over-clearing. Internal clearing permits. Clearing register. Annual Environmental Report.
Minimise the potential of vehicle strike causing death or injury to terrestrial fauna including the Carnaby's Black Cockatoo and the Southern Brown Bandicoot	Minimal fauna death attributable to mining vehicle strike.	- Avoid accidental disturbance to fauna and habitat by enforcing strict traffic management rules (e.g. keeping to designated tracks, limited driving between dusk and dawn, driving to road and weather conditions, reduced speed limits, and signage of fauna along roads). - All sightings and interactions with the conservation significant fauna to be reported to the Environmental Department. - Environmental personnel to identify and link with local wildlife carers/vets for injured conservation significant fauna. - Staff training and awareness to provide information on the conservation significant fauna (e.g. how to identify, conservation status, the importance of minimising impacts on the species, adherence to speed limits, reporting to Environmental Department).	Construction, Operation, Rehabilitation / Closure	Incident reports of speeding, unauthorised driving and fauna death and injury. Annual Environmental Report. Internal audits and inspections of vehicle speeds.
Minimise entrapment leading to death or injury of terrestrial fauna including the Carnaby's Black Cockatoo and the Southern Brown Bandicoot	Minimal fauna death due to entrapment in drill holes, containers, bins, open excavations, trenches, and landfill or water holding facilities.	- Avoid accidental death and/or entrapment of fauna by installing egress points and/or fauna ladders in excavations and dams. - Undertake regular inspections of water infrastructure. - Open holes, including drill holes, to be covered or capped during construction or rehabilitated when they are no longer required. - Domestic waste facilities will be fenced and putrescible wastes will be regularly covered. - Containers to have doors closed securely when not in use.	Construction, Operation, Rehabilitation / Closure	Incident reports for entrapped fauna. Internal audits and inspections of site high risk areas for potential for entrapment and death. Annual Environmental Report.

Management Objective	Management Targets	Management Actions	Timeframe/Phase	Reporting
Minimise requirements for clearing which results in habitat loss and fragmentation	No clearing outside approved clearing areas. Progressive rehabilitation undertaken.	- Avoid clearing of fauna habitat where possible. - minimise disturbance to fauna and habitat by locating infrastructure, where possible, in existing disturbed areas. - Internal clearing permit procedure to be developed and implemented (to include flagging of clearing areas by surveyors, supervision of clearing by a suitably qualified environmental professional, reporting of over-clearing). - Progressive land clearing with the amount of active disturbance minimised. - Progressive rehabilitation in accordance with a Mine Closure Plan. - Completion criteria will incorporate fauna and habitat restoration objectives. - Where possible, direct placement of topsoil and vegetation will be respread over rehabilitated areas. - The site layout will be designed to reducing fragmentation, and provide corridors allowing fauna to move through the landscape on all sides of the project.	Planning Construction Operation	Clearing Register. Internal clearing permits. Survey data. Annual Mine Plan. Incident reports for over clearing. Annual Environmental
Minimise light and noise emissions	Minimal disruptions to fauna from noise and light emissions.	- Lights will be strategically placed and designed to shine towards plant operations and minimise light spill to the surrounding environment. - Equipment design will specify compliance with Australian Standard noise limits. - Processing plant to be located within a shed to reduce noise and light emissions.	Construction, Operation, Rehabilitation / Closure	Incident reports for light spill and noise violations. Annual Environmental Report.
Minimise increases to predator abundance and herbivorous competitors	Waste and water sources not available to feral predators. Predator control program implemented. Minimal increase in predator abundance.	- Avoid attraction of both feral and native species to the project footprint by implementing domestic waste management procedures (e.g. fencing of landfills, regularly covering putrescible waste, secure lids on bins, borrow pits designed to avoid ponding water). - MRC will undertake pest animal control on site in cooperation with regional control programs where appropriate. - Staff training and awareness to include information on feral species (e.g. impact on native fauna, no feeding of feral species and all sightings of feral species to be reported).	Construction, Operation, Rehabilitation / Closure	Opportunistic observations. Incident reports of native fauna predation. Internal audits and inspections. Predator control to include monitoring of predator species. Annual Environmental Report.

Management Objective	Management Targets	Management Actions	Timeframe/ Phase	Reporting
No increase in fire frequency or intensity	No fires attributed to mining and associated activities.	- Avoid increases in fire frequency through maintenance of fire breaks and implementation of fire management procedures (e.g. Hot Work Permit system, fire-fighting training, Emergency Response Plan). - Firefighting equipment will be located on site and in vehicles. - Lightning protection equipment will be installed as part of Project design where necessary. - Vehicles will not be permitted to leave access tracks or cleared areas. - MRC will work with DFES and DBCA to undertake prescribed burns if deemed necessary. - Staff training and awareness to include information on the prevention and management of fires.	Construction, Operation, Rehabilitation / Closure	Aerial photography. Annual Environmental Report. Incident reports.

2.4. Monitoring

The following monitoring will be undertaken for this Threatened Species and Community Environmental Management Plan:

Flora and Vegetation:

- Biennially visual monitoring will take place on the Kwongkan Shrubland TEC, written and photographic records will be taken and kept of visual inspections.
- Annual Transect monitoring will address plant health and recruitment of Kwongkan Shrubland TEC. Plant condition for each individual that intersects the transect will be assessed.
- Annual monitoring will be taken on *R.johnstonii* habitat during flowering time for habitat health and for the presence of *R.johnstonii*.
- Annual monitoring will continue until completion of rehabilitation activities.

Terrestrial Fauna:

- Internal audit and inspection of areas of clearing, areas of potential entrapment, speeding and night driving.
- Monitoring of incident reports for native fauna predation, vehicle strike, speeding and night driving, over clearing, light and noise disturbance and fire.
- Monitoring of the existing feral fauna populations. This information is intended to provide a baseline for comparison of feral animal numbers over the life of mine. Best practice techniques developed following consultation with DPaW. The information will also guide any feral control programs implemented in the Project area.
- Monitoring of clearing through the clearing register, survey data and aerial photography.

Where there is evidence of management targets not being met, or a trigger value being breached – for instance, unauthorised clearing of Kwongkan Shrubland TEC or native fauna being killed, management measures will be reviewed to ensure further deaths do not occur.

2.5. Reporting

This Threatened Species and Community Management Plan sets out the reporting requirements relating to the implementation of the Plan. Reporting includes:

- Preparation of an Annual Environmental Report (AER) to be submitted to the appropriate regulatory authorities. The AER will include monitoring results and trends as compared to trigger and threshold criteria.
- Provision of data (annually) from monitoring programs to relevant regulatory authorities.
- In the event that a management target is exceeded (or not met), the relevant regulatory authorities will be notified within 7 days of identification of the exceedance, including threshold contingency actions which have been implemented due the exceedance of threshold criteria.

3. Adaptive Management and Review of the EMP

This Management Plan has defined the issues, outlined management and mitigation measures to address the issues, and introduced monitoring and evaluation of these measures.

The management approach for this management plan, although outcome based, will be adaptive. The management plan will be reviewed on an annual basis by a suitably qualified experienced person. In

In addition to this formal annual review, the Threatened Species and Community Management Plan will be reviewed if:

- New information is learned from monitoring, or monitoring indicates that management targets are not being achieved.
- New information becomes available about any of the managed species, i.e. change in conservation status.
- There is a change in the project description, i.e. and increase to the disturbance area.

4. Stakeholder Consultation

Early engagement has allowed MRC to understand the community in which they are working and identify key stakeholders that will be impacted by or impact the Project, including:

- State Government
- Federal Government
- Local Government
- Non-government organisations and interested parties
- Adjoining landowners and local communities e.g. Munghlinup

MRC is committed to open and transparent communication with its stakeholders throughout the life of the Project from development approval through to construction, operation and mine closure. The objectives for this communication are as follows:

- To manage expectations by ensuring the communities and relevant stakeholders fully understand the nature of the Project, including the likely impacts and benefits that may be derived from Project operations.
- To promote community confidence in MRC, as an organisation, and the Project by ensuring open and transparent communication of Project development processes, impacts and risk management processes
- To ensure a sustainable Project design and decision making by incorporating local community knowledge, views and concerns.
- To enable MRC to identify and address community concerns proactively and in collaboration with the community.
- To adopt a good neighbour policy.

A Community Engagement Plan has been developed to enable MRC to meet these objectives and outline the appropriate stakeholder engagements.

Whilst not specific to this EMP, ongoing stakeholder consultation has been underway since February 2018, with 2 community events held in Munghlinup and Esperance in August 2018 to provide an overview of the Project and environmental studies conducted.

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APPENDIX 1

MRC Flora and Vegetation and Terrestrial Fauna Risk Assessment

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Environmental Consequences Descriptions

Environmental Factor	Minor	Medium	Serious	Major	Catastrophic
	Limited damage to minimal area of low significance	Minor effect on biology or physical environment	Moderate short-term effects but not affecting eco-system	Serious medium-term environmental effects	Very serious long-term environmental impairment of eco-system
Biodiversity / Flora / Fauna / Ecosystems	None or insignificant impact on ecosystem component (physical, chemical or biological) expected with no effect on ecosystem function. Impact does not require specific management or rehabilitation	Moderate to minor impact to ecosystem component (physical, chemical or biological) Minor off-site impacts at a local scale. Damage is recoverable through short-term management and rehabilitation	Minor and short-term impact to high value or sensitive ecosystem expected Off-site impacts at a local scale. Rectification and rehabilitation over the medium-term.	Long-term impact to significant high value or sensitive ecosystem expected Long-term impact on a wide scale Adverse impact to a listed species expected. Rectification difficult but may be possible in the long-term.	Long-term impact to significant high value or sensitive ecosystem expected Long-term impact on a wide scale Adverse impact to a listed species expected. Rectification difficult and unlikely to result in recovery.
Threatened Species and Communities	No or negligible loss of a threatened community or threatened population's critical habitat. No mortality Impact recoverable without management	Temporary loss of a threatened community or threatened populations critical habitat (< 0.1%). Mortality of a few individuals with negligible impact on the population.	Temporary loss of 0.1-1% of a threatened community or threatened populations critical habitat. Mortality of few individuals leading to a temporary diminishment of a population.	Long term loss of 1-10% of a threatened community or threatened populations critical habitat. Mortality of sufficient individuals to lead to a long term diminishment of a population.	Permanent loss of >10% of a threatened community or threatened populations critical habitat. Mortality of a significant number of individuals leading to a permanent diminishment of a population.

Note: Percentages referred to in the Threatened Species and Communities Environmental Factor should be calculated based on the project area of influence.

Risk Consequence and Likelihood Definitions

Consequence Ranking			Likelihood Ranking		
1	Minor	Limited damage to minimal area of low significance	A	Almost Certain	The incident is expected to occur most of the time/every time.
2	Medium	Minor effect on biology or physical environment	B	Likely	The incident will probably occur in most circumstances/ regularly/ weekly.
3	Serious	Moderate short-term effects but not affecting ecosystem	C	Possible	The incident should occur at some time/ quarterly.
4	Major	Serious medium-term environmental effects	D	Unlikely	The incident could occur at some time in the life of the project.
5	Catastrophic	Very serious long-term environmental impairment of ecosystems	E	Rare	The incident may occur only in exceptional circumstances and may never happen.

Risk Assessment Categories

		Consequences				
		1	2	3	4	5
Likelihood		Minor	Medium	Serious	Major	Catastrophic
A	Almost Certain	Moderate 11	High 16	Extreme 20	Extreme 23	Extreme 25
B	Likely	Moderate 7	High 12	High 17	Extreme 21	Extreme 24
C	Possible	Low 4	Moderate 8	High 13	High 18	Extreme 22
D	Unlikely	Low 2	Low 5	Moderate 9	High 14	High 19
E	Rare	Low 1	Low 3	Low 6	Moderate 10	High 15

Management Plan Risk Assessment – Flora and Vegetation

Management Objective	Inherent Risk	Management Actions	Residual Risk	Timeframe/Phase
Minimise the potential for clearing to cause significant damage, degradation or unlawful loss to the Kwongkan Shrubland TEC	HIGH 13	- Avoid accidental clearing of the Kwongkan Shrubland TEC through implementation of an internal clearing permit procedure. - Where the Kwongkan Shrubland TEC has been recorded the following actions will be undertaken: - It will be avoided as far as practicable. - It will be incorporated into the mine plan. - Its identification and management will be incorporated into the environmental education package. - If areas containing the Kwongkan Shrubland TEC are cleared, the following actions will be undertaken to maximise rehabilitation: - Vegetation will be stockpiled separately and signed. - Topsoil will be stockpiled and preserved for rehabilitation. - Appropriate seed mix will be used to promote rehabilitation.	MODERATE 9	All Phases
Avoid the clearing or unlawful clearing of <i>R.johnstonii</i> habitat	HIGH 18	- Where <i>R.johnstonii</i> habitat has been identified the following actions will be undertaken: - It will be avoided as far as practicable - The area will have signage erected - If <i>R.johnstonii</i> habitat is cleared, the following will be undertaken: - Vegetation will be stockpiled separately and signed - Topsoil will be stockpiled and preserved for rehabilitation	MODERATE 10	All Phases
Minimise the introduction of invasive weed species through the Project area.	MODERATE 8	- Implementation of a Vehicle Hygiene Procedure which will include commentary on vehicles to be washed down prior to deployment to site, washdown bays on site, frequent use of washdowns. - Implementation of invasive species control, if deemed necessary. - Provide education and training to employees on weed management	LOW 5	All Phases

Management Objective	Inherent Risk	Management Actions	Residual Risk	Timeframe/Phase
No introduction of Phytophthora Dieback to the Project area.	HIGH 13	- Development and implementation of a Phytophthora Dieback Management Plan - Use of Dieback washdown stations for all vehicles and machinery entering and leaving the Site - Maintenance of Dieback Washdown Stations - Provide education and training to employees on Phytophthora Dieback and the use of washdown stations	MODERATE 9	All Phases
Minimise dust emissions across the Project area	HIGH 12	- Dust will be reduced on site through stabilisation of topsoil stockpiles, implementation of speed limits on unsealed roads and application of dust suppression methods along roads and on stockpiles. - Conveyors will be covered to minimise dust - Watercarts or fixed spray sprinklers will be implemented to minimise dust off ROM stockpiles	LOW 5	Operations
Minimise the risk to flora and vegetation from unauthorised off-road driving	HIGH 17	- Avoid accidental disturbance to conservation significant flora by enforcing strict traffic management rules such as: - keeping to designated tracks, - reduced speed limits, - prohibiting access to native vegetation areas except for monitoring purposes, - signed No-Go areas	MODERATE 9	All Phases
Minimise clearing which could cause fragmentation	HIGH 13	- Design infrastructure and site layout to avoid listed threatened species, habitats and the Kwongkan Shrubland TEC. - Design site layout to account for vegetation corridors - Internal clearing permit procedure to be developed and implemented (to include flagging of clearing areas, supervision of clearing by a suitably qualified environmental professional, reporting of unauthorised clearing). - Undertake progressive land clearing with the amount of active disturbance minimised. - Undertake progressive rehabilitation in accordance with the site Mine Closure Plan	LOW 6	All Phases

Management Objective	Inherent Risk	Management Actions	Residual Risk	Timeframe/Phase
		Where possible, direct placement of topsoil and vegetation will be respread over rehabilitated areas.		
No increase in fire frequency or intensity	HIGH 18	- maintenance of fire breaks and implementation of fire management procedures (e.g. Hot Work Permit system, fire-fighting training, Emergency Response Plan). - Firefighting equipment will be located on site and in vehicles. - Lightning protection equipment will be installed as part of Project design, where necessary. - Vehicles will not be permitted to leave access tracks or cleared areas. - MRC will work with DPaW and DFES to undertake prescribed burns. - MRC will contribute to fire management in the region. - Staff training and awareness to include information on the prevention and management of fires.	MODERATE 10	All Phases
Terrestrial Fauna				
Minimise the potential for clearing activities to cause death or injury to terrestrial fauna including the Carnaby's Black Cockatoo and the Southern Brown Bandicoot	HIGH 12	- Avoid unauthorised clearing though implementation of an internal clearing permit procedure. - Avoid or minimise disturbance to Carnaby Cockatoo foraging habitat - Avoid disturbance to Southern Brown Bandicoot dens - Pre-clearance surveys will be completed prior to all clearing to record the presence/absence of Southern Brown Bandicoot dens in the area to be cleared. - Injured fauna will be taken to a wildlife carer for treatment and rehabilitation whenever possible	LOW 5	All Phases
Minimise the potential of vehicle strike causing death or injury to terrestrial fauna including	HIGH 12	- Avoid accidental disturbance to fauna and habitat by enforcing strict traffic management rules (e.g. keeping to designated tracks, limited driving between dusk and dawn, driving to road and weather conditions, reduced speed limits, and signage of fauna along roads). - All sightings and interactions with the conservation significant fauna to be reported to the Environmental Department.	LOW 5	All Phases

Management Objective	Inherent Risk	Management Actions	Residual Risk	Timeframe/Phase
the Carnaby's Black Cockatoo and the Southern Brown Bandicoot		- Environmental personnel to identify and link with local wildlife carers/vets for injured conservation significant fauna. - Staff training and awareness to provide information on the conservation significant fauna (e.g. how to identify, conservation status, the importance of minimising impacts on the species, adherence to speed limits, reporting to Environmental Department).		
Minimise entrapment leading to death or injury of terrestrial fauna including the Carnaby's Black Cockatoo and the Southern Brown Bandicoot	HIGH 13	- Avoid accidental death and/or entrapment of fauna by installing egress points and/or fauna ladders in excavations and dams - undertake regular inspections of water infrastructure. - Open holes, including drill holes, to be covered or capped during construction or rehabilitated when they are no longer required. - Domestic waste facilities will be fenced and putrescible wastes will be regularly covered. - Containers to have doors closed securely when not in use.	MODERATE 9	All Phases
Minimise requirements for clearing which results in habitat loss and fragmentation	HIGH 17	- Avoid clearing of fauna habitat where possible - minimise disturbance to fauna and habitat by locating infrastructure, where possible, in existing disturbed areas. - Internal clearing permit procedure to be developed and implemented (to include flagging of clearing areas by surveyors, supervision of clearing by a suitably qualified environmental professional, reporting of over-clearing). - Progressive land clearing with the amount of active disturbance minimised. - Progressive rehabilitation in accordance with a Mine Closure Plan. - Completion criteria will incorporate fauna and habitat restoration objectives. - Where possible, direct placement of topsoil and vegetation will be respread over rehabilitated areas. - The site layout will be designed to minimise fragmentation, and provide corridors allowing fauna to move through the landscape on all sides of the project.	MODERATE 9	Planning Construction Operation

Management Objective	Inherent Risk	Management Actions	Residual Risk	Timeframe/Phase
Minimise light and noise emissions	MODERATE 8	- Travel between dusk and dawn will be limited to essential travel. - Lights will be strategically placed and designed to shine towards plant operations and minimise light spill to the surrounding environment. - Equipment design will specify compliance with Australian Standard noise limits. - Processing plant to be located within a shed to reduce noise and light emissions	LOW 5	All Phases
Minimise increases to predator abundance and herbivorous competitors	HIGH 16	- Avoid attraction of both feral and native species to the project footprint by implementing domestic waste management procedures (e.g. fencing of landfills, regularly covering putrescible waste, secure lids on bins, borrow pits designed to avoid ponding water). - MRC will undertake pest animal control on site in cooperation with regional control programs where appropriate. - Staff training and awareness to include information on feral species (e.g. impact on native fauna, no feeding of feral species and all sightings of feral species to be reported).	LOW 5	All Phases
No increase in fire frequency or intensity	HIGH 18	- Avoid increases in fire frequency through maintenance of fire breaks and implementation of fire management procedures (e.g. Hot Work Permit system, fire-fighting training, Emergency Response Plan). - Firefighting equipment will be located on site and in vehicles. - Lightning protection equipment will be installed as part of Project design where necessary. - Vehicles will not be permitted to leave access tracks or cleared areas. - MRC will work with DPaW and DFES to undertake prescribed burns. - MRC will contribute to fire management in the region. - Staff training and awareness to include information on the prevention and management of fires.	MODERATE 10	All Phases

APPENDIX G: CULTURAL HERITAGE MANAGEMENT PLAN (DRAFT)



MRC GRAPHITE PTY LTD



MUNGLINUP GRAPHITE CULTURAL HERITAGE MANAGEMENT PLAN

Prepared by Integrate Sustainability

Munglinup Graphite Project

Cultural Heritage Management Plan

Document Control

Revisions	Author	Date of Issue
Revision 1	Integrate Sustainability Pty Ltd	
Revision 2		
Revision 3		
Revision 4		

DRAFT

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1. INTRODUCTION

This Cultural Heritage Management Plan (CHMP) has been drafted as a living document to protect heritage values and to strengthen the relationship between MRC Graphite (MRC) and the Esperance Nyungar People. This CHMP outlines the processes to be implemented to mitigate any potential impacts to cultural heritage during execution of the Munglinup Graphite Project (the Project) and during exploration activities.

The MRC tenements are located within the traditional lands of the Aboriginal people referred to as Esperance Nyungar People. In March 2014, the Federal Court handed down its determination recognising Esperance Nyungar People Native Title Rights within the broader Esperance Region. Due to the level of historic land use within the region key areas such as MRC Mining Lease (M74/245) and the underlying Mining Reserve (R24714), it was determined that Native Title had been extinguished. Native Title was recognised as remaining in other areas and Esperance Nyungar People had the right to negotiate about future acts that would impact on these rights.

MRC respects the cultural rights and responsibilities of the Esperance Nyungar People and acknowledges that they have the responsibility to protect sites of significance to the Esperance Nyungar People.

1.1. Scope

This CHMP is applicable for all activities occurring within M74/245, E74/565 and E74/505 to which the following tenement endorsement applies - the licensee is made aware of the provisions of the *Aboriginal Heritage Act 1972*.

This document shall apply to all personnel, including contractors and sub-contractors of MRC working within project tenure.

1.2. Objectives

The objectives of this CHMP is to ensure that:

- Cultural heritage value within the MRC tenements are identified and protected;
- All legal requirements are complied with;
- Activities are designed to avoid areas of significant heritage values and minimise impacts on other heritage values where practical; and
- Traditional Owners involvement in the protection and monitoring of heritage values is facilitated.

1.3. Background

A baseline heritage assessment was undertaken in April and July 2018 within M74/245 by Applied Archaeology Australia and the representatives from the Esperance Tjaltjraak Native Title Aboriginal Corporation (ETNTAC). During this assessment a range of heritage values were recorded, ranging from culturally important plants, artefact scatter, historic tools and ethnographic sites. Due to the density of the vegetation much of the area has not been formally assessed and require post-clearing inspections.

A database of all currently identified heritage values and new occurrences is maintained by MRC to assist ongoing management. Consultation with all relevant Aboriginal stakeholders is an ongoing process for this CHMP and MRC remains open for continuing consultation with current and additional

stakeholders on management advice, new site information or other measures to ensure ongoing effective site management.

2. APPLICABLE LEGISLATION

The following legislation is relevant to Aboriginal heritage management for the Project:

Table 1. Legislation relating to Aboriginal Heritage Management

Legislation	Summary
<i>Aboriginal Heritage Act 1972 (WA)</i>	Introduced in Western Australia in 1972 to protect Aboriginal heritage, the Act recognises Aboriginal people's strong relationships to the land, which may go back thousands of years. The Act provides automatic protection for all places and objects in Western Australia that are important to Aboriginal people because of connections to their culture. Under the Act it is an offence for anyone to excavate, damage, destroy, conceal or in any way alter an Aboriginal site without the Minister for Aboriginal Affairs (the Minister) permission.
<i>Aboriginal Heritage Regulations 1974 (WA)</i>	The Regulations apply to any Aboriginal site or protected area or land held subject to a covenant in favour of the Minister in relation to which the Minister has a duty under the Aboriginal Heritage Act 1972.
<i>Australian Heritage Commission Act 1975 (Cth)</i>	An Act to establish the Australian Heritage Council and for related purposes.
<i>Aboriginal and Torres Strait Island Heritage Protection Act 1984 (Cth)</i>	The Act offers protection for significant places or objects through Ministerial decision. Aboriginal people who believe that a place or object is threatened and believe that state government processes offer inadequate protection can apply to the Federal Minister for Environment to protect the place or object.
<i>Protection of Movable Culture Heritage Act 1986 (Cth)</i>	An Act to protect Australia's heritage of movable cultural heritage, to support protection by foreign countries of their heritage of movable objects and for related purposes.
<i>Native Title Act 1993 (Cth)</i>	Native Title describes the rights and interests of Aboriginal and Torres Strait Islander people in land and waters, according to their traditional laws and customs that are recognised under Australian law.
<i>Environmental Protection and Biodiversity Conservation Act 1999 (Cth)</i>	Protects the environment, particularly matters of National Environmental Significance. It streamlines national environmental assessment and approvals processes, protects Australian biodiversity and integrates management of important natural and cultural places.

3. ROLES AND RESPONSIBILITIES

The MRC Exploration Manager is responsible for the management of Register Sites and other Heritage values within the MRC tenure un.

Table 2 Roles and Responsibilities

Exploration Manager	Actively participate in and support cross-cultural events
All Personnel	Have an appreciation for the culture and heritage of the local area
	Respect the cultural diversity and heritage
	Attend cross cultural training
Environmental Advisor	Arrange for cross cultural training to be undertaken by all personnel
	Ensure all identified sites are protected and if required arrange for S18 approval for removal/destruction of a site
	Organise for ethnographic and archaeological surveys to be conducted as required
	Ensure that areas of significant heritage value are reported to the Department of Land, Planning and Heritage (DLPH) for assessment and inclusion in the state Aboriginal Heritage Register
	Liaise with Traditional Owners requesting access to ethnographic or archaeological sites
	Annual review of the Cultural and Heritage Management Plan
Management Team	Incorporate potential impacts to indigenous sites and the impact on the business of preserving sites when there is a conflict with operational plans into the Risk Management Strategy for the Project.
	Ensure S18 approvals have been obtained prior to disturbing known indigenous sites
	Ensure employees and contractors attend cross cultural training
	Attend cross cultural training
	Ensure that training records are maintained for induction and personnel involved in cross culture awareness sessions
Designated Spokesman	Conduct reporting requirements to regulatory authorities
	Lead consultation with local indigenous communities

4. CULTURAL HERITAGES

4.1 Definition of Aboriginal Sites

Section 4 of the *Aboriginal Heritage Act 1972* (the Act) defines an Aboriginal site as:

- Any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;
- Any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;
- Any place, which in the opinion of the Aboriginal Cultural Material Committee is or was associated with the Aboriginal people and which is of historical, anthropological or

ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the state; and

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

Artefacts: An artefact site is a place where human activity is identifiable by the presence of a portable object/s (e.g., stone, glass, bone and shell) utilised or modified by Aboriginal people in relation to traditional cultural life past or present Figure 1.



Figure 1 MRC Site Fine Grain Chert Artefacts (Source: 2018 Heritage Survey Report)

Fish Trap: A stone, wood, or other similar structure made by Aboriginal people for catching fish. Such structures are generally found on the coast of Western Australia, and in its lakes and rivers.

Man-Made Structure: The placement or arrangement, by Aboriginal people, of stone, wood or other material made into a structure for ceremonial or utilitarian purposes.

Mythological: A place that is connected to the great spirit ancestors, in their various manifestations, of the 'Dreamtime' which continues to be important and of special significance to persons of Aboriginal descent.

Ceremonial: A place used for a formal act or series of acts prescribed by ritual, belief in a mythological manifestation, religious belief or observance, protocol or convention that is connected with the traditional cultural life of Aboriginal people past or present.

Repository/Cache: A place where cultural or utilitarian objects are/were taken, or stored, by Aboriginal people, either past or present.

Grinding Patches/Grooves: A place where grinding patches or grooves can be found. Grinding patches or grooves are smoothed areas or grooves on rock surfaces (non-portable) that have been created by grinding activity associated with food production such as seed milling, preparation of pigments, tool manufacture and/or maintenance and ritual.

Midden: A place where there is an accumulation of shell refuse that is derived from exploitation of a mollusc resource by Aboriginal people. Such sites may also contain artefacts, fireplaces, burnt shell and bones.

Painting: Places where Aboriginal people have painted on surfaces. Paintings (including daubings, drawings, stencils, prints) can be figurative or non-figurative markings or motifs on surfaces such as rocks, rock walls and trees at fixed locations that are produced by adding pigments and or mediums, such as ochre, blood, beeswax, animal fats, vegetable dyes and tree saps.

Skeletal Material/Burial: A place where Aboriginal skeletal material is buried and/or where mortuary practices occurred. At least one of the following pieces of evidence is required to establish that the reported place is of Aboriginal origin:

- Aboriginal skeletal material is visible; and
- Aboriginal mortuary/burial markers and or ethnographic evidence about the burial/skeletal material.

Engraving: A motif (either figurative or non-figurative) on a rock surface produced by percussion or abrasion. Engravings are also often referred to as petroglyphs.

Historical: A place that has historical associations with Aboriginal people that may or may not contain physical evidence of those associations.

Modified or Scarred Tree: A place with one or more tree(s), living or dead, that has been modified by Aboriginal people by removing the bark or wood resulting in the formation of a scar (Figure 2). This sort of modification was and is frequently done for the making of implements, tools or other materials that were used in traditional cultural practices. At least two of the following pieces of evidence are required to establish that a scar is of

Aboriginal origin:

- The scarred tree is an indigenous species and a mature individual;
- The scar base normally begins above ground level;
- The scar is roughly parallel-sided and fairly symmetrical in its overall shape;
- The bark regrowth is generally regular;
- The scar terminations are either squared off or pointed as a result of bark regrowth;
- Axe marks are present; and
- Suspected toe holes are arranged in a usable pattern.



Figure 2 Scar Tree (SWALSC, 2018)

Quarry: When outcrops of rock suitable for the manufacture of stone tools were quarried by Aborigines, evidence of the flaking and chipping of the source material can usually be seen in situ and nearby. Ochre and other mineral pigments were mined from naturally occurring seams and other deposits. This activity can sometimes be recognised by the presence of wooden digging sticks or the marks made by these implements. At least two of the following pieces of evidence are required to establish that a natural occurrence of raw material has been used as a quarry:

- Evidence for the removal of material/modified surfaces in the form of negative scarring, crushing, areas of excavation etc;
- Presence of implements used during extraction (e.g. hammerstones, fire-hardened sticks) at the source;
- Evidence of flaking and reduction of the stone material at the source;
- Presence of partially-worked material at the source; and
- Ethnographic evidence relating to the extraction of raw material at the source.

Landscape features, which possibly contain Aboriginal sites and should therefore be approached with care, include but are not limited to:

- a) rock outcrops;
- b) caves;
- c) foreshores and coastal dunes;
- d) (d) ranges and hills;
- e) areas of bio-geographical significance, such as natural wetlands;
- f) permanent and semi-permanent waterholes, natural springs, gnamma holes, and watercourses;
- g) some hill and mound formations; and
- h) areas with potential archaeological deposit, such as rock shelters, caves, alluvial terraces, dune deposits and other relevant geo-morphological features.

The *Aboriginal Heritage Act 1972* also provides protection to objects, which are defined in Section 6 as:

- a) All objects whether natural or artificial and irrespective of where found or situated in the State, which are or have been of sacred, ritual or ceremonial significance to persons of Aboriginal descent, or which are or were used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people past or present; and
- b) Objects so nearly resembling an object of sacred significance to persons of Aboriginal descent as to be likely to deceive or be capable of being mistaken for such an object.

4.2. Identification of Aboriginal Sites and Features

During ethnographic surveys Aboriginal advisors are asked about their associations with the land that is under consideration and whether they know of the existence of any places that might be considered Aboriginal sites.

4.2.2 Archaeological Surveys

Archaeological survey involves visual inspection of the ground surface to determine whether any Aboriginal cultural material (e.g. stone tools) is present. The purpose of an archaeological survey is to:

- Establish whether a piece of land contains physical evidence of past Aboriginal occupation and land use (archaeological sites); and

- To record, assess and make recommendations regarding the management of archaeological sites.

4.3. Other Heritage Features

Other heritage features include any area or object that the local Aboriginal people locate during site surveys that are not an already registered site with the DLHP.

4.4. Aboriginal Heritage Sites at Munglinup

4.4.1. Ethnographic

To date no State recognised registered ethnographic heritage sites have been recorded within M74/245, while one registered site has been located on tenement E74/565, this being the Oldfield River. During the 2018 assessment two ethnographic sites were recorded at the Munglinup River and Mungan Wilgie Koort. Both sites have been lodged with the DLPH for consideration and potential inclusion in the State Aboriginal Heritage Register (Table 3). In August 2018, the Munglinup River was registered as an aboriginal heritage site.

Table 3 Ethnographic sites and places known to occur within MRC Tenure

AHIS Site ID	Restriction	Site Name	Site Type	Tenement
26265	No	Oldfield River	Mythological	E74/565
37695	No	Munglinup River and tributaries	Cultural Place	M74/245
-	-	Mungan Wilgie Koort	Cultural Place	M74/245

4.4.2. Archaeological

To date no State recognised registered archaeological heritage sites have been recorded within MRC tenements. During the 2018 assessment, five archaeological places were recorded. These are presented in Table 4.

Table 4 Archaeological sites and places known to occur within MRC Tenure

AHIS Site ID	Restriction	Site Name	Site Type	Tenement
-	-	MRC 01	artefact scatter	M74/245
-	-	MRC 02	artefact scatter	M74/245
-	-	MRC 03	artefact scatter and ochre source	M74/245
-	-	MRC 04	artefact scatter	M74/245
-	-	MRC 05 / Mungan Wilgie Koort	artefact scatter, ochre source	M74/245

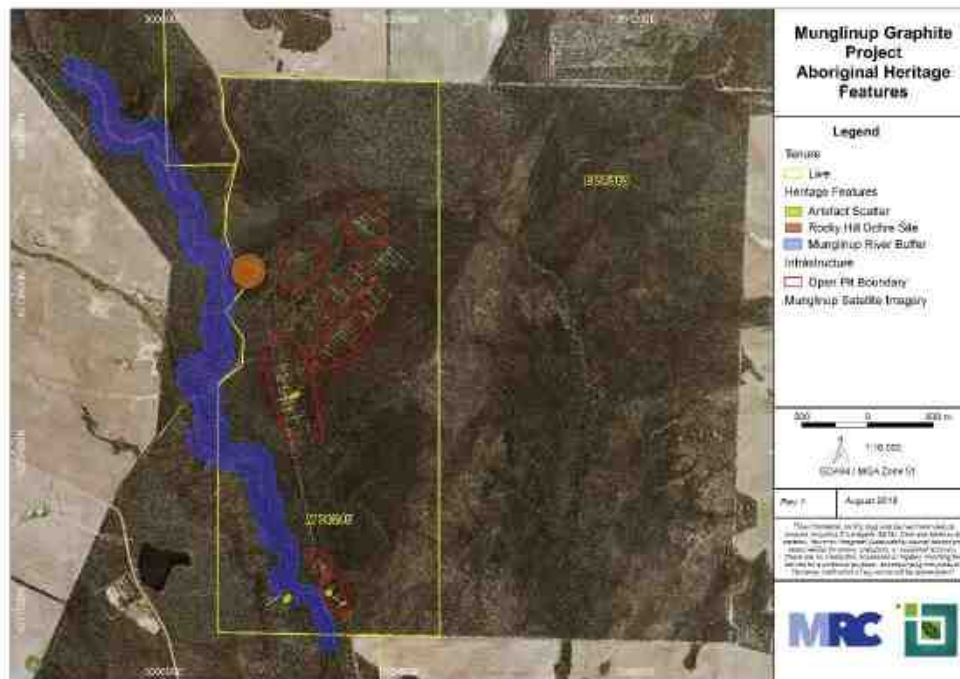


Figure 3 Ethnographic and Archaeological Values with exclusion zone recorded in 2018.

4.5. Other Heritage Features at Munglinup

There are a number of other heritage features that have been identified within M74/245, several important isolated finds were identified – including a kodj (axe), a grinding stone, a unifacial point, and a number of backed artefacts. All these implements hold cultural value and are of major research interest, through the study of morphology and use-wear and residue analysis.

Within the assessment area the Traditional Owners also identified areas they determined to be Culturally Sensitive Areas (CSA). The CSA include a pocket of zamia palms, a rocky ochre outcrop, artefact scatters and the Munglinup River and its tributaries (Figure 4).



Figure 4 Munglinup Graphite Project Heritage values and Culturally Sensitive Areas

5. MANAGEMENT AND PROTECTION OF SITES

The *Aboriginal Heritage Act 1972* provides protection for all Aboriginal sites whether or not they are recorded on the Register of Aboriginal Sites. Under Section 17 of the Act it is an offence to disturb an Aboriginal site. A person who:

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

commits an offence unless they are acting with the authorisation of the Registrar of Aboriginal Sites or the consent of the Minister for Indigenous Affairs.

The Aboriginal sites and features within the MRC tenure are protected using a combination of the following methods:

- Ethnographic and archaeological heritage values identified using recognised specialist and traditional owner representatives;
- The DLPH are advised of any identified significant heritage values, in order that they be assessed for inclusion in the State Aboriginal Heritage Register, with MRC also establishing an onsite exclusion zone around any significant feature;
- MRC will incorporate all heritage values identified into a project spatial database;
- Heritage values will be considered when planning and obtaining approvals for exploration and developing the operation;
- Heritage monitors will monitor clearing activities that occur outside the 2018 Heritage Assessment areas and clearing undertaken within Halbert's South;
- Heritage monitors will undertake post raised blade clearing inspections within the 2018 Heritage Assessment area;
- Heritage monitors will inspect areas to be cleared within the 2018 Heritage Assessment Area that are within 20m of a previously recorded heritage value or point of interest within CSA;
- Personnel involved in clearing will be required to complete significant values induction which includes information on heritage values;
- The location of Aboriginal features is to be considered during planning and mining activities. Where possible projects will be designed to avoid disturbance of Aboriginal sites;
- Information on sites and features of cultural significance will be provided as part of the general induction;
- No Registered Aboriginal site will be disturbed unless approval has been granted by the Minister pursuant to Section 18 of the *Aboriginal Heritage Act 1972*; and
- Clearing of vegetation within a significant heritage values buffer will be undertaken in the presence of Heritage monitors.

5.1. Induction

The MRC General Induction will be completed by all employees and contractors and will incorporate an introduction to heritage values and heritage protection at Munglinup.

In addition to the General Induction, employees and contractors involved in clearing activities will complete the MRC significant values induction. This induction incorporates the significant cultural and heritage sites and values. All who sit the induction will need to complete a test to be signed off. A

record of all employees and contractors that have completed the induction must be maintained on file.

5.2. Cultural Awareness

MRC will establish cultural awareness sessions, these sessions will be developed and presented by either ETNTAC or a suitably qualified service provider. The cultural awareness session will be completed by the MRC Management Team and Senior Representatives from all major contractors involved in the Project.

5.3. Heritage Clearances/Inspections Tracking

MRC will complete a Heritage Inspection Record Form and compile spatial data for all area inspected or cleared by Heritage Monitors. The Heritage Inspection Record Form will record:

- Date of the clearance/inspection
- Name of people involved
- Areas visited, and activities planned
- Outcomes and comments
- Spatial data of heritage values / feature observed
- Map of the areas visited, and record of heritage values/features observed.
- Photo where appropriate.

A copy of the Heritage Inspection Record Forma will be provided to ETNTAC as soon as practical after the inspection /clearance has been completed.

5.4. Management of sites and features that have been identified

1. The location, summary information and management requirements with respect to the recorded Aboriginal Sites, features and other Heritage Sites or CSA's is to be included in a database and is to be maintained and kept up to date by the Environmental Advisor. Authority to access this information must be documented and must only be given to those members of staff who require the information to conduct their work.
2. No Go buffers will be established around significant heritage values, these buffers will be developed in consultation with ETNTAC.
3. The Environmental Advisor is to ensure that employees and contractors are made aware of and have ready access to the *Aboriginal Heritage Act 1972*, *Heritage of WA Act 1990* and *National Trust of Australia (WA) Act 1964*.
4. The Environmental Advisor should ensure that Registered and not Registered Sites are managed in accordance with the protocols agreed with Traditional Custodians (via the ETNTAC) and the relevant provisions of the *Aboriginal Heritage Act 1972*.
5. No employee or contractor is allowed to use land on any site which is either registered or in the process of being registered, as defined by the *Aboriginal Heritage Act 1972*, without first obtaining consent from the Minister after the lodgement of a section 18 Notice to the Aboriginal Cultural Material Committee.
6. The collection or relocation of Aboriginal artefacts must only be done according to the provisions of the *Aboriginal Heritage Act 1972* and in consultation with and approval from the Traditional Custodians via the ETNTAC.

5.5. Recording and protecting previously unidentified sites

If a previously unidentified Aboriginal site is found (i.e. artefacts are uncovered) at the Project the following actions will be taken:

1. Ground disturbing activity in the area will be stopped. The site will be barricaded to prevent further inadvertent access or disturbance.
2. A heritage survey will be conducted by a suitably qualified consultant. Relevant Aboriginal people will be consulted where appropriate.
3. If the heritage survey determines that the area is not an Aboriginal site, work will recommence.
4. If the heritage survey determines that the area is an Aboriginal site, a report will be prepared and submitted. The report will be prepared in accordance with the relevant template on the DLPH website.
5. The Registrar of Aboriginal Sites (Registrar) will ensure that the site is recorded and placed on the Register of Aboriginal Sites.
6. If MRC wishes to carry on activity in the area, a section 18 Notice to use the land will be lodged with the Aboriginal Cultural Material Committee. The Notice will be prepared by a suitably qualified consultant with relevant experience and in accordance with the requirements of the Guidelines for Preparing Reports for Application to the Aboriginal Cultural Material Committee Under Section 18 of the *Aboriginal Heritage Act 1972*.
7. If appropriate, MRC will prepare an Aboriginal Heritage Management Plan for the site. The Plan will be developed in accordance with the relevant WA Guidelines and requirements and relevant Aboriginal groups consulted. The following information will be included in the Aboriginal Heritage Management Plan:
 - Current use of site;
 - Prospective use of site;
 - Presentation of site;
 - What is significant about the site;
 - Strategies for maintenance, protection and monitoring of the site;
 - Current threats and how these can be solved;
 - Potential threats and how these could be prevented;
 - Cause of the threat and how the cause can be eliminated;
 - Management of the site; and
 - Performance monitoring and reporting.

5.6. Aboriginal Skeletal/Ancestral Remains

Aboriginal skeletal/ancestral remains are of great significance to Aboriginal people, who feel strongly about the removal of remains from grave sites. If a burial site or Aboriginal remains are found during ground disturbing activity the following actions will be taken:

1. Ground disturbing activity in the area will be stopped immediately. The site will be barricaded to prevent further inadvertent access or disturbance.
2. The Police and Registrar will be notified immediately.
3. Detailed photographs will be taken of the skull (front, back, left, right, top and bottom) without further disturbing the site to help with identification. Photographs will also be taken of the general area.
4. The location of the remains will be recorded in the Project GIS database.
5. The Police will investigate the site as soon as possible.

6. Upon notification that the remains are of Aboriginal origin and not a matter for further Police involvement, the Registrar will seek the immediate involvement of the relevant Aboriginal people. If it is necessary to disturb the remains for the purpose of identification this will be undertaken by a qualified archaeologist or forensic specialist.
7. MRC will develop, in consultation with the DLHP and relevant Aboriginal people, an appropriate action plan for the management of the remains. The following options will be considered during the development of the action plan:
 - Leave the remains in situ if they have not been disturbed or disturbance has been minimal;
 - Rebury in the same place if the burial has only been partially disturbed and activity at the site can be halted permanently;
 - Rebury as close as possible to the location at which the remains were found where the risk of future re-disturbance is minimised; and
 - Rebury in a gazetted cemetery or keeping place if disturbance in the area is unavoidable.
8. The Registrar will ensure that the burial place is recorded and placed on the Register of Aboriginal Sites.
9. The Registrar will ensure that the burial place is reported to the Commonwealth Minister for Indigenous Affairs, in accordance with the legal requirements under the *Aboriginal and Torres Strait Islander Protection Act 1984*.
10. If MRC wishes to carry on activity in the area they will lodge an application to use the land. The Section 18 Notice will be prepared by a suitably qualified consultant with relevant experience. The application and supporting documentation will be prepared in accordance with the requirements of the Guidelines for Preparing Reports for Application to the Aboriginal Cultural Material Committee Under Section 18 of the *Aboriginal Heritage Act 1972*. The following information will be included in the application:
 - Description of proposed activities;
 - Summary of previously reported Aboriginal sites;
 - Review of previous heritage survey reports and other research materials;
 - Description of methodology used during the survey;
 - Acknowledgements and list of survey participants;
 - Thorough description of Aboriginal site(s);
 - Relevant information about the importance and significance of any Aboriginal sites, taking into account the criteria referred to in Section 5 and 39 (2) of the *Aboriginal Heritage Act 1972*;
 - Detailed description of the effect or potential effect of a proposed land use(s) on the cultural heritage values of Aboriginal sites;
 - Measures that might be taken to avoid or minimise the impact on affected places; and
 - Recommendation on whether or not the Minister should consent to the use of the land and, where applicable, the extent to which and conditions upon which consent should be given.

5.7. Reporting damage to sites and other heritage areas

A heritage site is disturbed when it is excavated, destroyed, damaged, concealed, or in any way altered without prior authorisation of the Registrar and/or consent of the Minister.

The AHA protects places and objects that may be of importance and significance to people of Aboriginal descent in Western Australia. These places and objects may be identified as a site and recorded on the Register of Aboriginal sites. All sites are protected under the AHA whether or not they are recorded on the Register. Under section 17 of the AHA it is an offence to disturb a site. In the

unlikely event that there is an alleged disturbance of an Aboriginal site associated with MRC's operations, MRC will take the following actions:

1. Ground disturbing activity in the area will be stopped immediately. The site will be barricaded off to prevent further inadvertent access or disturbance.
2. An incident report will be prepared in consultation with the person who reported the disturbance.
3. The DLHP will be contacted as soon as possible to notify them of the alleged disturbance.
4. A thorough internal incident investigation will be carried out.

Disturbing an Aboriginal site is an offence against the AHA and may lead to legal action. In the case of a disturbance by an individual, penalties comprise fines from \$ 20,000 to \$ 40,000 and imprisonment for nine months to two years and a daily penalty of \$400. A disturbance by a body corporate may result in penalties that comprise fines ranging from \$50,000 to \$100,000 and a daily penalty of \$1,000.

6. Community Engagement

While Native Title (WC1996/064) was found to be extinguished by past activities within M74/245, Native Title has been found to occur in other areas. ETNTAC is an organisation registered under the *Corporations (Aboriginal and Torres Strait Islander) Act 2006*. ETNTAC is the registered Native Title body corporate in the Esperance Region, representing the Esperance Nyungar People. Native title over this area was recognised in the Esperance Nyungar native title consent determination. This determination was negotiated for eighteen years when agreement was reached, and all parties recognised the Esperance Nyungar People's native title rights over the determination area. To facilitate the use of land within E74/565 where native title has not been extinguished, the tenement holders of E74/565 has entered into a formal agreement with the ETNTAC.

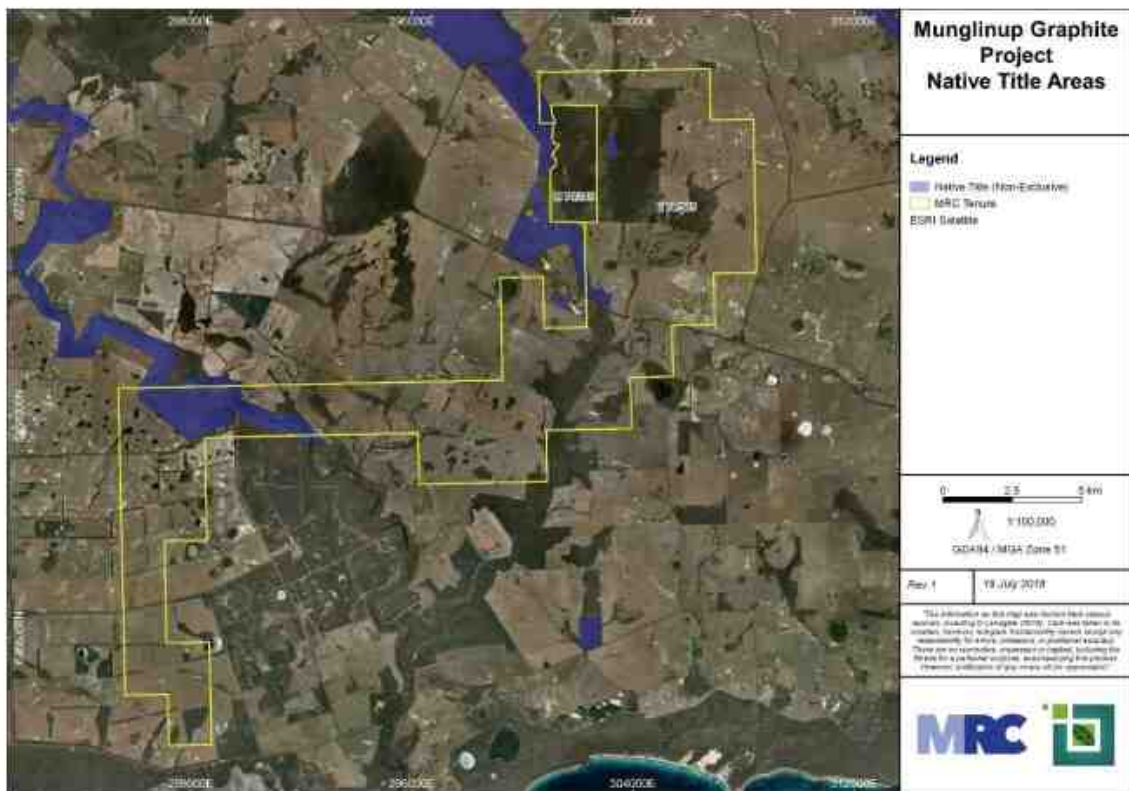


Figure 5 Munglinup Graphite Tenure and Area of Non Exclusion Native Title

7. Review

The Aboriginal Cultural Heritage Plan will be reviewed as required, including when:

- there is a significant change proposed to the Project such as an expansion which may require further aboriginal heritage surveys and increase the likelihood of identification of new Aboriginal sites;
- there is a change in legislation relating to the identification and protection of Aboriginal sites; or
- Annually, by the environmental advisor.

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APPENDIX H: ENVIRONMENTAL MONITORING PLAN (DRAFT)



MRC GRAPHITE PTY LTD



MUNGLINUP GRAPHITE ENVIRONMENTAL MONITORING PLAN

Prepared by Integrate Sustainability

Document Control

Version	Author	Date of Issue
Version 1	Integrate Sustainability Pty Ltd	
Version 2		
Version 3		

DRAFT

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1. Overview

The Environmental Monitoring Plan contained within this document provides an overview of all environmental monitoring that will occur over the life of the MRC Munglinup Graphite Project (Project). The actual monitoring methods may change over the life of the Project as more appropriate technologies and methodologies become available.

2. Purpose

Conducting environmental monitoring allows for quantitative risk-based analysis of a Project's impact and is a key component within an Environmental Management System. The purpose of this document is to outline the environmental monitoring activities which are undertaken for the Project.

3. Scope

The scope of this monitoring plan applies to the Mineral Commodities Limited (MRC) Munglinup Graphite Project (Project), and include mining lease M74/245 and exploration lease E74/565. These areas are referred to as the "monitoring area". This Environmental Monitoring Plan is applicable to all activities associated with the Project from exploration through to closure.

4. Background

The Munglinup Graphite Project is located 105km west of Esperance, 85km east of Ravensthorpe and 4km north of the town of Munglinup in the south coast region of Western Australia. It is located on the Esperance side of the Esperance/Ravensthorpe boarder. The Project is located within the Esperance Plains IBRA region and the Recherche IBRA sub-region. Monitoring activities have been selected following the completion of baseline environmental studies that have identified potential risks to environmental values from the Project. The environmental studies completed within the Project area are presented in Table 1.

Table 1 Current Baseline Surveys

Report Title	Consultant	Date	Survey Target
Munglinup Graphite Flora and Fauna Assessment	Ecologia	December 2015	Fauna, Flora and Vegetation
Munglinup Complementary Fauna Assessment – Munglinup Graphite Project	Red Dog Environmental	April 2018	Fauna Assessment
Munglinup Terrestrial Vertebrate Fauna – Fauna Assessment	Biostat Pty Ltd	July 2018	Fauna Assessment
Munglinup Graphite Project Flora and Vegetation Assessment – Interim Report	Woodman Environmental	August 2018	Proteaceae Dominated Kwongan Shrublands of the southeast coastal floristic province of Western Australia and <i>Rhizanthella johnstonii</i>

5. Legal Requirements

There are several acts, regulations and other requirements that should be considered during the life of the Project. The most significant documents are summarised in **Error! Reference source not found.**Table 2.

Table 2 Relevant Legislation

Name	Application	Responsible Agency
Aboriginal Heritage Act 1972 (WA)	Preservation of the places and objects customarily used by or traditional to the original inhabitant of Australia or their dependents. Requirement to report known or suspected heritage sites.	Department of Aboriginal Affairs
Biodiversity Conservation Act 2016	The Biodiversity Conservation Act 2016 provides for; • The conservation and protection of biodiversity and biodiversity components in Western Australia; • The ecologically sustainable use of biodiversity components in WA; and • The repeal of the <i>Wildlife Conservation Act 1950</i> and <i>Sandalwood Act 1929</i>.	Department of Biodiversity, Conservation and Attractions (DBCA)
Contaminated Sites Act 2003 (WA)	The <i>Contaminated Sites Act 2003</i> provides for the identification, recording, management and remediation of contaminated sites. A site is considered contaminated if it has 'a substance present ... at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value'. Various facilities and activities associated with different stages of the life of the Project have the potential to generate a contaminated site under this Act. MRC will appropriately manage its obligations under the act, particularly in regard to: • Bulk hydrocarbon storage; • Waste rock dumps and low-grade ore stockpiles; and • The tailings storage facility.	Department of Water and Environmental Regulation (DWER)
Dangerous Goods Safety Act 2004 (WA)	<i>Dangerous Goods and Safety Act 2004</i> relates to the safe storage, handling and transport of dangerous goods and related purposes. The Act indicates those activities and substances which require licensing prior to use, storage or transport. The aim of the Act is to reduce or minimise risk from dangerous goods. Several substances used on the Project will require management under this Act and its associated regulations. For example: • Hydrocarbons (e.g. diesel fuel). The Project will need to ensure certain activities and substances that require licensing are identified. Places where dangerous goods are stored or handled or transported must also be licensed under this Act.	Department of Mines, Industry Regulation and Safety (DMIRS)

<i>Mining Act 1978 (WA)</i>	The <i>Mining Act 1978</i> is the key piece of legislation for all mineral exploration and mining activities in WA. The Act covers all aspects relating to obtaining prospecting licenses, exploration and mining leases, obtaining access to land for mineral activities, bonds and expenditure. Conforming to Tenement Conditions, Mining Proposal and Program of Work requirements under this Act will be crucial for all phases of the Project.	DMIRS
<i>Environmental Protection Act 1986 (WA)</i>	The <i>Environmental Protection Act 1986</i> (EP Act) provides for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing	DWER, DMIRS (delegated responsibility)
<i>Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)</i>	The <i>Environmental Protection Regulations 2004</i> relates to the Projects procedures and protocols for the clearing of native vegetation for development activities.	DWER, DMIRS (delegated responsibility)
<i>Environmental Protection Regulations 1987 (WA)</i>	The <i>Environmental Protection Regulations 1987</i> has guidance on the control of pollution and required monitoring. It stipulates penalties and infringements for environmental pollution and harm offences.	DWER, DMIRS (delegated responsibility)
<i>Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i>	The <i>Environment Protection and Biodiversity Conservation Act 1999</i> (the EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as matters of national environmental significance. The EPBC Act enables the Federal Government to join with the states and territories in providing a truly national scheme of environment and heritage protection and biodiversity conservation.	Department of Environment and Energy (DoEE)
<i>Rights in Water and Irrigation Act 1914 (WA)</i>	The <i>Rights in Water and Irrigation Act 1914</i> provides for the planning, regulation, management, protection and allocation of water resources in Western Australia. The objectives of the legislation include providing for the management, sustainable use and development of water resources to meet the needs of current and future users, and for the protection of their ecosystems and the environment in which water resources are situated. The Act provides for the permanent transfer of a licence or water entitlement (i.e. part of a licence), and also temporary transfer (called agreements with licensees).	Department of Water
<i>Wildlife Conservation Act 1950 (WA)</i>	The <i>Wildlife Conservation Act 1950</i> (WC Act) is a key piece of legislation in the protection and conservation of all native flora, vegetation and fauna within WA. Under the Act, the Minister may declare any flora and fauna to be specifically	Department of Biodiversity, Conservation and

	listed as threatened, rare or extinct. These lists of specially protected species are regularly updated and published in the Government Gazette. Note: This Act will be replaced by the <i>Biodiversity Conservation Act 2016</i> during 2019.	Attractions (DBCA)
National Pollution Inventory	The National Pollutant Inventory (NPI) provides the community, industry and government with information regarding substance emissions in Australia. The NPI is tracking pollution across Australia, and ensuring that the community has access to information about the emission and transfer of toxic substances which may affect them locally. The desired environmental outcomes of the NPI program are to: • maintain and improve air and water quality; • minimise environmental impacts associated with hazardous waste; and • improve the sustainable use of resources.	Department of Environment and Energy (DoEE)

5.1 Other Requirements and Considerations

Department of the Environment and Energy Priority List

Species or communities recognised under the Department of the Environment and Energy (DoEE) Priority scheme. If a species does not meet the criteria for listing as Threatened Fauna or Declared Rare Flora under the WC Act (e.g. due to lack of information) and is poorly known and/or conservation dependent, it may be classified as a Priority Species at the discretion of the DoEE. Priority species are not provided any extra protection to other native species in Western Australia. The listing of a species or a community as a Priority indicates that activities which may impact them require special consideration. A similar program exists for Priority Ecological Communities.

6. Roles and Responsibilities

The **Managing Director** is responsible for:

- Demonstrating leadership and commitment to the achievement of the Company's environmental objectives through the implementation on this monitoring plan; and
- Ensuring that the required resources are allocated to fulfil the requirements of this monitoring plan.

The **Site Supervisor** is responsible for:

- Coordinating the monitoring activities as outlined in this plan;
- Providing adequate training and direction to external monitoring technicians to ensure they have a safe system of work as they undertake monitoring activities; and
- Auditing the safety performance of external monitoring technicians when applicable.

The **Environmental Supervisor** is responsible for:

- Providing training and guidance on health and safety and auditing of external monitoring technicians, where applicable, to ensure understanding of methodologies and protocols for the collection of environmental baseline data;
- Delegation of monitoring activities between external monitoring technicians and internal MRC monitoring technicians;
- Ensuring that required baseline monitoring is carried out as per the requirements of this Plan;
- Reviewing the monitoring data collected and reporting to Management when significant environmental risks is identified; and
- Reporting the occurrence of conservation significant species to relevant State and Federal Government agencies.

7. Hazard and Risk Management

MRC values the provision of a safe work environment for all employees, contractors and visitors. Compliance with hazard and risk management processes must occur for all personnel carrying out monitoring activities at the Project.

These processes include:

- Journey Management
- Hazard Identification / JHAs
- Training competency
- Fitness for work
- Dieback Management

8. Summary of Monitoring Activities

Table 3 Summary of Monitoring Activities

Parameter	Monitoring Requirement	Purpose	Method	Monitoring Frequency
Meteorological Monitoring				
Weather Data	Monitor local weather in terms of rainfall, air temperature, relative humidity, wind speed and solar radiation	Assist in planning, calculations and environmental variation	Gather information from the Munglinup Weather Station	Weekly
Groundwater Monitoring				
TSF – Groundwater Characteristics	Monitor piezometers within the TSF	Monitor phreatic surface	Piezometer	Monthly
	Monitor bores in the TSF embankment and downstream of the embankment	Assess TSF seepage	Monitor Water Level	Monthly
			Monitor Water Quality	Quarterly
Site - Groundwater Characteristics	Monitor groundwater levels, quantity and quality (including groundwater and recharge monitoring against modelling) on site.	Assess impacts to groundwater and to assess pressure changes over the life of the project.	Monitor bores for water level and abstraction rate	Monthly
			Monitor bores for water quality	Quarterly
	Monitor the drawdown effect over the life of the Project to determine if the operations are affecting the local groundwater supply beyond what was modelled.	Assess impacts of dewatering on groundwater levels. Indicator for impact to vegetation, flora and terrestrial fauna habitat. Assess accuracy of predicted recharge during operations.	Monitor mining area bores for water level and abstraction rate (inside and outside the operational footprint).	Quarterly
Groundwater Usage	Monitor groundwater abstraction volumes (flow meter readings).	Record groundwater abstraction volumes	Flow meter readings	Monthly
Surface Water Monitoring				
Surface Water Characteristics	Monitor surface water depth and observations of river condition and aquatic fauna	Assess the potential impact on water quality and environmental values	Monitor water depth Visual observations	Weekly
	Monitor surface water quality.	Assess the potential impact on water quality and environmental values	Monitor water quality	Monthly
	Monitor surface water quality during or after storm events			during or after storm events
Surface Water Quality	Monitor pit water quality post operations	Assess the water quality water post rehabilitation and closure	Monitoring of pit water post rehabilitation and closure.	Biannually for first 3 years then annually

Parameter	Monitoring Requirement	Purpose	Method	Monitoring Frequency
				until return of site to state
	Monitor run-off (waste landforms) in the collection point following significant rain events.	To determine if management strategies are working.	Monitor surface water quality in collection points.	Following rain events of over 20mm in 24 hr or when surface water is observed in collection ponds.
Dewatering Discharge				
Dewatering	If relevant. Monitor point source emissions to surface water / groundwater / environment	Assess the water quality	Monitor water quality	Monthly
Air Quality				
Dust	Monitor dust emissions from construction in areas at high risk of dust.	Assess dust levels and compliance with environmental and health guidelines	Dust monitoring stations	Monthly
	Monitor dust emissions at TEC	Assess dust generation from internal traffic at TEC areas		Quarterly
Emissions	Monitor GHG emissions across the site as required by NGERS and NPI	Assess fuel usage and other air emissions that contribute to GHG emissions	Electricity and fuel usage	Monthly
Flora and Vegetation				
Flora and Vegetation Condition	Monitor vegetation and flora adjacent to the Project and road corridor to identify indirect impacts e.g. dust (both internal and Mine Access Road).	To quantitatively determine level of decline/impact for flora and vegetation within a predetermined buffer area.	Remote sensing, photo points and physical flora and vegetation survey including indicator species ¹ within monitoring sites of potentially impacted areas outside of the Project footprint (within a 200 m buffer of the Operational Area footprint and a 100 m buffer of the Mine Access Road and Water Supply	Annually with additional photo monitoring – Quarterly during construction and six monthly during operations.

Parameter	Monitoring Requirement	Purpose	Method	Monitoring Frequency
			Area infrastructure) as well as reference sites that are not subject to Project impacts.	
	Monitor Project footprint boundaries	To ensure clearing boundaries are clearly marked and that there are no breaches in boundaries (e.g. unauthorised clearing, off road driving).	Visual inspection of clearing boundaries.	Fortnightly check during construction. Annually during operation.
			Reconciliation between satellite (and other) imagery and project GIS data.	Annually
Presence, distribution, abundance and density/cover of invasive flora	Assessment of weeds present including: species, their distribution, abundance and density/cover of weeds.	Monitor the introduction of weeds to determine if weed treatment is required.	Visual inspection for weeds at known locations in and around the Project footprint and at high risk areas (e.g. the airport and rest stops on Mine Access Road). Annual vegetation monitoring sites will include the collection of weed data (if present in monitoring sites).	Annually and six weeks after significant rainfall events (>20mm)
	Monitor weed presence within the Project area and on roadsides.	To ensure weeds do not spread from known locations and high-risk areas.	Visual inspection for weeds at known locations in and around the Project footprint and at high risk areas. Satellite or 'similar' imagery will be utilised.	Annually and six weeks after significant rainfall events (>20mm)
	Monitor weed hygiene compliance.	To ensure that weed hygiene measures are being adhered to	Random check of compliance by subcontractor	As Required

Parameter	Monitoring Requirement	Purpose	Method	Monitoring Frequency
Clearing	Tracking of clearing and cleared areas against approval.	Maintain a record of the total area cleared	Combination of aerial imagery and on ground activities	Monthly / Annually
Rehabilitation	Monitor vegetation establishment in rehabilitated areas	To identify the attainment of successful rehabilitation stages	Combination of remote sensing and visual assessments will be used to assess factors such as soil condition, vegetation stability and establishment appropriate to the establishment of rehabilitation	Annually
	Following rehabilitation, areas will be monitored and treated for invasive flora invasion, if necessary.	To assess the occurrence of invasive flora in rehabilitated areas.	Visual inspection for weeds in rehabilitated areas	Annually
	Rehabilitated areas	Maintain a record of the total area rehabilitated	Combination of aerial imagery and on ground activities	Monthly / Annually
Closure	Compliance with closure criteria	To track progress with meeting closure criteria and ensuring Project compliance with environmental requirements.	Administrative	Biannually (post operations)
Fauna				
Fauna health, injury and mortality	Monitor use of TSF by fauna (particularly birds).	To ensure contaminants from the TSF are not impacting native fauna and to prevent entrapment/ death at the TSF.	Visual inspections of fauna utilising the TSF.	Daily
	Monitor presence of fauna (particularly birds) at potentially contaminated and potable water ponds	To prevent fauna entrapment/death in ponds and to ensure contaminants are not impacting native fauna.	Visual inspections of fauna utilising ponds in the mining area.	Daily
	Inspections of trenches during construction and other high-risk areas to identify and release entrapped fauna.	To prevent fauna entrapment/death in trenches.	Visual inspection of trenches while trenches are open. Records will be kept of all fauna removed and any deaths.	Twice-daily or more frequently if the weather requires

Parameter	Monitoring Requirement	Purpose	Method	Monitoring Frequency
Threatened Fauna Population	Monitor impacts to threatened species identified in the Munglinup Graphite Threatened Species and Communities Environmental Monitoring Plan	To assess whether Project operations (including clearing, pit excavation, noise, and vibration) has impacted the identified species populations.	Monitoring methods to be created and individualised for each species.	To be developed
Introduced Fauna	Monitor the abundance of invasive fauna populations.	Monitor the introduction/ spread of fauna to determine if fauna control is required.	Visual inspections of village and mine for evidence of feral animals, observations to be recorded in the Project's feral animal register.	Quarterly
Waste				
Recyclable Material Volumes	Record volumes of recyclable material leaving site.	To track recyclable material leaving site.	Tracking system	Monthly or as required
Controlled Waste Volumes	Record volumes of recyclable material leaving site.	To track recyclable material leaving site.	Tracking system	As Removed
Soil				
Topsoil	Measure / record volumes of topsoil	To ensure the volume available meets rehabilitation requirements.	Tracking system and regular inspection. Survey of topsoil stockpiles.	Monthly

9. Document Change and Review

A review shall be carried out to ensure the content of this plan is still applicable, current and practicable. A review should be undertaken regularly (every two years), following the change in legal requirements, when significant changes to the Project's operations occur or site closure.

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