NATIVE VEGETATION CLEARING

(PURPOSE) PERMIT APPLICATION
CANE RIVER SAND PROJECT

ASHBURTON SHIRE, WESTERN AUSTRALIA

Proponent:	Geoffrey Ross Ladyman
Tenement Holder:	Geoffrey Ross Ladyman (M08/546)
Physical Address:	Unit 3/6 McNamara Way, Cottesloe, WA 6011
Postal Address:	PO Box 613, Cottesloe, WA 6911
Key Contact:	Tony Smith
	stwrtgarden@gmail.com

Prepared for GR Ladyman by:

Stewart Garden Pty Ltd

Email: stwrtgarden@gmail.com

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1 Tenement Holder / Authorisation

1.1 Prospecting Licence Holder

This Native Vegetation Clearing (Purpose) Permit (NVCP) application is submitted in order to authorise clearing for mining, mineral exploration and associated activities on mining lease M08/546.

The holder of the prospecting licence is Geoffrey Ross Ladyman – details provided below in Table 1-1.

Table 1-1: GR Ladyman Prospecting Licence

Tenement	Commence	Expiry	Holder
M08/546	28/11/2023	27/11/2044	Geoffrey Ross Ladyman ABN 26 139 459 094 Unit 3/6 McNamara Way, Cottesloe, WA 6011 PO Box 613, Cottesloe, WA 6911

Tenement appraisal and summary reports are provided in Appendix 1 as evidence of ownership.

1.2 Authorisation

Geoffrey Ross Ladyman is the holder of the mining lease M08/546.

Stewart Garden Pty Ltd is authorised by Geoffrey Ross Ladyman to undertake environmental approvals applications.

A signed letter of authorisation is attached in Appendix 2.

2 Proposal Description

2.1 Mining Description

Mining and exploration activities are proposed on M08/546 when relevant approvals are attained. Areas of sand will be excavated where there is little or no vegetation (Plate A). Excavation of sand will not occur below the water table. If groundwater is intercepted sand excavation in that area shall cease immediately.

Mining will be conducted on a campaign basis, generally between July and December when the sand is likely to be driest (it is difficult to screen when it is damp).

Two to three people will use medium sized earth moving equipment to conduct the mining. The sand mining process is simply excavating the sand down to the hard clay bed underlying the sand using a front-end loader or excavator. The sand is loaded directly onto an articulated dump truck, which then carts the raw sandy material to a laydown on the adjacent tenement M08/69, where it is stockpiled. Up to 2,000 t of sand may be mined, carted and stockpiled per day.

Plate A: Open riverbed featuring vegetation community VTb

2.2 Biological Survey

A biological survey was undertaken by Animal Plant Mineral Pty Ltd during 2022. The survey undertook flora, vegetation and fauna assessments in accordance with EPA guidance documents and best practice survey methods.

The biological survey report is attached as Appendix 3. The biological survey report provides a comprehensive summary of existing environmental conditions and the context of the area under assessment.

2.3 Clearing

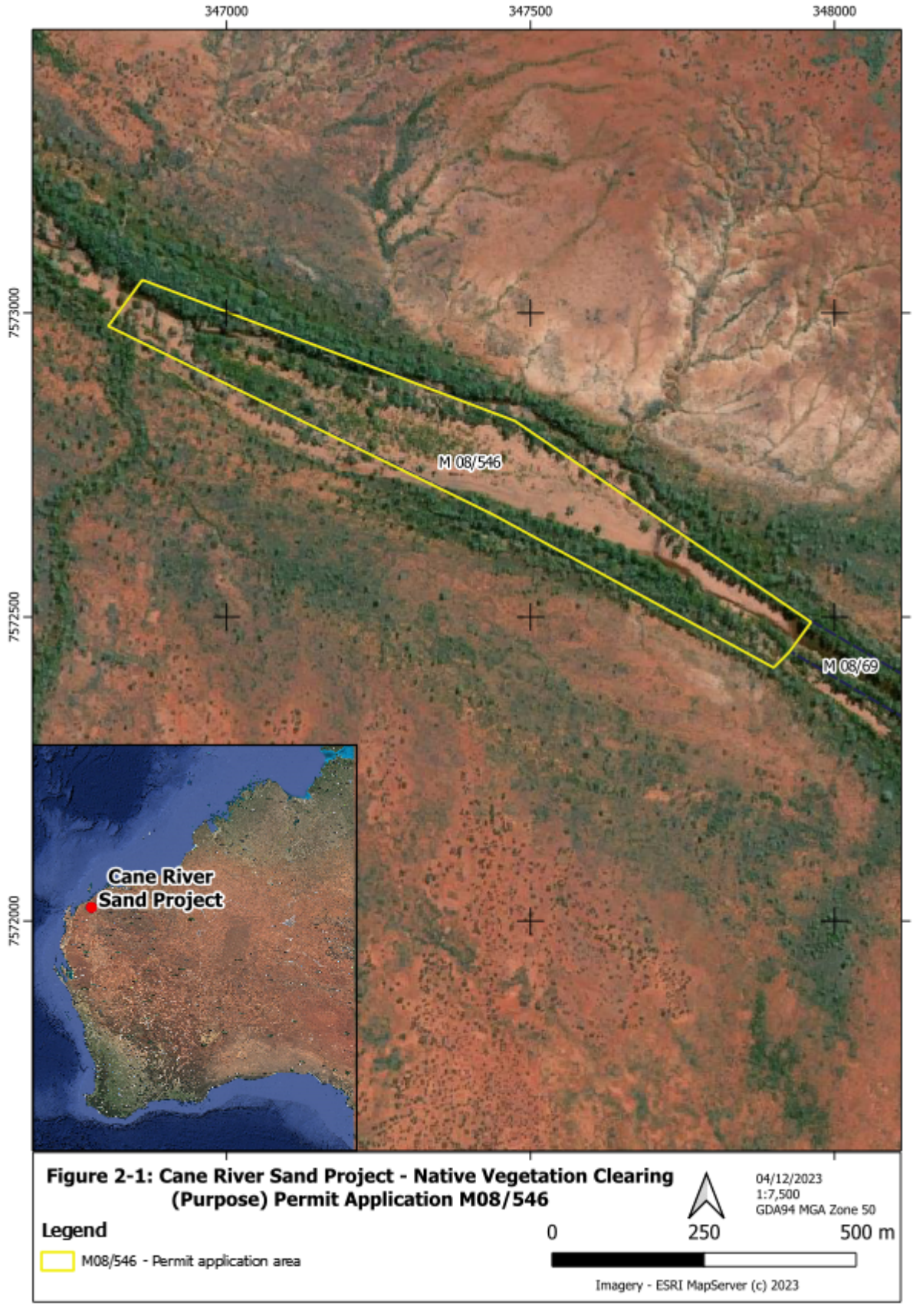
It is proposed to undertake clearing within the boundaries of the mining lease M08/546 (Figure 2-1). The total area of the prospecting licence is 15.28 ha. This is regarded as the purpose permit application area.

Within this area up to 6.0 ha of vegetation is proposed to be cleared for the purposes of sand mining and associated activities.

The clearing will predominately occur within the VTb vegetation community that corresponds closely with the FH2 Fluvial Habitat (Plate B) described in the fauna section of the biological report.

Plate B: FH2: Fluvial Zone Habitat

Figure 2-1: Cane River Sand Project - Native Vegetation Clearing (Purpose) Permit Application Area M08/546



3 Existing Environment

3.1 Regional setting

The Project is located with the Shire of Ashburton, in the Pilbara region of Western Australia, approximately 66 km south-east of Onslow on the Cane River.

3.2 Climate

The climate is arid, semi-desert tropical with highly variable rainfall, particularly occurring over summer. Significant cyclonic activity occurs annually, where several systems affect the coast and hinterland (Kendrick & Stanley, 2001).

The nearest Bureau of Meteorology (BoM) weather station with a long historical record is at Onslow Airport (BoM Site Number: 005017), approximately 56 km southeast of the Survey Area. Onslow Airport has recorded rainfall from 1940 to 2022 (82 years), and temperature from 1943 to 2022 (79 years). Average monthly rainfall, maximum and minimum temperatures recorded at station 005017 are shown in Figure 3-1. Monthly mean maximum temperature ranges from 36.5°C in January to 25.6°C in July. Monthly mean rainfall ranges from 70 mm in March to 0.8 mm in October, with a mean annual rainfall of 303.8 mm (BoM 2022).

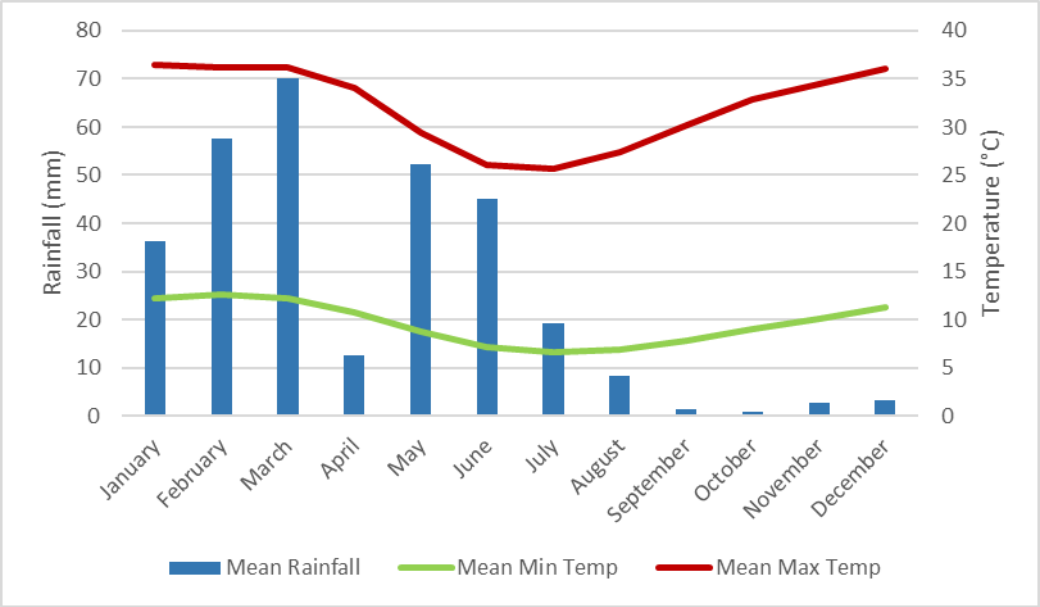


Figure 3-1: Temperature and rainfall averages for Onslow Airport weather station (Station No. 005017) (BoM 2022).

3.3 Biogeographic regionalisation

The Interim Biogeographic Regionalisation for Australia (IBRA, version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (Thackway and Cresswell 1995). The mapping completed by Beard (1975), provides the basis for the IBRA bioregions. IBRA mapping (Version 7), places the Project within the Pilbara bioregion.

The Pilbara Bioregion is further subdivided into the Chichester, Fortescue, Hamersley and Roebourne sub-regions. The Project lies entirely within the Roebourne sub-region.

The Roebourne sub-region comprises of quaternary alluvial and older colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera* (Kendrick & Stanley, 2001). Uplands are dominated by *Triodia* hummock grasslands and ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands (Kendrick & Stanley, 2001).

3.4 Land systems

Land Systems of the Pilbara region are described by van Vreeswyk et al. (2004). Mapping of Land Systems is available from Department of Primary Industry and Regional Development ((DPIRD) 2019). The prospecting licences fall within the Cane land system. It is described as:

> *'Flood plains, stony alluvial plains and river channels; non-saline and weakly saline clayey soils.'*

The vegetation of the Cane land system is described as:

> *'Alluvial plains and flood plains supporting snakewood shrublands, soft and hard spinifex grasslands and tussock grasslands.'*

3.5 Regional vegetation

The prospecting licences are located within the Eremaean Botanical Province. The remaining extent of the vegetation association is presented in the most recent Department of Biodiversity, Conservation and Attractions (DBCA) Statewide Vegetation Statistics table dated 2018 and outlined in Table 3-1 below.

Vegetation associations within the Survey Area generally have over 99% pre-European Vegetation extent remaining. Conservation significance ranking of vegetation associations occurring within the Survey Area are of 'Least Concern'.

Table 3-1: Vegetation associations of the permit application area

Vegetation Association	Vegetation Description	Pre-European Extent (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent within DBCA Managed Lands (%)
605	Hummock grasslands, shrub steppe; *Acacia pachycarpa* & waterwood over soft spinifex	114,116	114,116	100	0.36

3.6 Surface water

The Cane River is a significant drainage system that spans approximately 400 km and has a catchment area of approximately 2,290 km^2. The drainage pattern for the Cane River is considered to be dendritic, with no major tributaries (Ruprecht & Ivanescu, 2000).

The Cane River discharges onto tidal flats adjacent to the Indian Ocean on the Onslow Coastal Plain, 35 km north-east of the Onslow townsite.

No permanent pools have been identified within the Cane River, and are mostly intermittent in nature, only occurring during the wetter years, however, one semi-permanent pool (Jabaddar Pool) has been identified (Department of Water, 2011). This semi-permanent pool is within the furthest southern portion of tenement P08/801, with its size and capacity varying depending on the seasonal conditions. This is approximately 3.5 kilometres upstream of the M08/546 permit application area.

3.7 Environmentally significant areas

3.7.1 Conservation Estate

The Western Australian Conservation Estate includes land and waters vested in the Conservation and Parks Commission under the *Conservation and Land Management Act 1984*. The Conservation Estate is generally managed by the Parks and Wildlife Service of DBCA to protect Western Australia's biodiversity, and includes National Parks, Nature Reserves, Conservation Reserves, and other areas managed primarily for biodiversity conservation (Department of the Environment and Energy, 2016).

A search of the Collaborative Australian Protected Area Database returned one gazetted area located within 50 km of the permit application area. This is the 'Class A' Cane River Conservation Park. Two areas are in the process of being gazetted and will be an expansion of the Cane River Conservation Park. These include ex Mount Minnie Station, less than a kilometre to the west and ex Nanutarra Station, 30 km to the south of the permit application areas.

3.7.2 Environmentally Sensitive Areas

There are no Environmentally Sensitive Areas within the permit application area.

There are no wetlands listed in the Directory of Important Wetlands within 500 km of the permit application area.

4 Consideration of the Ten Clearing Principles

Principles for clearing native vegetation are provide under Schedule 5 of the *Environmental Protection Act 1986.* The principles must be considered in the assessment of the clearing permit application. The principles are presented below with a statement providing the context of the permit application area.

a) Native vegetation should not be cleared if it comprises a high level of biological diversity

The vegetation subject to clearing (vegetation type VTb) is comprised of *Eucalyptus camaldulensis*, *Melaleuca argentea* low open woodland; *Melaleuca glomerata*, *Acacia trachycarpa*, *Vachellia farnesiana* tall sparse shrubland; *Cyperus vaginatus*, *Dichanthium sericeum* subsp.*sericeum, Eragrostis tenellula* low isolated tussock grasses/sedges.

The diversity within the VTb vegetation type is not particularly high and is well represented outside of the permit application area along the stream flow areas of the Cane River. The application is not at variance with this clearing principle.

b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia

The native vegetation that is proposed for clearing comprises vegetation type VTb and the Fluvial Habitat Zone FH2. The Fluvial zone of the main channel consists of loose gravelly/stony and coarse alluvial sand substrate. This is the active river channel and substrate is moved and disturbed during flood periods. There is very little vegetation in this zone. *Melaleuca argentea*, *M.glomerata* and A*cacia trachycarpa* seedlings are present, however they do not establish as successive flooding disturbs the habitat and prohibits establishment of deep-rooted woody vegetation. Short-lived ephemeral grasses and herbs occur scattered through this zone which complete their life cycle within the interflow period.

Surface water is seasonally available and during periods of inundation, shallow wading habitat, shallow pools and perches overhanging flowing and still water are present. These dry out to sandy bare river-beds during the dry season. This habitat is not exclusive to the permit application area and it is likely this habitat will re-establish following clearing.

No clearing of adjacent habitat, FH3 (parafluvial zone/riverine margins), FH4 (floodplains) and FH5 (clay breakaways) is proposed. This habitat is consistent with habitats described as critical for survival of conservation significant species (Northern Quoll, Pilbara Olive Python).

c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora

No rare, threatened or priority flora were found within the permit application area during targeted survey (APM 2022).

d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community

There are no Threatened Ecological Communities listed under the *Environmental Protection and Biodiversity Conservation Act 1999* or the *Biodiversity Conservation Act 2016* known to occur with the permit application area (APM 2022).

e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared

Vegetation is contiguous along the Cane River and should not be considered a remnant. Vegetation associations within the permit application area generally have over 99% pre-European vegetation extent remaining (APM 2022, page 16).

f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland

The vegetation identified for removal is located within the active stream-flow area of the Cane River. The vegetation is generally saplings and grasses associated with germination in between flow events. This vegetation establishes quickly, but is also subject to removal during flow events by substrate movement and desiccation. All vegetation within the permit application area with a diameter at chest height of >100 mm will be retained and no clearing will be conducted within three metres of a trunk of that diameter or within the dripline of their canopy. Trees with a trunk diameter of between 50 and 100 mm will be avoided where possible.

g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation

The clearing of vegetation is for the purposes of sand extraction. All clearing is proposed to be within the dynamic stream flow areas of the application area. These areas are generally comprised of small saplings and grasses as they are subject to removal by natural flow events. No bank clearing is proposed, so there is no clearing of vegetation on the riparian margin. The dynamic nature of the water course from which the sand will be extracted lends itself to replenishment of sand during flow events. There will be no appreciable land degradation related to the proposed clearing.

h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area

The permit application area is not within a conservation area. The nearest conservation area is the Cane River Conservation Park approximately 3 km to the south of the permit application area of M08/546. The permit application area is downstream of the Cane River Conservation Park and clearing within the permit application area is not likely to have any impact on the conservation area.

The proposed Cane River (Mount Minnie and Nanutarra) reserve is approximately 1 kilometre to the south of the permit application area. The Cane River does not intersect with the Mount Minnie/ Nanutarra block downstream so clearing is not likely to have any impact on this area.

i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water

No water is to be taken from within the permit application area and proposed clearing is unlikely to impact recharge of groundwater.

The Cane River flows intermittently as a result of cloud bursts and high intensity rainfall events upstream. River flows are very turbid and carrying significant amount of suspended solids which continually fall out of suspension and are reanimated during flow events. The clearing may enable the mobilisation of sand, however significant amounts of sand will also be deposited in cleared areas. The water quality associated with river flow events is unlikely to be significantly impacted.

j) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding

The Cane River is subject to intermittent flows, often featuring over-the-bank flows as a result of rain events upstream. The proposed 6.0 hectares of clearing is unlikely to materially alter the propensity for flooding within or surrounding the permit application area.

5 References

References appear within Appendix 3 – APM 2022 Biological Survey Report.

6 Appendices

Appendix 1: Tenement Appraisal and Reports Demonstrating Ownership

MINING TENEMENT DETAILS REPORT

DISCLAIMER: This is not the official Register referred to in Reg. 84C of the Mining Regulations 1981.

MINING LEASE 08/546

Tenement Summary

Identifier : M 08/546
District : ASHBURTON M.F.
Current Area : 15.28428 HA
Status : Live
Mark Out : 05/04/2023 15:20:00
Received : 11/04/2023 15:39:05
Term Granted : 21 Years
Lodging Office : ONLINE
Commence : 28/11/2023
Expiry : 27/11/2044
Purpose :
Death :

OWNERSHIP DETAILS

Current Holders

Name and Address	Shares
LADYMAN, Geoffrey Ross C/- M & M WALTER CONSULTING, PO BOX 8197, SUBIACO EAST, WA, 6008, xxxxx@mmwc.com.au, xxxxxxxxx866	100
Total Shares:	**100**

Holder Changes

Dealing	Status Date	From (Shares)	To (Shares)

Applicants on Receival

Name and Address	Shares
LADYMAN, Geoffrey Ross C/- M & M WALTER CONSULTING, PO BOX 8197, SUBIACO EAST, WA, 6008, xxxxx@mmwc.com.au, xxxxxxxxx866	100
Total Shares:	100

DESCRIPTION DETAILS

Description

Block Type :
Effective From :

Locality : CANE RIVER

Datum : Datum situated at MGA GDA 94 Zone 50 coordinates 347902.000 mE and 7572418.000 mN.

Boundary : Then to 347440.000 mE 7572670.000 mN
Then to 346807.000 mE 7572980.000 mN
Then to 346863.000 mE 7573056.000 mN
Then to 347476.000 mE 7572824.000 mN
Then to 347963.665 mE 7572492.801 mN (NE Corner of M08/69)
Then to 347927.627 mE 7572443.533 mN (NW Corner of M08/69)

Then to 347902.000 mE 7572418.000 mN back at Datum

(Section 49 Conversion of P08/760)

Area :	Type	Dealing No	Start Date	Area
	Granted		28/11/2023	15.28428 HA
	Applied For		05/04/2023	15.28427 HA

RELATIONSHIPS

Relationships

Relationship	Dealing No	Dealing Status	Tenement ID	Tenement Status
Section 49	Conversion 672999	Recorded	P 08/760	Dead

State Agreement Conversions

Applicable Legislation	Effective Start	Effective End

SURVEY DETAILS

Survey

Surveyed Area	Surveyed Date	Surveyor`s Name	Field Book	Instruction Date	Project
					34334

Standard Plan **Diagram**

GENERAL DETAILS

General

Objection Closing Date : 16/05/2023 **Application Fee :** $608.00
File Reference : **Survey Fee :**
Receipt Number : 32708604039

Special Indicator

Special Indicator	Start	End

SHIRE DETAILS

Shire

Shire	Shire No	Start	End	Area
ASHBURTON SHIRE	250	11/04/2023		15.28428 HA

NATIVE TITLE DETAILS

Native Title Referrals

Date Referred	Referral Type	Procedure	Current Status
26/06/2023	Tenement Application	Right to Negotiate	RTN Procedure : Right to Negotiate Cleared - Grant

RTN Details

Sec 29 Notification Date : 12/07/2023 **Sec 29 Notification Close Date :** 12/11/2023
Grantee Party Sec 31 Letter Sent :
Proposed Area to Grant : 15.28428 HA
Centroid Latitude : 21° 56' 35" S **Centroid Longitude :** 115° 31' 20" E
Locality : 54.1km SE'ly of Onslow
Purposes :

Claims

Aboriginal Representative Area Bodies

Code	Region	Representative Body
12	Pilbara	Yamatji Marlpa Aboriginal Corporation

GRANT DETAILS

Recommendation

Recommended for : Grant 23/06/2023

Grant

Granted : 28/11/2023 **Holder Notified :** 28/11/2023 **Licence/Lease issued :**

Term

Term : 21 Years **From :** 28/11/2023 **To :** 27/11/2044

ENDORSEMENTS/CONDITIONS DETAILS

Endorsements and Conditions

#	ENDORSEMENTS	Start Date	End Date
1	The Lessee's attention is drawn to the provisions of the Aboriginal Heritage Act 1972 and any Regulations thereunder.	28/11/2023	
2	This mining lease authorises the mining of the land for all minerals as defined in Section 8 of the Mining Act 1978 with the exception of uranium ore.	28/11/2023	
3	The Lessee's attention is drawn to the Environmental Protection Act 1986 and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, which provides for the protection of all native vegetation from damage unless prior permission is obtained.	28/11/2023	
	In respect to Water Resource Management Areas (WRMA) the following endorsements apply:	28/11/2023	
4	The Lessee's attention is drawn to the provisions of the: • Waterways Conservation Act, 1976 • Rights in Water and Irrigation Act, 1914 • Metropolitan Water Supply, Sewerage and Drainage Act, 1909 • Country Areas Water Supply Act, 1947 • Water Agencies (Powers) Act 1984	28/11/2023	
5	The rights of ingress to and egress from, and to cross over and through, the mining tenement being at all reasonable times preserved to officers of Department of Water and Environmental Regulation (DWER) for inspection and investigation purposes.	28/11/2023	
6	The storage and disposal of petroleum hydrocarbons, chemicals and potentially hazardous substances being in accordance with the current published version of the Department of Water and Environmental Regulation (DWER) relevant Water Quality Protection Notes and Guidelines for mining and mineral processing.	28/11/2023	
7	The taking of groundwater from an artesian well and the construction, enlargement, deepening or altering of any artesian well is prohibited unless current licences for these activities have been issued by Department of Water and Environmental Regulation (DWER).	28/11/2023	
8	Measures such as drainage controls and stormwater retention facilities are to be implemented to minimise erosion and sedimentation of adjacent areas, receiving catchments and waterways.	28/11/2023	
9	All activities to be undertaken so as to avoid or minimise damage, disturbance or contamination of waterways, including their beds and banks, and riparian and other water dependent vegetation.	28/11/2023	
	In respect to Proclaimed Surface Water Areas (Pilbara), Irrigation District Areas and Rivers (RIWI Act) the following endorsements apply:	28/11/2023	
10	The taking of surface water from a watercourse or wetland is prohibited unless a current licence has been issued by the Department of Water and Environmental Regulation (DWER).	28/11/2023	

#	ENDORSEMENTS	Start Date	End Date
11	Advice shall be sought from the Department of Water and Environmental Regulation (DWER) and the relevant water service provider if proposing mining activity in an existing or designated future irrigation area, or within 50 meters of a channel, drain or watercourse from which water is used for irrigation or any other purpose, and the proposed activity may impact water users.	28/11/2023	
12	No mining activity is to be carried out if: • it may obstruct or interfere with the waters, bed or banks of a watercourse or wetland • it relates to the taking or diversion of water, including diversion of the watercourse or wetland unless in accordance with a permit issued by the Department of Water and Environmental Regulation (DWER).	28/11/2023	
	In respect to Proclaimed Ground Water Areas (Pilbara) the following endorsement applies:	28/11/2023	
13	The taking of groundwater and the construction or altering of any well is prohibited without current licences for these activities issued by the Department of Water and Environmental Regulation (DWER), unless an exemption otherwise applies.	28/11/2023	

#	CONDITIONS	Start Date	End Date
1	All disturbances to the surface of the land made as a result of exploration, including costeans, drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, Department of Mines, Industry Regulation and Safety. Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, Department of Mines, Industry Regulation and Safety.	28/11/2023	
2	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.	28/11/2023	
3	Unless the written approval of the Environmental Officer, Department of Mines, Industry Regulation and Safety is first obtained, the use of drilling rigs, scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.	28/11/2023	
4	The Lessee making verbal or written contact with the holder of any underlying pastoral or grazing lease within a reasonable time prior to undertaking airborne geophysical surveys or any ground disturbing activities utilising equipment such as scrapers, graders, bulldozers, backhoes, drilling rigs; water carting equipment or other mechanised equipment.	28/11/2023	
5	The Lessee or transferee, as the case may be, shall within thirty (30) days of receiving written notification of:- • the grant of the Lease; or • registration of a transfer introducing a new Lessee; advise, by registered post, the holder of any underlying pastoral or grazing lease details of the grant or transfer.	28/11/2023	
6	The lessee submitting a plan of proposed operations and measures to safeguard the environment to the Executive Director, Resource and Environmental Compliance, Department of Mines, Industry Regulation and Safety for their assessment and written approval prior to commencing any developmental or productive mining or construction activity.	28/11/2023	

DEALINGS DETAILS

Dealings

Encumbrances

End of Search

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

eMiTS MINERAL TITLES ONLINE

MINING TENEMENT SUMMARY REPORT

MINING LEASE 08/546

Status: Live

TENEMENT SUMMARY

Area: 15.28428 HA
Mark Out : 05/04/2023 15:20:00
Received : 11/04/2023 15:39:05
Term Granted : 21 Years
Death Reason :
Death Date :
Commence : 28/11/2023

CURRENT HOLDER DETAILS

Name and Address
LADYMAN, Geoffrey Ross
C/- M & M WALTER CONSULTING, PO BOX 8197, SUBIACO EAST, WA, 6008, xxxxx@mmwc.com.au, xxxxxxxxx866

DESCRIPTION

Locality: CANE RIVER
Datum: Datum situated at MGA GDA 94 Zone 50 coordinates 347902.000 mE and 7572418.000 mN.
Boundary: Then to 347440.000 mE 7572670.000 mN Then to 346807.000 mE 7572980.000 mN Then to 346863.000 mE 7573056.000 mN Then to 347476.000 mE 7572824.000 mN Then to 347963.665 mE 7572492.801 mN (NE Corner of M08/69) Then to 347927.627 mE 7572443.533 mN (NW Corner of M08/69) Then to 347902.000 mE 7572418.000 mN back at Datum (Section 49 Conversion of P08/760)

Area :	Type	Dealing No	Start Date	Area
	Granted		28/11/2023	15.28428 HA
	Applied For		05/04/2023	15.28427 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
ASHBURTON SHIRE	250	11/04/2023		15.28428 HA

Appendix 2: Authorisation to submit approvals

Geoffrey Ross Ladyman

Address: Unit 3, 6 McNamara Way, COTTESLOE WA 6011
Postal: PO Box 613 COTTESLOE WA 6911 (718) 555–0100
Contact: 0428 260 644
Email: ross.ladyman@bigpond.com

Re: Authorisation to lodge approvals

To Whom It May Concern,

As the tenement holder of Mining Lease M08/546 and Prospecting Licences P08/761 and P08/801, I, Geoffrey Ross Ladyman hereby authorise Stewart Garden Pty Ltd to seek environmental approvals for the purposes of mining and supporting activities.

Yours sincerely,

Signed: Geoffrey Ross Ladyman Date: 1/12/2023

Appendix 3: APM 2022 Cane River Biological Survey

Cane River Biological Survey

Cane, Western Australia

Prepared on behalf of G.R Ladyman by
Animal Plant Mineral Pty Ltd.

July 2022

DOCUMENT REVISION HISTORY AND STATUS

Revision	Date Issued	Reviewed by	Approved by	Date Reviewed/Approved
0	31/07/2022	TS		
1	02/08/2022			

Printed	
Last Saved	02/08/2022
Author	Dr Eleanor Hoy
Project Manager	Dr Mitch Ladyman
Client	G.R Ladyman
Document Title	Terrestrial Flora and Fauna Biological Survey – Cane River
Document Version	1.0
Project Number	GRL001

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PO Box 410, Bassendean WA 6934
www.animalplantmineral.com.au

EXECUTIVE SUMMARY

G.R Ladyman has identified prospecting licences P 0800760, P 0800761 and P 0800801 that have the potential to support sand mining activities. G.R Ladyman commissioned Animal Plant Mineral Pty Ltd to undertake vegetation, flora, and fauna surveys to describe the existing environment and identify biological values within the sites. The prospecting licences are located approximately 56 kilometres southeast of the town of Onslow on the Cane River and adjacent to the Cane River Conservation Park. The Survey Area is comprised of four separate areas with a total survey area of 74 hectares. The Access Road is within the Cane River Conservation Park.

A Detailed and Targeted Flora and Vegetation Survey and a Basic and Targeted Fauna Survey were conducted. Field survey was carried out between the 14th and 23rd June 2022. Seasonal conditions were suitable for flora and fauna survey and surface water was present in the Cane River at the time of survey.

Three vegetation types were described. There are no Threatened or Priority Ecological Communities present in the Survey Area. No Threatened or Priority flora was recorded in the Survey Area. One flora species listed as Critically Endangered under the EPBC Act and BC Act has the potential to occur in the Survey Area. This is *Seringia exastia*. This species has recently been taxonomically revised and nominated for delisting.

Five fauna habitats are described for the Survey Area. The Pilbara Leaf-nosed Bat was recorded in the Survey Area from acoustic bat detection devices. The Pilbara leaf-nosed bat is listed as Priority 4 under the Western Australia Biodiversity Conservation Act (**BC Act**) and Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act (**EPBC Act**). The Survey Area contains no diurnal roosting habitat. Foraging habitat available in the Survey Area is classified and prioritised in the EPBC Act Conservation Advice for the species (Threatened Species Scientific Committee 2016) as:

- Major watercourses (Priority 4)— In the Survey Area this is described as Fauna Habitats FH2 and FH3.
- Open grassland and woodland (Priority 5)—In the Survey Area this is described as Fauna Habitats FH1 and FH4.

The Survey Area contains suitable habitat for the Northern Quoll. The Northern Quoll is listed as Endangered under the BC Act and EPBC Act. Hollow bearing trees within the parafluvial zone are suitable denning habitat. The parafluvial, floodplains and clay breakaway habitats are suitable foraging habitats. Targeted searches for signs and deployment of camera traps determined that the Survey Area does not contain a high or low-density population of Northern Quoll. A low-density population was present in the adjoining Conservation Park as recently as 2014 and the parafluvial, floodplains and clay breakaway habitats of the Survey Area are suitable foraging and/or dispersal habitat for that low density population if it is persistent.

Fourteen threatened and migratory bird species returned from the database searches have the potential to occur in the Survey Area due to the availability of suitable habitat. For 10 species including the EPBC and BC Act Critically Endangered Curlew Sandpiper, the availability of suitable habitat is temporally limited to times when surface water is present. The suitable habitat occurs in the Fluvial zone and is no longer suitable after pools have dried.

Four predatory bird species may utilise the Survey Area are. These are the Red Goshawk and Grey Falcon (both listed as Vulnerable under the BC and EPBC Acts) the Osprey (Migratory) and the Peregrine Falcon (Other Specially Protected). Suitable nesting habitat is present in the Survey Area within the Parafluvial habitat. Suitable foraging habitat is available across all habitats within the Survey Area, except for the Osprey where prey is most likely to be sourced from the Fluvial zone during periods of inundation.

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PROJECT TERMS

Abbreviation	Meaning
The Survey Area	Prospecting licences P 0800760, P 0800801, P 0800761 and Access Road

UNITS OF MEASURE

Unit	Measure
°C	Degrees Celsius
ha	Hectare
km	Kilometre

LIST OF ABBREVIATIONS

Abbreviation	Meaning
APM	Animal Plant Mineral Pty Ltd
BAM Act	Biosecurity and Agriculture Management Act 2007
BC Act	*Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
CR	Critically Endangered
DBCA	Department of Biological Conservation and Attractions
EN	Endangered
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
MI	Migratory
MNES	Matters of National environmental significance
NVIS	National Vegetation Information System
OS	Other Specially Protected Species
P	Priority
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
T	Threatened
TEC	Threatened Ecological Community
VU	Vulnerable
WA	Western Australia
WoNS	Weeds of National Significance

1 INTRODUCTION

1.1 PROJECT AND LOCATION

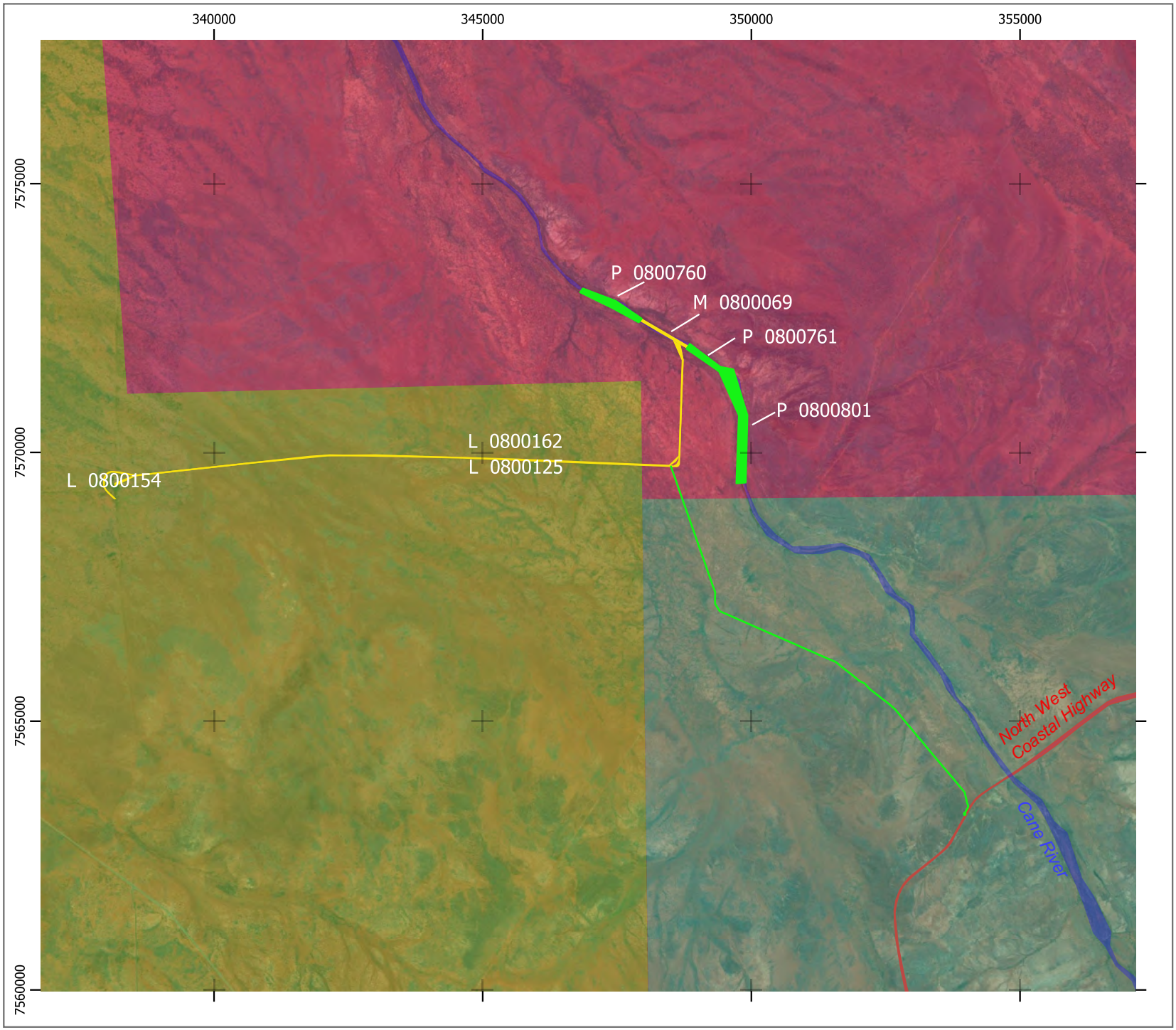
G.R Ladyman has identified prospecting licences P 0800760, P 0800801, P 0800761, that have the potential to support sand mining activities. G.R Ladyman commissioned Animal Plant Mineral (**APM**) to undertake vegetation, flora and fauna surveys within prospecting licences P 0800760, P 0800801, P 0800761 to describe the existing environment and identify biological values within the sites. The prospecting licences are located approximately 56 kilometres (**km**) southeast of the town of Onslow and 10 km west of the Northwest Coastal Highway (Figure 1-1).

The Survey Area is comprised of four separate areas listed in Table 1-1. The total survey area is 74 hectares (**ha**).

Table 1-1 Survey Areas

Prospecting licence/ area	Dimensions	Area (ha)
P 0800761	720 metres (**m**) long by 100 m in width	7.4
P 0800760	1.2 km long by 150 m in width	15.2
P 0800801	2.2 km long by 250 m in width	41.9
Cane River Highway (Access Route)	9 km long and 10 m wide	9.5
Total		**74.0**

The Project location and Survey Areas are shown in Figure 1-1.



Legend

- Survey Areas
- Cane River (Mount Minnie and Nanutarra)
- Cane River Conservation Reserve
- Peedamulla Pastoral Lease
- Hanson PL Tenements

Scale: @ A4
1: 100,000

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 27/07/2022

Project Location

Prepared for:
G. R. Ladyman

Figure: 1-1

1.2 SCOPE OF WORK

The scope of work was to conduct a Detailed vegetation and Targeted flora survey, in accordance with the Environmental Protection Authority's *Technical Guidance - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016); and a Basic and Targeted fauna survey in accordance with (EPA, 2020) *Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment.*

1.2.1 Flora and Vegetation

The aims of the desktop study were to:

- Establish vegetation types previously determined for the site;
- Identify species previously determined as present on site including threatened (**T**) and priority (**P**) flora (under the provisions of the *Biodiversity Conservation Act 2016* (**BC Act**) and *Environment Protection and Biodiversity Conservation Act 1999* (**EPBC Act**);
- Identify the previously determined presence of threatened ecological communities (**TECs**) and priority ecological communities (**PECs**) on site;
- Identify weed species previously determined as present on site, in particular any Declared Weeds; and
- Identify potentially suitable habitat for conservation significant flora known from the region.

The aims of the field survey were to:

- Describe vegetation types on the site in accordance with National Vegetation Information System (**NVIS**) level V protocol;
- Identify species present on site including T and P flora (under the provisions of the BC Act and EPBC Act);
- Identify vegetation types present on site that are regarded as being "significant" at both local and regional scales; and
- Identify weed species present on site, in particular any Declared Weeds.

1.2.2 Terrestrial Fauna

The aims of the desktop study were to:

- Identify significant species previously determined as present in the local area including T and P fauna (under the provisions of the BC Act and EPBC Act);
- Identify habitat types suitable for T and P fauna known to occur in the local area and assess the likelihood of occurrence within the Survey Area; and
- Identify introduced species previously determined as present in the local area.

The aims of the field survey were to:

- Record habitats suitable for T and P fauna and assess the quality of available habitats; and
- Perform Targeted survey for T and P fauna determined as present in the local area for which suitable habitat is present within the Survey Area.

2 BACKGROUND AND SUPPORTING INFORMATION

2.1 RELEVANT LEGISLATION AND GUIDANCE

2.1.1 Commonwealth EPBC Act

Nationally, T flora and fauna species and ecological communities are protected under the EPBC Act. The EPBC Act provides for the identification and listing of species and ecological communities as T under several categories listed in Appendix A. The EPBC Act also provides for the development of conservation advice and recovery plans, development of a register of critical habitat, recognition of key threatening processes and the development of threat abatement plans and referral guidelines. Listed T species and ecological communities are recognised under the EPBC Act as Matters of National Environmental Significance (**MNES**) and must be referred to the Minister and undergo an environmental assessment and approval process if they are likely to be significantly impacted.

Migratory species are also protected under the EPBC Act as MNES, and significant aggregations and important habitat is defined under the Act.

2.1.2 Western Australia BC Act

The BC Act provides a statutory basis for the listing of T species, specially protected species, extinct species, TEC, collapsed ecological communities, critical habitat, and key threatening processes in Western Australia (**WA**). The BC Act provides for the listing of T flora and fauna species and ecological communities under specified conservation categories (Appendix A). Species and communities listed within the BC Act are protected and require authorisation by the Minister to take or disturb. Listings are published in the WA Government Gazette with the current list published on the 11 September 2018.

Species may also be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or, are of special interest to science. Species of special conservation interest, migratory species, and species subject to international agreements are known as Specially Protected Species in the BC Act. This includes those described as P species and communities. The categories covering P species and communities are listed in Appendix A.

2.1.3 Biosecurity and Agriculture Management Act

The Department of Primary Industries and Regional Development regulates harmful plants under the Biosecurity and Agriculture Management Act 2007 (**BAM Act**). Plants that are prevented entry into the State or have control or keeping requirements within the State are known as declared pests.

The Western Australian Organism List contains information on the area(s) in which a plant is declared and the control and keeping categories to which it has been assigned in WA. Categories are listed in Appendix A.

The Commonwealth Government has compiled a list of Weeds of National Significance (**WoNS**). In WA, WoNS are regulated under the BAM Act.

2.1.4 Assessment Guidance

The terrestrial biological assessment was conducted in accordance with the above Commonwealth and State legislation, and relevant policy and guidance for environmental surveys as outlined below:

- *Technical Guidance: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2020a); and
- *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

Relevant species-specific survey and assessment guidelines include:

- Survey Guidelines for Australia's T Bats (Department of the Environment Water Heritage and the Art (**DEWHA**) 2010a);
- Survey Guidelines for Australia's T Birds (DEWHA 2010b);
- Survey Guidelines for Australia's T Mammals (Department of Sustainability Environment Water Population and Communities (**DSEWPAC**) 2011a); and
- Survey Guidelines for Australia's T Reptiles (DSEWPAC 2011b).

Relevant guidance for the preparation of spatial datasets to accompany this report are:

- Instructions for the preparation of data packages for the Index of Biodiversity Surveys for Assessments (EPA 2020b).

2.2 LAND USE

The area under consideration as a potential access is on an existing gravel road passing through the Class A Cane River Conservation Park. P 0800760, P 0800801, P 0800761 and the northern end of the Access Route are within the Peedamulla pastoral lease where the land is used for cattle grazing.

P 0800760 and P 0800761 are directly adjacent to mining tenement M 080069 held by Hanson Construction Materials Pty Ltd. Sand mining is operational within this tenement and is accessed from miscellaneous licenses L 0800125, L 0800154, and L 0800162 to Mount Minnie Station to the west.

2.3 CLIMATE

The climate is arid, semi-desert tropical with highly variable rainfall, particularly occurring over summer. Significant cyclonic activity occurs annually, where several systems affect the coast and hinterland (Kendrick & Stanley, 2001).

The nearest Bureau of Meteorology (**BoM**) weather station with a long historical record is at Onslow Airport (BoM Site Number: 005017), approximately 56 km southeast of the Survey Area. Onslow Airport has recorded rainfall from 1940 to 2022 (82 years), and temperature from 1943 to 2022 (79 years). Average monthly rainfall, maximum and minimum temperatures recorded at station 005017 are shown in Figure 2-1. Monthly mean maximum temperature ranges from 36.5°C in January to 25.6°C in July. Monthly mean rainfall ranges from 70 mm in March to 0.8 mm in October, with a mean annual rainfall of 303.8 mm (BoM 2022).

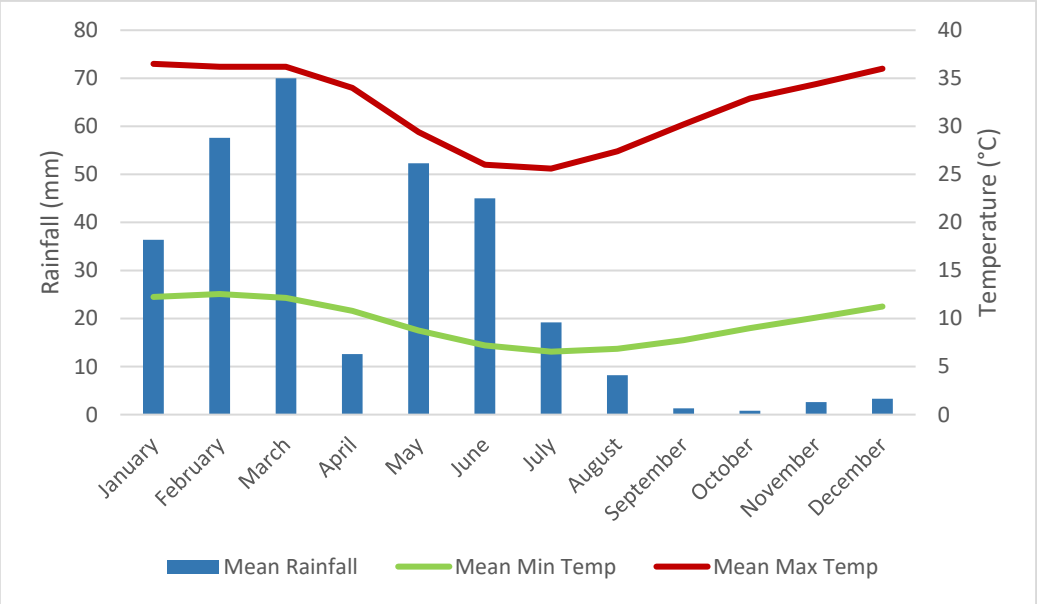


Figure 2-1. Temperature and rainfall averages for Onslow Airport weather station (Station No. 005017) (BoM 2022).

2.4 BIOGEOGRAPHIC REGIONALISATION

The Interim Biogeographic Regionalisation for Australia (**IBRA**, version 7) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (Thackway and Cresswell 1995). The mapping completed by Beard (1975), provides the basis for the IBRA bioregions. IBRA mapping (Version 7), places the Project within the Pilbara bioregion.

The Pilbara bioregion is characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges. Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses.

The Pilbara Bioregion is further subdivided into the Chichester, Fortescue, Hamersley and Roebourne sub-regions. The Project lies entirely within the Roebourne sub-region.

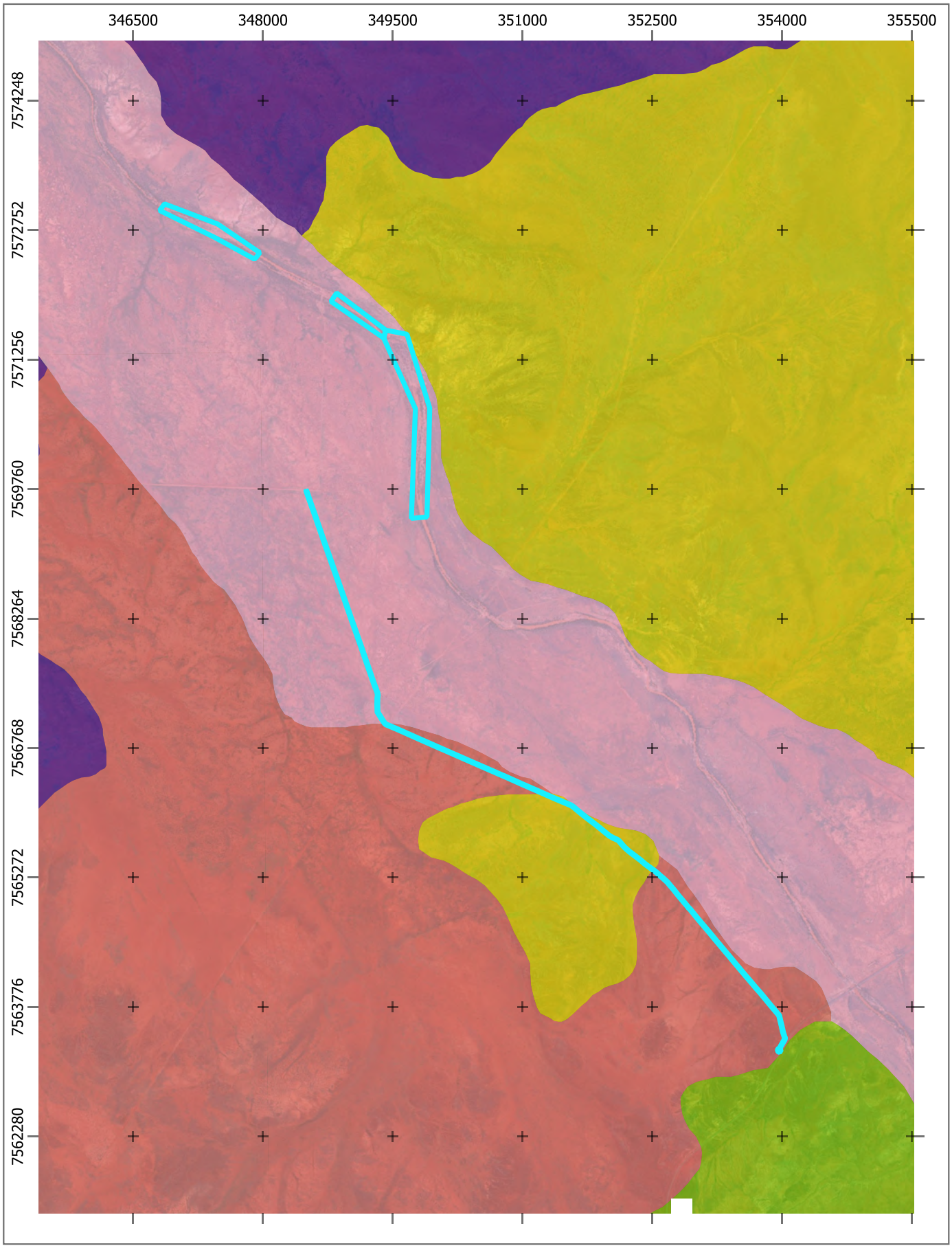
The Roebourne sub-region comprises of quaternary alluvial and older colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera* (Kendrick & Stanley, 2001). Uplands are dominated by *Triodia* hummock grasslands and ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands (Kendrick & Stanley, 2001).

2.5 LAND SYSTEMS

Land Systems of the Pilbara region are described by van Vreeswyk *et al.* (2004). Mapping of Land Systems is available from Department of Primary Industry and Regional Development ((**DPIRD**) 2019). The Survey Area falls within four soil landscape systems, as listed in Table 2-1 and illustrated in Figure 2-2.

Table 2-1. Land Systems of the Survey Area

Land System	Landform	Description
Cane	Flood plains, stony alluvial plains and river channels; non-saline and weakly saline clayey soils.	Alluvial plains and flood plains supporting snakewood shrublands, soft and hard spinifex grasslands and tussock grasslands.
Houndstooth	Low hills and plains on shale, drainage floors with braided channels, relief usually less than 30 m.	Rough shale hills, stony plains and broad drainage floors supporting hard spinifex grasslands and sparse shrubs.
Peedamulla	Level to gently undulating gravelly plains and broad, usually unchanneled drainage tracts, relief up to 15 m.	Gravelly plains supporting hard spinifex grasslands and minor snakewood shrublands.
Stuart	Gently undulating stony plains with quartz surface mantles and broad tributary drainage tracts, relief up to 25 m.	Gently undulating stony plains supporting hard and soft spinifex grasslands and snakewood shrublands.



Land Systems

Prepared for:

G.R Ladyman

2-2

Legend

Survey Areas

Land Systems

Cane

Houndstooth

Peedamulla

Stuart

Uaroo

Author: TB Approved: EH Date: 17/05/2022

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Scale: @ A4
1: 6,0000

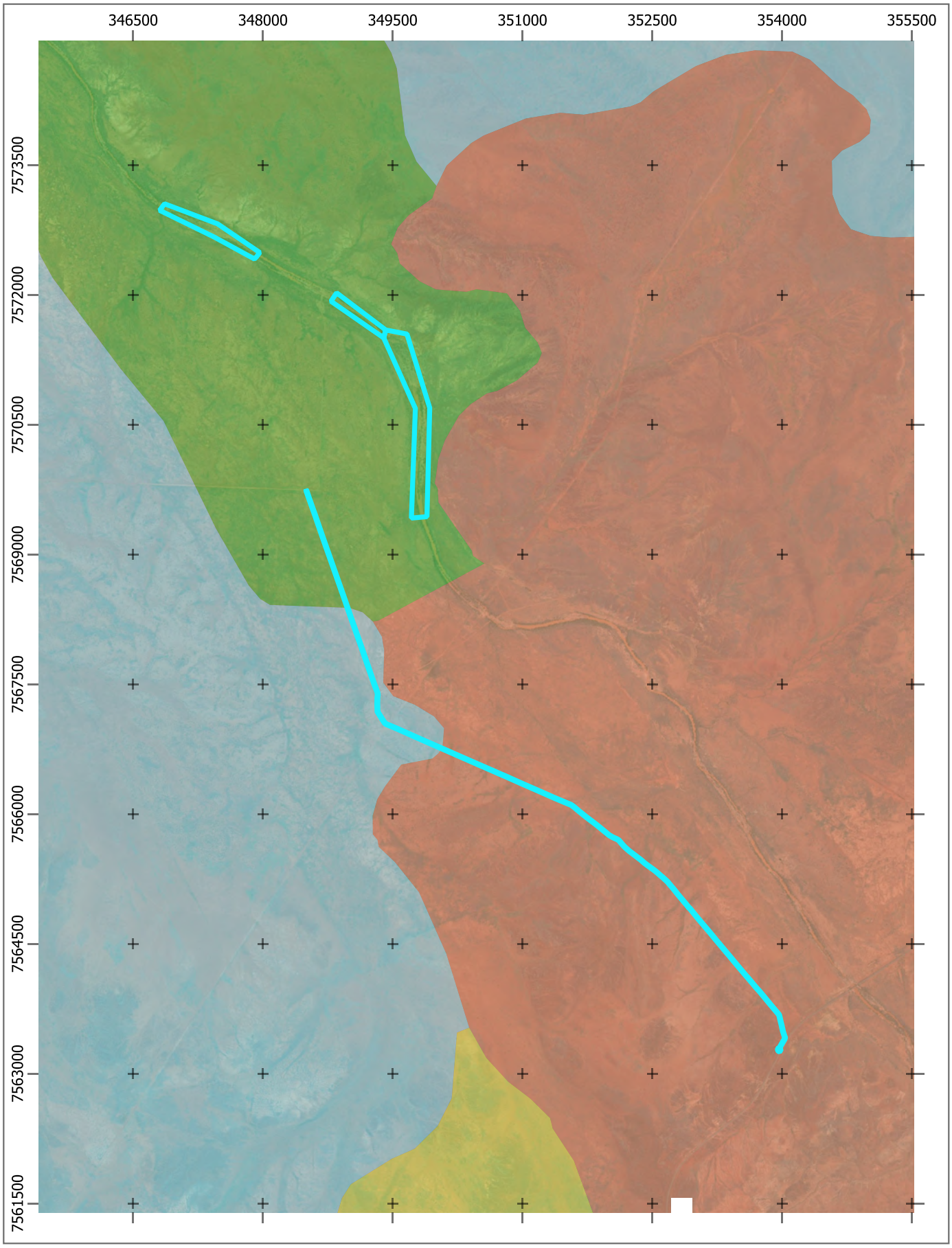
2.6 REGIONAL VEGETATION

The Survey Area is located within the Eremaean Botanical Province and contains two pre-European Beard vegetation associations of the Onslow Coastal Plain System, and one vegetation association of the Stuart Hills region as shown in Figure 2-3. The remaining extent of these vegetation associations is presented in the most recent Department of Biodiversity, Conservation and Attractions (**DBCA**) Statewide Vegetation Statistics table dated 2018 and outlined in Table 2-2 below.

Vegetation associations within the Survey Area generally have over 99% pre-European Vegetation extent remaining. Conservation significance ranking of vegetation associations occurring within the Survey Area are of 'Least Concern'.

Table 2-2 Pre-European Beard Vegetation Associations within the Survey Area

Vegetation Association	Vegetation Description	Pre-European Extent (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent within DBCA Managed Lands (%)
583	Hummock grasslands, sparse shrub steppe; kanji & *Acacia bivenosa* over hard spinifex *Triodia basedowii* & *T. wiseana*	243,112	243,112	100	40.85
585	Mosiac: Shrublands; snakewood & *Acacia victoriae* scrub / Hummock grasslands, shrub-steppe; kanji over soft spinifex & *Triodia basedowii*	145,571	145,559	99.99	62.77
605	Hummock grasslands, shrub steppe; *Acacia pachycarpa* & waterwood over soft spinifex	114,116	114,116	100	0.36



Pre-European Beard Vegetation Associations

Prepared for:

G.R Ladyman

2-3

Legend

Survey Areas

Vegetation Association

583

584

585

605

Author: TB Approved: EH Date: 25/7/2022

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

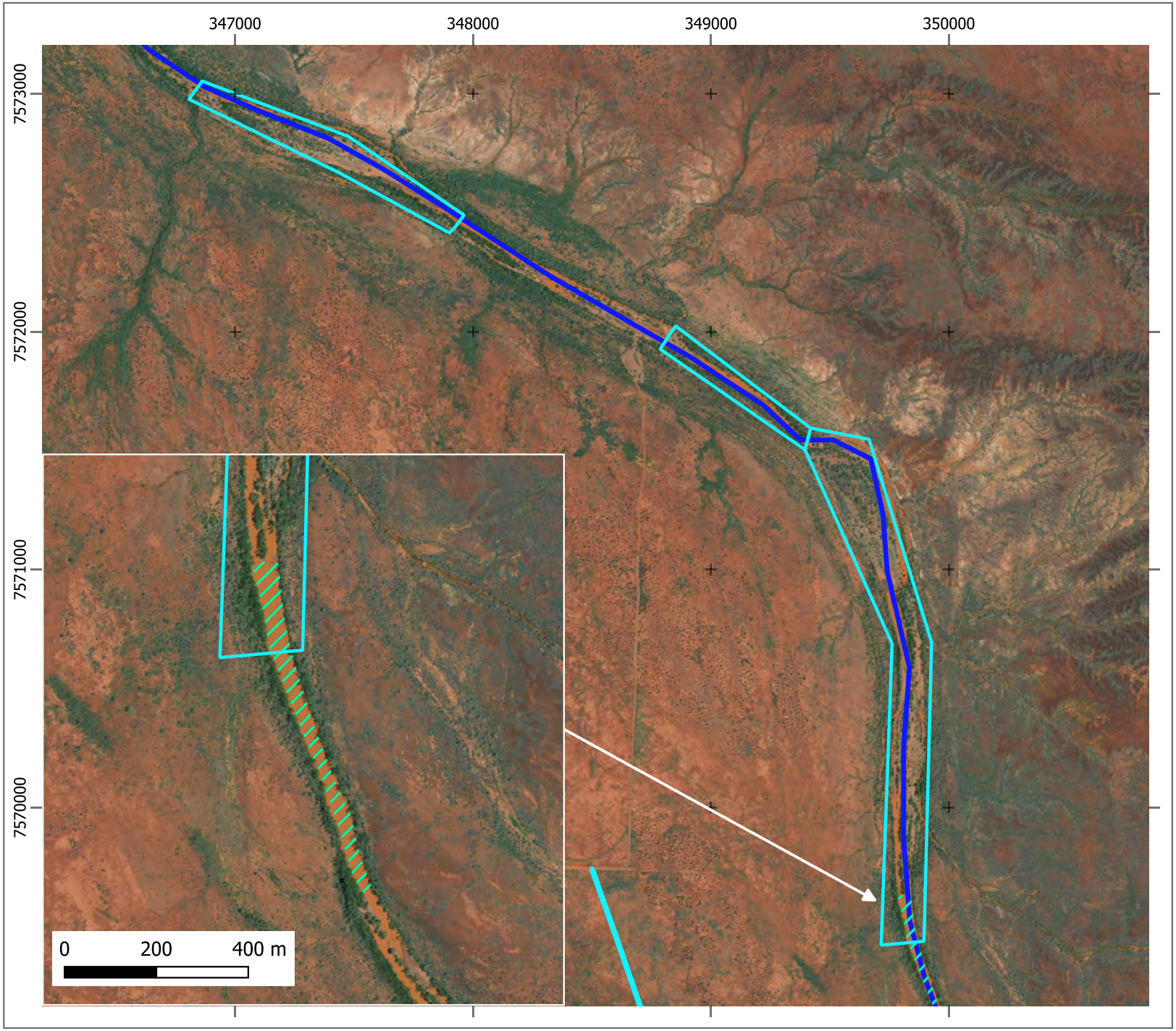
Scale: @ A4
1: 6,0000

2.7 SURFACE WATER

The Cane River is a significant drainage system that spans approximately 40 km and has a catchment area of approximately 2290 km^2. The drainage pattern for the Cane River is considered to be dendritic, with no major tributaries (Ruprecht & Ivanescu, 2000).

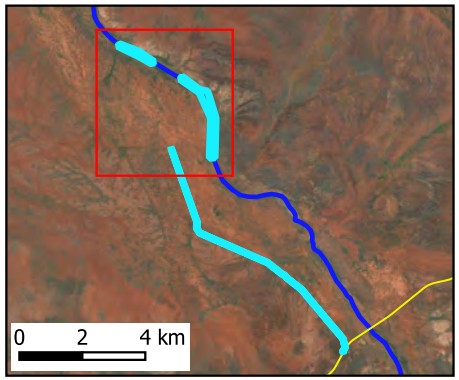
The Cane River discharges onto tidal flats adjacent to the Indian Ocean on the Onslow Coastal Plain, 35 km north-east of the Onslow townsite. Whilst some channels within the river across the coastal plain are maintained, flow capacity is diminished, and tidal influence increases as the channel approaches the coast.

No permanent pools have been identified within the Cane River, and are mostly intermittent in nature, only occurring during the wetter years, however, one semi-permanent pool (Jabaddar Pool) has been identified (Department of Water, 2011). This semi-permanent pool is within the furthest southern portion of tenement P 0800801 within the Survey Area (Figure 2-4), with its size and capacity varying depending on the seasonal conditions.



Legend

- Survey Areas
- Cane River
- Roads
- Jabaddar Pool



Scale: @ A4
1: 2300

0 250 500 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: TB Approved: EH Date: 14/07/2022

Surface Water

Prepared for:
G.R Ladyman

Figure: 2-4

2.8 ENVIRONMENTALLY SIGNIFICANT AREAS

2.8.1 Conservation Estate

The Western Australian Conservation Estate includes land and waters vested in the Conservation and Parks Commission under the Conservation and Land Management Act 1984. The Conservation Estate is generally managed by the Parks and Wildlife Service of DBCA to protect Western Australia's biodiversity, and includes National Parks, Nature Reserves, Conservation Reserves, and other areas managed primarily for biodiversity conservation (Department of the Environment and Energy, 2016).

A search of the Collaborative Australian Protected Area Database returned one gazetted area located within 50 km of the Survey Area. The southern-most Survey Area occurs within the 'Class A' Cane River Conservation Park. Two areas are in the process of being gazetted and will be an expansion of the Cane River Conservation Park. These include ex Mount Minnie Station, less than a kilometre to the west and ex Nanutarra Station, 30 km to the south of the Survey Areas.

2.8.2 Environmentally Sensitive Area

Environmentally Sensitive Areas are areas that are defined by the Department of Water and Environment Regulation (DWER 2019) as:

- A declared World Heritage property as defined in s.13 of the EPBC Act;
- An area that is included on the Register of the National Estate, because of its natural heritage value under the Australian Heritage Council Act 2003;
- A defined wetland and the area within 50 m of the wetland;
- The area covered by vegetation within 50 m of T flora, to the extent to which the vegetation is continuous with the vegetation in which the T flora is located;
- The area covered by a TEC;
- A Bush Forever site;
- Areas covered by the Gnangara Mound Crown Land Policy and Western Swamp Tortoise Policy;
- Areas covered by lakes, wetlands and fringing vegetation of the Swan Coastal Plain Lakes Policy, including South West Agricultural Zone Wetlands Policy and Swan and Canning Rivers Policy; and
- Protected wetlands as defined in the Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998.

There are no Environmentally Sensitive Areas within the Survey Area.

The Australian Wetlands Database includes nationally significant wetlands (as listed in the directory of important wetlands), wetlands listed under the Ramsar convention, wetlands that are representative, rare or unique, or wetlands that are considered of international importance (Department of the Environment and Energy 2019). There are no wetlands listed in the Directory of Important Wetlands within 500 km of the Survey Areas.

3 METHODOLOGY

3.1 SURVEY TIMING AND PERSONNEL

The terrestrial vertebrate fauna field survey was carried out by Dr Mitchell Ladyman. The flora and vegetation field survey was undertaken by Dr Neil Pettit and Ms Tia Berard.

Acoustic analysis and bat call identification was conducted by Dr Kyle Armstrong and Yuki Konishi at Specialised Zoological, a scientific consultancy business that specialises in bats, bioacoustics and genetic identification. Dr Armstrong has 20 years' experience in environmental consultancy specialising on bats.

The report was drafted by Ms Tia Berard, Dr Neil Pettit, Dr Ladyman and reviewed by Dr Eleanor Hoy.

Table 3-1 lists the personnel involved in the field survey.

Table 3-1. Field Survey personnel

Survey Date	Personnel	Experience	Description
14th – 15th June 2022	Dr Mitchell Ladyman	20+ years	Terrestrial vertebrate fauna survey
21st – 23rd June 2022	Dr Neil Pettit Tia Berard	25+ years under instruction	Flora and vegetation survey

3.2 DESKTOP STUDY

A search of the EPBC Act list of protected species was undertaken using the Department of Climate Change, the Environment, Energy and Water's Protected Matters Search Tool (**PMST**) to identify flora, fauna and TECs considered to be MNES. The PMST identifies EPBC listed flora and fauna species and communities based on predicted distributions of the species and/or their habitat, in conjunction with species records. The PMST may predict the occurrence of a species or community in an area where there are no documented records from the area, or documented records are historic. Therefore, for this search, a search area of 30 km was applied to ensure relevancy for the habitats present within and adjacent to the Project.

The conservation codes are described in Appendix A. The results of the PMST search are included in Appendix B.

A request was made for a search of DBCA databases for T and P flora and fauna and the presence of TECs or PECs. A 60 km buffer was applied to the fauna search, a 30 km buffer to the flora search, and a 50 km buffer was applied to the community search from a central coordinate of 350070, 7567900 (GDA 1994/MGA Zone 50).

Table 3-2 lists the database searches conducted for the desktop study.

Table 3-2. Database Searches

Attribute	Search Area	Database	Reference
Threatened and Priority Ecological Communities	50 km radius around a central point within the Survey Areas	DBCA	Figure 4-2 Section 4.1.2
	30 km radius around a central point within the Survey Areas	PMST	Appendix B
Threatened Flora	50 km radius around a central point within the Survey Areas	DBCA	Figure 4-1 Section 4.1.1
	30 km radius around a central point within the Survey Areas	PMST	Appendix B
Introduced Flora	50 km radius around a central point within the Survey Areas	NatureMap	Section 4.1.3
Threatened Fauna	60 km radius around a central point within the Survey Areas	DBCA	Figure 5-1 Section 5.1.1
	30 km radius around a central point within the Survey Areas	PMST	Appendix B
Introduced Fauna	50 km radius around a central point within the Survey Areas	NatureMap	Section 5.1.2

Threatened and Priority flora, fauna and communities returned from the database were assessed for their likelihood of occurrence within the Survey Area using the likelihood of occurrence criteria listed in Table 3-3.

Table 3-3. Likelihood of occurrence criteria

Likelihood of occurrence	Criteria
Recorded	Identified from database records or field survey as occurring within the Survey Area
Potential to occur	Preferred habitat occurs in the Survey Area
Unlikely to occur	No preferred habitat occurs in the Survey Area

A literature review was conducted to identify previous local surveys. No vegetation and flora surveys are known to have been previously conducted in the Survey Area. The following surveys have been conducted in the locality and were reviewed as part of this report:

- Vascular flora of Cane River Conservation Park, Western Australia: a report to the Bush Blitz Program, Australian Biological Resources Study. Markey, Adrienne, Dillon, Steven. Dept. of Environment & Conservation, Kensington, W.A. Publication Date: 2012; and

- Cane River Level 1 Flora and Vegetation Survey. Prepared on behalf of Hanson Construction Materials Pty Ltd by Astron Environmental Services. Publication Date: April 2013.

3.3 FIELD SURVEY

Conditions were suitable for flora and fauna survey. There was 394.2 mm of rainfall in the six months prior to survey, and therefore conditions were wetter than the long-term average of 232.2 mm for the same period (BoM 2022). Furthermore, the rainfall in May (the month prior to the survey), was 310.4 mm which is almost six times higher than the long-term average of 52.3 mm for the same period. During the survey period, temperatures reached a maximum of between 28.5 and 30.6 °C and a minimum of 14.3°C overnight, which is typical of the time of year (BoM 2022). No adverse weather occurred during the survey periods that would affect survey outcomes.

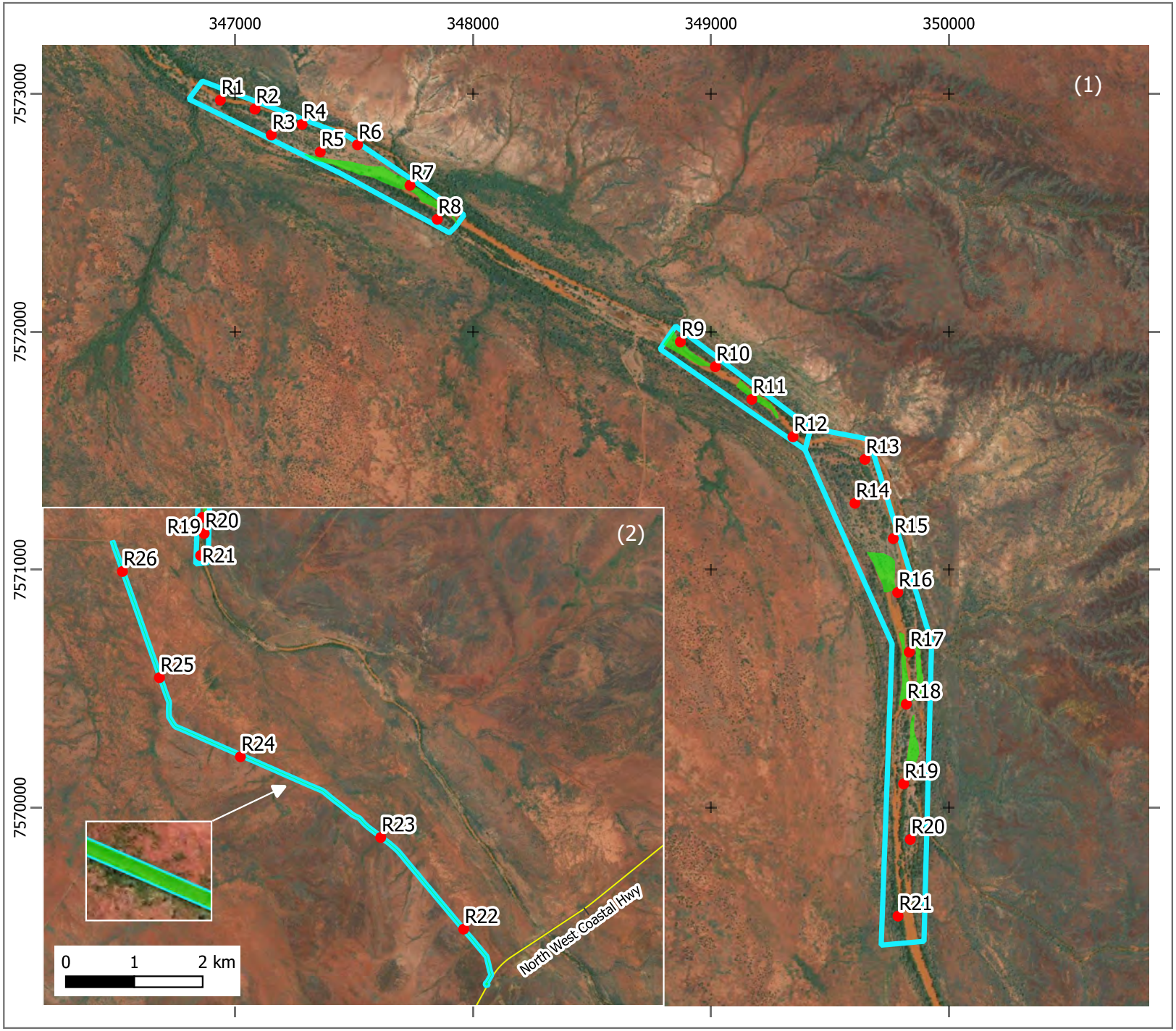
Surface water was present in the Cane River at the time of survey.

The Survey Areas are in the Eremaean botanical province, and therefore, recommended timing for flora and vegetation survey is 6 to 8 weeks post wet season (March to June) for Primary survey, and a Dry season survey (after winter rainfall if available) for Supplementary survey (EPA 2016). The timing of the field survey was within the recommended Primary survey period for the region.

The recommended timing for fauna survey varies depending on the Target fauna. The recommended time for birds and amphibians is immediately after rain events and for mammals there is no specific season recommended. The survey period was suitable for these groups. For reptiles, survey is recommended between September and April.

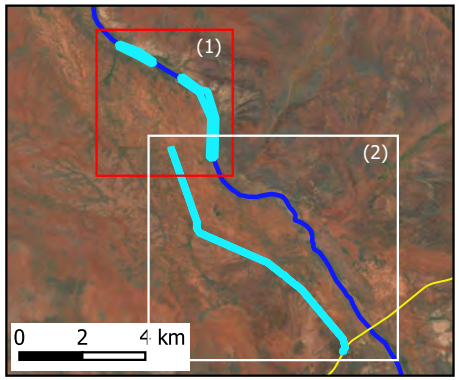
3.3.1 Flora and Vegetation

A Detailed level survey (EPA 2016) was conducted, and vegetation was sampled using 26 relevés of approximately 50 x 50 m (Figure 3-1). Field data at each survey site was recorded on a pro-forma data sheet and included the parameters listed in Table 3-4. Details of survey sites are provided in Appendix C. A flora inventory was compiled from taxa listed in Detailed survey sites and from opportunistic floristic collections made throughout the Survey Areas, with at least one collection made for every taxon encountered. Specimens were identified by an experienced botanical taxonomist in the Western Australia Herbarium using published reference material. The nomenclature applied is consistent with Florabase (WAH 1998-). The conservation status of all recorded flora was determined from the DBCA Wildlife Conservation Rare Flora Notice 2020, the T and P Flora List 5th December 2020, and the EPBC Act List of T Flora (DCCEEW 2022).



Legend

- Survey Areas
- Cane River
- Roads
- Releve
- Targeted Search Areas



Scale: @ A4
1: 2300

0 250 500 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: TB Approved: SA Date: 03/08/2022

Flora Survey Sites

Prepared for:
G.R Ladyman

Figure: 3-1

Table 3-4. Parameters recorded at each Reléve site

Variable	Parameters
Collection attributes	Personnel/recorder; date, quadrat dimensions and marking method, photographs of the quadrat, site code.
Physical features	Landform, slope, aspect, soil attributes, ground surface cover, litter, rock type and physical attributes.
Location	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System tool (Garmin) to accuracy approximately ± 5 m.
Vegetation	Dominant growth form, height, cover and species for the three traditional strata (upper, mid and ground) compatible with NVIS Level V (ESCAVI 2003).
Vegetation condition	Vegetation condition was assessed using the condition rating scale devised by Trudgen (1988).
Disturbance	Level and nature of disturbances (*e.g.* weed presence, fire and time since last fire, impacts from grazing, vegetation clearing, erosion).
Flora	List of all species within the quadrat including weeds and listing species average height, cover and abundance.

Vegetation was mapped at the association level (Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003), however in WA they are referred to as Vegetation Type (EPA 2016). Vegetation units were identified, detailed survey sites allocated, and boundaries delineated using a combination of aerial photography, topographical features, and field data/observations during traverses.

Vegetation condition was assigned using the scale developed for the Eremaean and Northern Botanical Provinces adapted from Trudgen (1988) as recommended in EPA (2016). Table 3-5 lists the six potential categories.

Table 3-5. Vegetation Condition Scale

Vegetation Condition	Eremaean and Northern Botanical Provinces adapted from Trudgen (1988)
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.

Vegetation Condition	Eremaean and Northern Botanical Provinces adapted from Trudgen (1988)
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; *i.e.* areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs

Targeted searches were conducted where suitable substrate occurs for the purpose of sand mining and therefore where disturbance may be proposed. The traverses were 20 m apart and flora of conservation significance was targeted. The Cane River access track was also traversed. The targeted search areas are shown in Figure 3-1.

Data analysis was applied to the floristic data. Floristic composition vegetation classification methodology was applied to the full suite of species present within quadrats, to determine whether the sites fall into clusters of similar communities. The Primer 7 (Clarke and Gorley, 2015), software was used to perform the non-parametric multivariate statistical analysis. A species by site matrix was prepared using species projected cover values and square root transformation applied. The square root transformation was selected to moderate the effect of the most dominant species without giving the singleton and sporadic species excessive weight. A resemblance matrix was constructed using the Bray Curtis similarity measure on the transformed data set. A cluster analysis was performed using group averages to identify sites with similarities in species composition and cover values. The SIMPROF routine was used to test the hypothesis that the species and/or abundances are different at each group of sites using 999 permutations and a significance level of 5%.

3.3.2 Fauna

Fauna survey methodology was developed to be compliant with EPA (2020), *Technical Guidance Terrestrial vertebrate fauna surveys for environmental impact assessment* at a Basic and Targeted level of assessment.

Habitat assessments were made during traverses of the Survey Area at 50 to 100 m intervals, to record fauna habitats and microhabitats, with reference to those valuable to fauna of conservation significance. Thirty-three fauna habitat assessments were performed. Descriptive data was recorded including soil type, landform, presence of microhabitats, disturbances and images were recorded. Site photos are included in Appendix D.

Targeted search was conducted for signs of conservation significant fauna during the traverses. Signs include scats, prints, slough skin, scratchings made during foraging and other diggings, burrows and mounds. Traverses were conducted from sunrise to sunset (0700 to 1700 hrs) and included dawn and dusk. All observations of water birds were recorded.

Sixteen motion-triggered cameras were deployed through the Survey Area. Eight cameras in P800760 and P800761 recorded for seven nights (15th to 22nd June 2022), and eight cameras in P800801 recorded for eight nights (14th to 22nd June 2022). Camera function was checked at deployment and collection

and operation days were confirmed to be equal to the deployed days. The total number of recording nights was 120.

Cameras were set to sample each of the major fauna habitat types and were targeted to improve the chances of detecting the Conservation Significant fauna most likely to occur. These were the Northern Quoll, Pilbara Olive Python and Threatened and Migratory water birds.

The presence of surface water presented the opportunity to detect species foraging at or moving along the edge of the water line. Sites were selected where vegetation and stream flow encouraged the target species to move between vegetation and along the water's edge, or in the shallower water, in front of a deployed camera. Plate 3-1 provides an example of a camera field of view. Other cameras, set in dry fauna habitats, were set in positions where vegetation and debris directed the movement of fauna past the cameras or in places where shelter is available. Wrack piles are very dense litter accumulated as large piles at the base of trees. Large wrack piles provide valuable temporary refuge for several fauna species that occupy riverine habitats, including the Northern Quoll and Pilbara Olive Python. Table 3-6 lists the cameras deployed at each tenement, the camera setup, and the number of trap nights.

Table 3-6. Motion-triggered camera setup and duration

Tenement	Targeted fauna habitat	Trap nights
P800760	• GRLFS04, GRLFS05 and GRLFS06 were targeted to the edge of water; and • GRLFS02, GRLFS10 and GRLFS03 were set at the base of a large river red gum trees in wrack piles.	6 cameras 7 nights 42 trap nights
P800761	• GRLFS21 was set at the base of a large river red gum in an open area of fluvium between several other large trees; • GRLFS23 was set in a heavily wooded parafluvial/riparian area. Leaf litter and fallen debris were very dense, providing abundant cover for foraging species moving along the banks of the main river channel.	2 cameras 7 nights 14 trap nights
P800801	• GRLFS27 and GRLFS29 were positioned to capture footage of fauna forced to move along the bank in front of the camera, and water birds foraging in the shallow flowing water. Shown in Plate 3-2; • GRLFS25 was set up on an exposed stony clay surface suitable for Pilbara Olive Python forage and refuge (Plate 3-3); • GRLFS28, GRLFS32 and GRL34 were set up in the heavily wooded vegetation in the para-fluvial zone, with large wrack piles or deep leaf litter; • GRLFS26 was set up in an area of deep alluvium supporting a thick groundstorey vegetation (Plate 3-4), providing good foraging sites for Northern Quoll; and • GRLFS35 was positioned in back-channel/floodplain habitat with open vegetation and bank and channel landform.	8 cameras 8 nights 64 trap nights
Total		**120 trap nights**

Plate 3-1. GRLFS05 (347079, 7572948)

Plate 3-2. GRLFS27 (349640, 7571541)

Plate 3-3. GRLFS025 (349516, 7571574).

Plate 3-4. GRLFS26 (349633, 7571461)

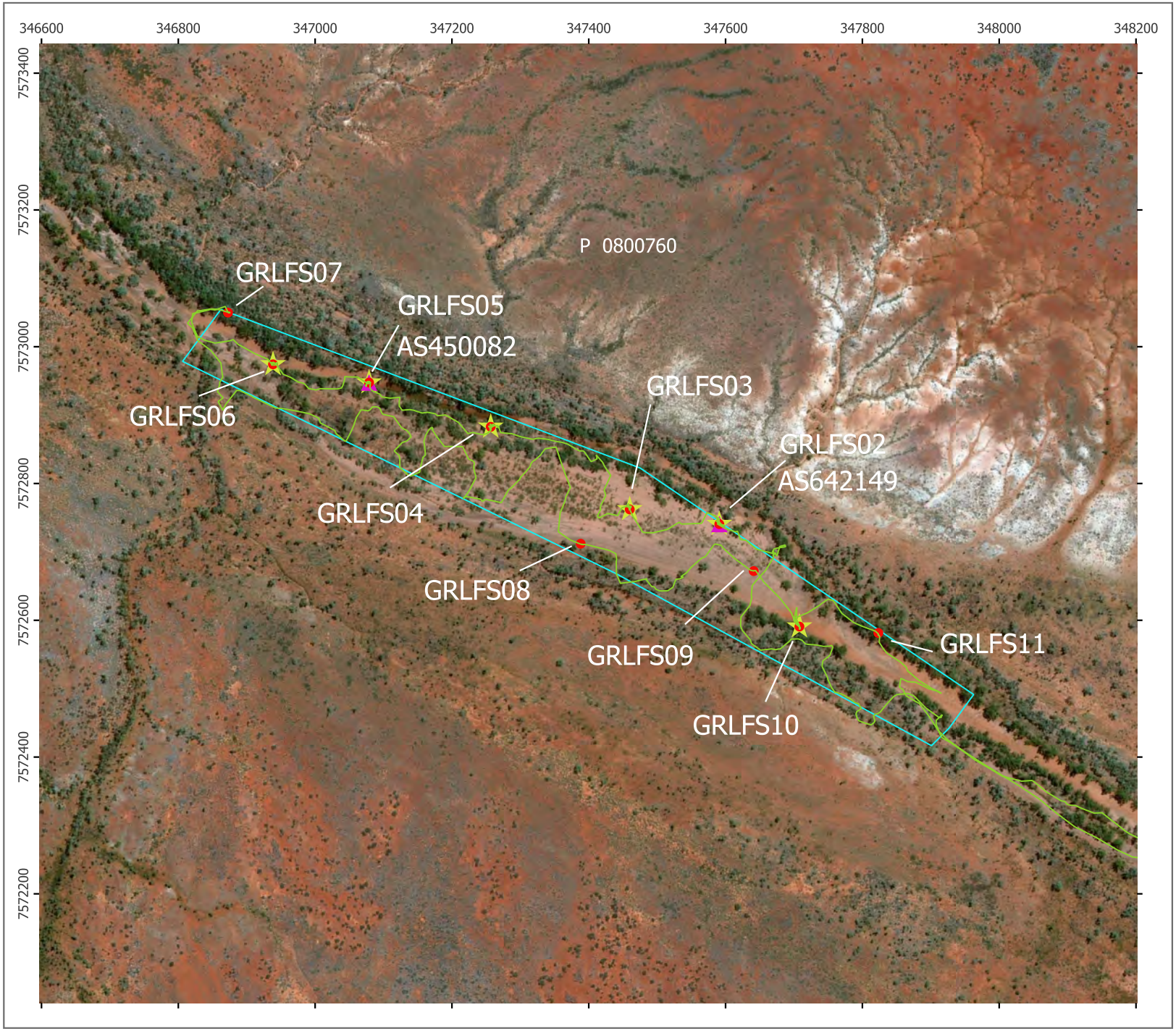
Four Anabat Swift acoustic bat recording devices were deployed seven nights from the 14th to the 21st June 2022 for a total of 28 trap nights. Table 3-7 lists the acoustic bat recording devices deployed at each tenement, the setup and the number of trap nights.

Table 3-7. Acoustic bat recording device setup and duration

Tenement	Targeted fauna habitat	Trap nights
P0800760	AS642149 was placed at the base of a *Eucalyptus camaldulensis* tree at GRLFS02 in the para-fluvial habitat. The flight path was very open along the main river channel, with few large trees in close association with the Anabat Swift. To the north, the tree line of the Riverine margin was approximately 25m away. To the south the treeline was more than 90m away. AS450082 was placed in the para-fluvial habitat, in denser vegetation. The flight path was less than 20 m wide between the vegetation (mixed *Eucalyptus* and *Melaleuca* spp.) that grew over a small river sub-channel that was gently flowing.	2 Anabats 7 nights 14 trap nights
P0800761	AS642022 was on the northern fringe of a broad fluvial zone of the Survey Area, where the river channel was un-vegetated and more than 60 m wide. AS642022 was placed at the base of a *Eucalyptus camaldulensis* tree with a small number of other mature trees in proximity, creating an open flight path past the recording device.	1 Anabat 7 nights 7 trap nights
P0800801	AS450007 was placed in the fluvial zone with the device elevated on the depositional side of a river power bend. Water was flowing nearby and the riverine margins were heavily wooded with river red gum, creating a very well-defined flight path to direct species past the detection device.	1 Anabat 7 nights 7 trap nights
Total		**28 trap nights**

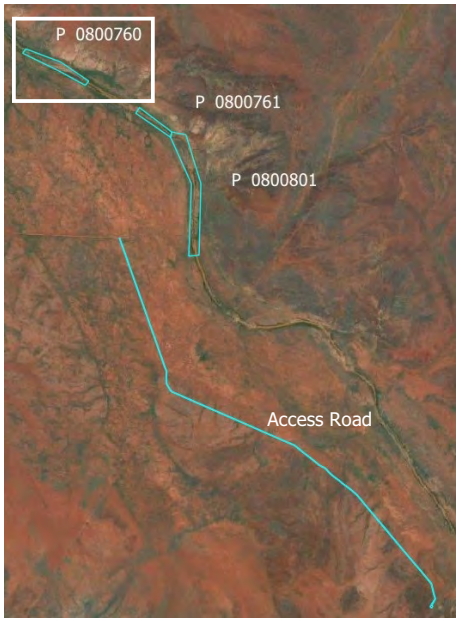
Bat call analysis was performed by Dr Kyle Armstrong of Specialised Zoological. A technical report with specifications on the analysis method is included as Appendix E. The scope of the analysis was limited to the detection of the Threatened-listed Ghost Bat *Macroderma gigas* and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*.

Figures 3-2 a-c show the location of motion-triggered cameras, bat acoustic recording devices, fauna habitat assessment sites and targeted searches.



Legend

- Fauna Targeted Search
- Acoustic bat detector
- Fauna Habitat Survey
- Motion-triggered camera
- Survey Area P800760



Scale: @ A4
1: 8,000

0 100 200 m

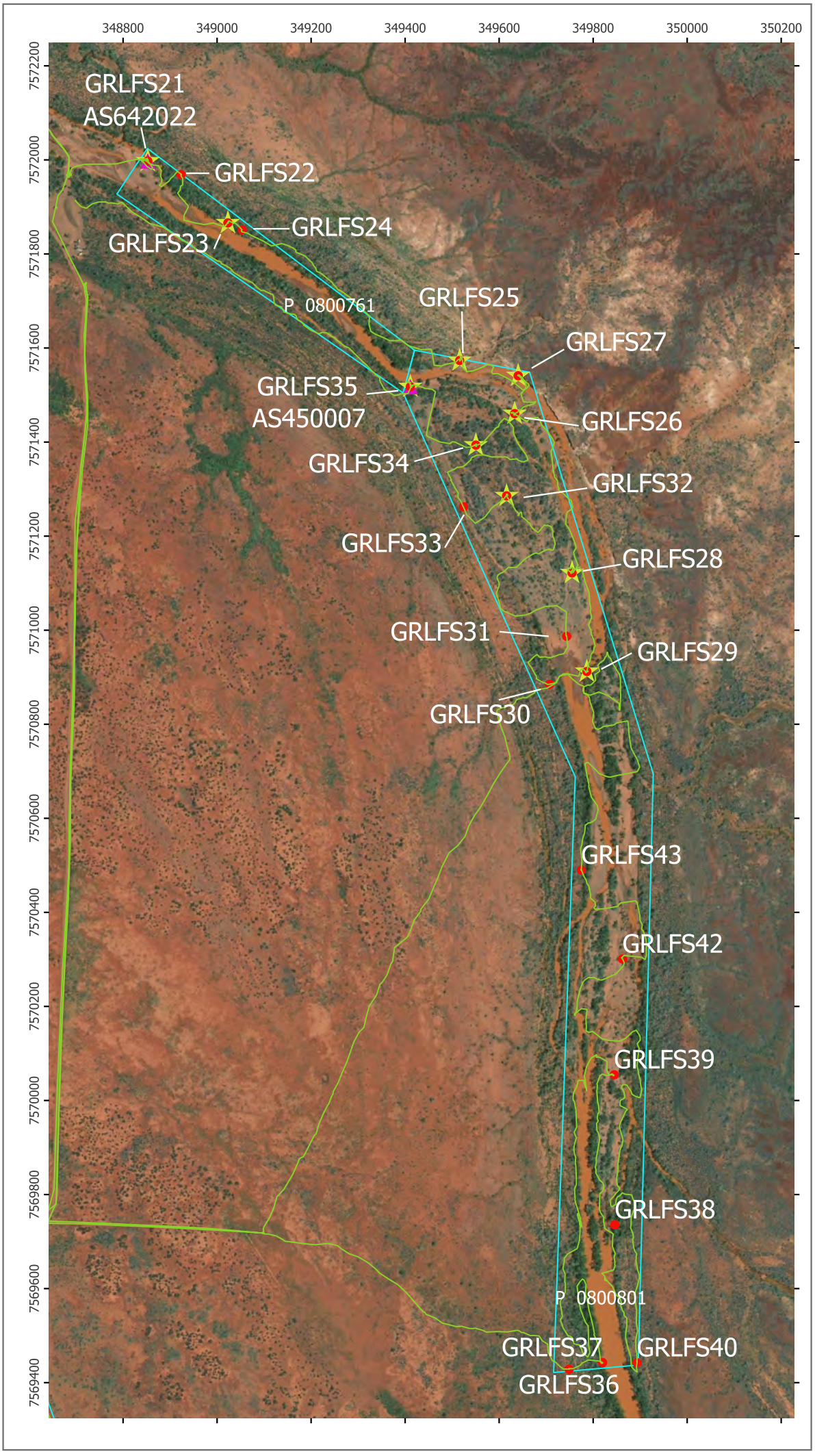
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 29/07/2022

Fauna Survey Sites
P 0800760

Prepared for:
G.R. Ladyman

Figure: 3-2a



Legend

- Fauna Targeted Search
- Acoustic bat detector
- Fauna Habitat Survey
- Motion-triggered camera
- Survey Area

0 150 300 m

Scale: @ A4
1: 11,000

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

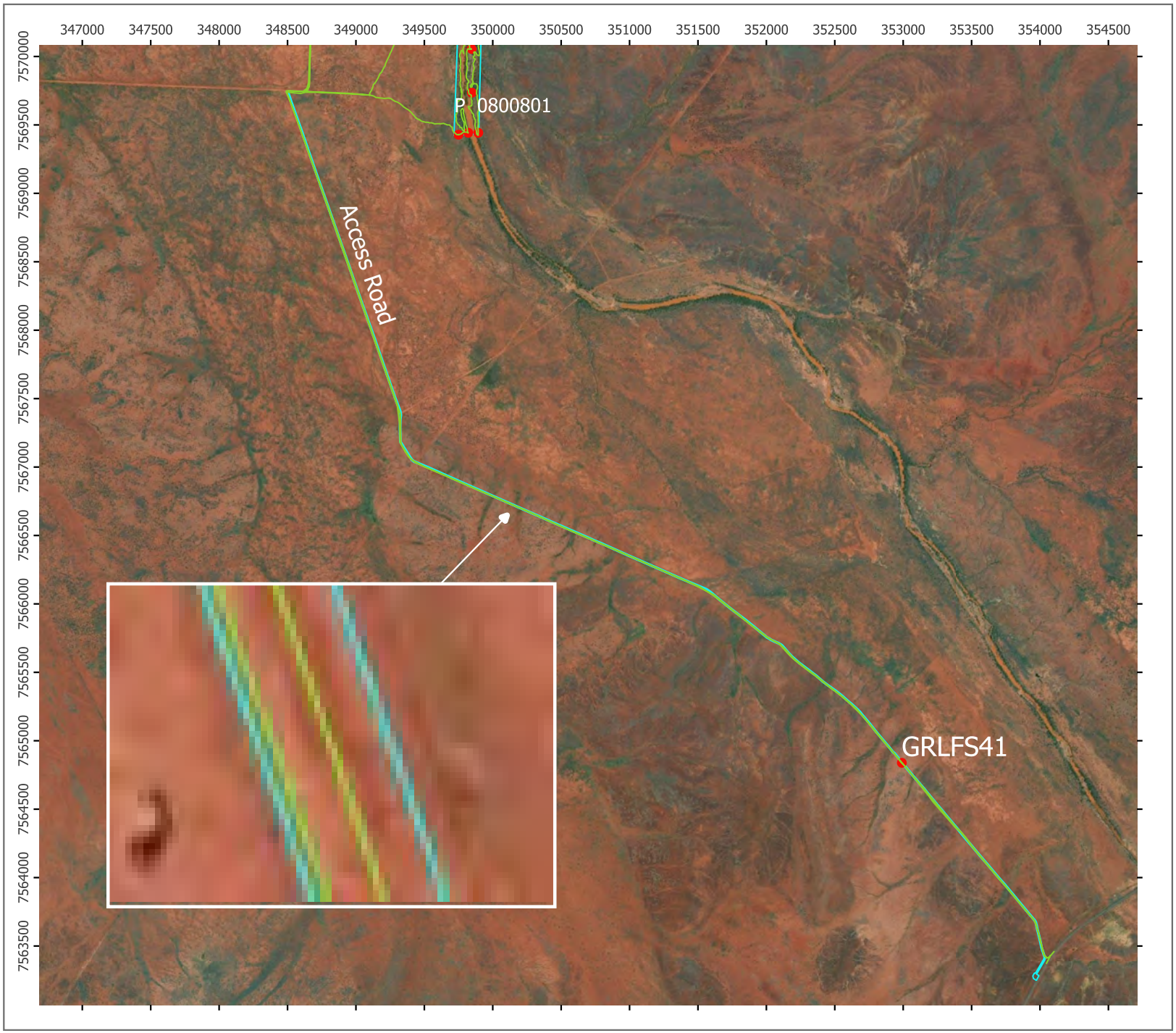
Author: EH Approved: ML Date: 29/07/2022

Fauna Survey Sites P 0800761 and P0800801

Prepared for:

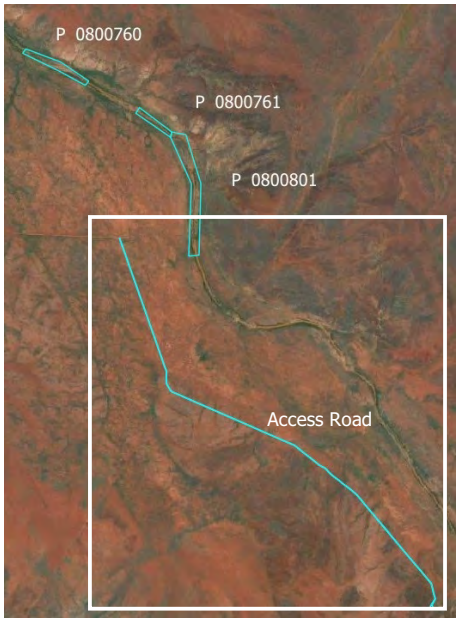
G.R. Ladyman

Figure: 3-2b



Legend

- Fauna Targeted Search
- Fauna Habitat Survey
- Survey Area



Scale: @ A4
1: 40,000

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 29/07/2022

Fauna Survey Sites
Access Road

Prepared for:
G.R. Ladyman

Figure: 3-2c

3.4 CONSTRAINTS

The guidelines (EPA 2016, 2020), outline several limitations that may arise during field survey. These potential survey limitations are listed below in Table 3-8. with comments on the constraint to survey outcomes.

Table 3-8. Survey Constraints

Factor	Impact of survey outcomes
Access problems	Not a constraint All Survey Areas were accessed. Surface water was present in large pools within the river channel that prevented targeted flora search in those inundated areas.
Experience levels	Not a constraint The personnel were suitably qualified
Scope: Flora and vegetation	Not a constraint Survey was carried out at a level of Detailed and Targeted assessment
Scope: Fauna	Not a constraint The survey was carried out at a level of Basic and Targeted, suitable for the size and intensity of the proposed Project, and the level of .
Timing, weather, season, cycle	Not a constraint The Survey Areas are within the Eremaean Botanical district. Recommended Primary survey timing is March to June, with Supplementary survey in the dry season. The June survey timing is within the recommended Primary survey period. Rainfall in the six months prior was higher than average and therefore, weather and seasonal conditions were not a constraint. Surface water was present during the survey. No inclement weather occurred during the survey period that would impact the detection of target fauna. Survey timing was within that recommended for birds, amphibians and mammals. Suitable conditions were available for migratory shorebirds.
Sources of information	Not a constraint Previous botanical reports and database records are available for the locality and region.
Completeness: Flora and vegetation	Not a constraint The scope was completed. Four plants (4.3% of the collection) were not able to be determined to the species level due to sterile specimens.
Completeness: Fauna	Not a constraint The scope was completed. The survey resulted in no ambiguous identifications of bat calls or photos.

4 FLORA AND VEGETATION RESULTS

4.1 DESKTOP STUDY

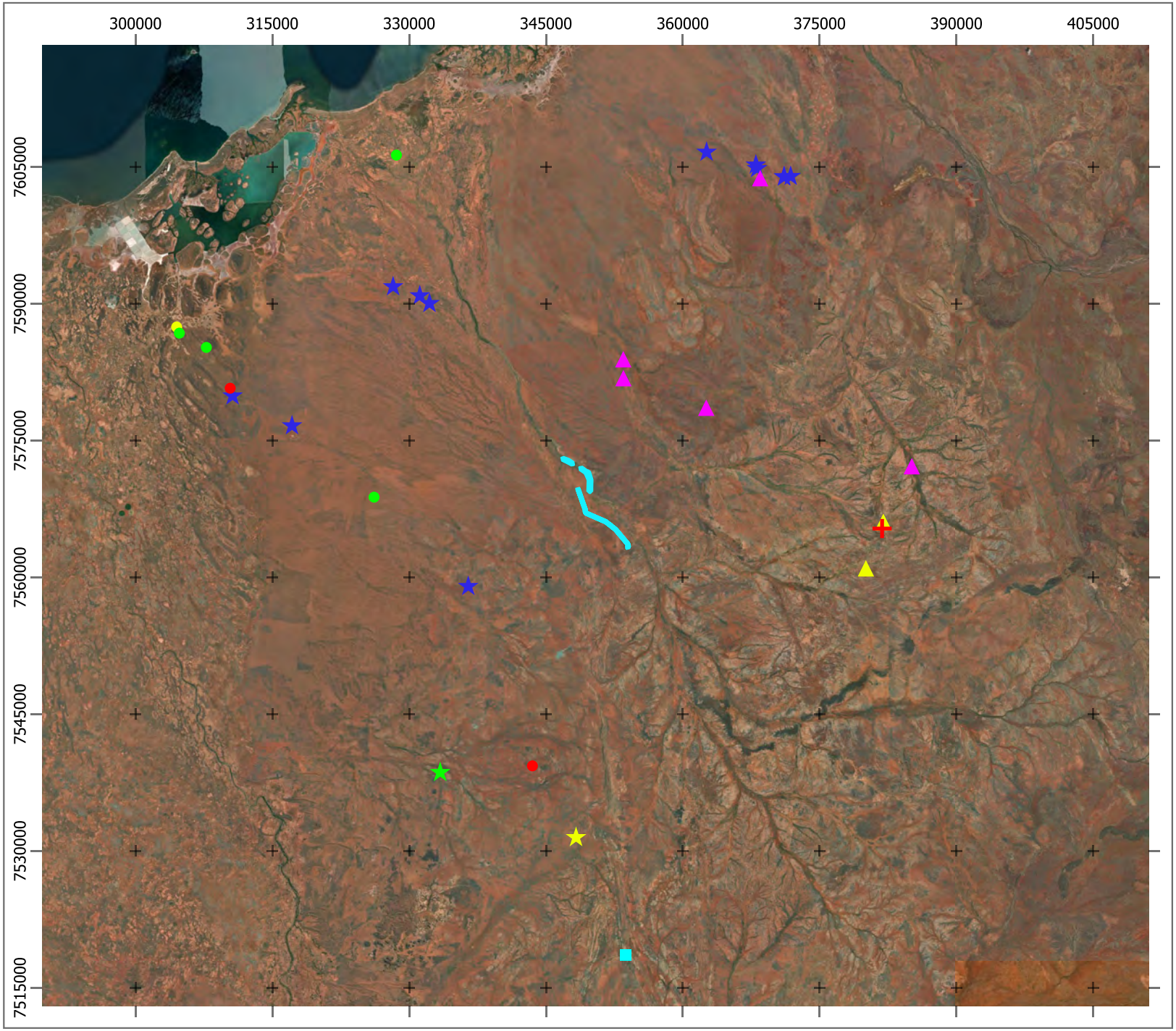
4.1.1 Threatened and Priority Flora

No T or P Flora listed under the BC Act or EPBC Act have been previously recorded within the Survey Area.

The T flora species *Seringia exastia* (listed as Critically Endangered [**CR**] under the EPBC Act and BC Act) and *Eleocharis papillosa* (listed as Vulnerable [**VU**] under the EPBC Act and Priority 3 in WA) were returned from the database searches. Three P1, one P2, two additional P3 and two P4 species also have records within 50 km of the Survey Area.

No additional T or P species were returned from the PMST or literature review.

T and P flora returned from the DBCA database with records within 50 km of the Survey Area are shown in Figure 4-1.



Legend

Survey Areas

Critically Endangered
- Seringia exastia

Priority 1
- Abutilon sp. Onslow (F. Smith s.n. 10/9/61)
- Helichrysum oligochaetum
- Indigofera roseola

Priority 2
- Solanum pycnotrichum

Priority 3
- Eleocharis papillosa
- Eremophila forrestii subsp. viridis
- Triumfetta echinata

Priority 4
- Goodenia nuda
- Ptilotus mollis

Scale: @ A4
1: 600,000

0 7.5 15 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: TB Approved: SA Date: 25/05/2022

Threatened and Priority Flora Records

Prepared for:
G.R Ladyman

Figure: 4-1

An assessment of the likelihood of these 10 species to occur within the Survey Area was performed using the criteria listed in Table 3-3. The results of the assessment are listed in Table 4-1.

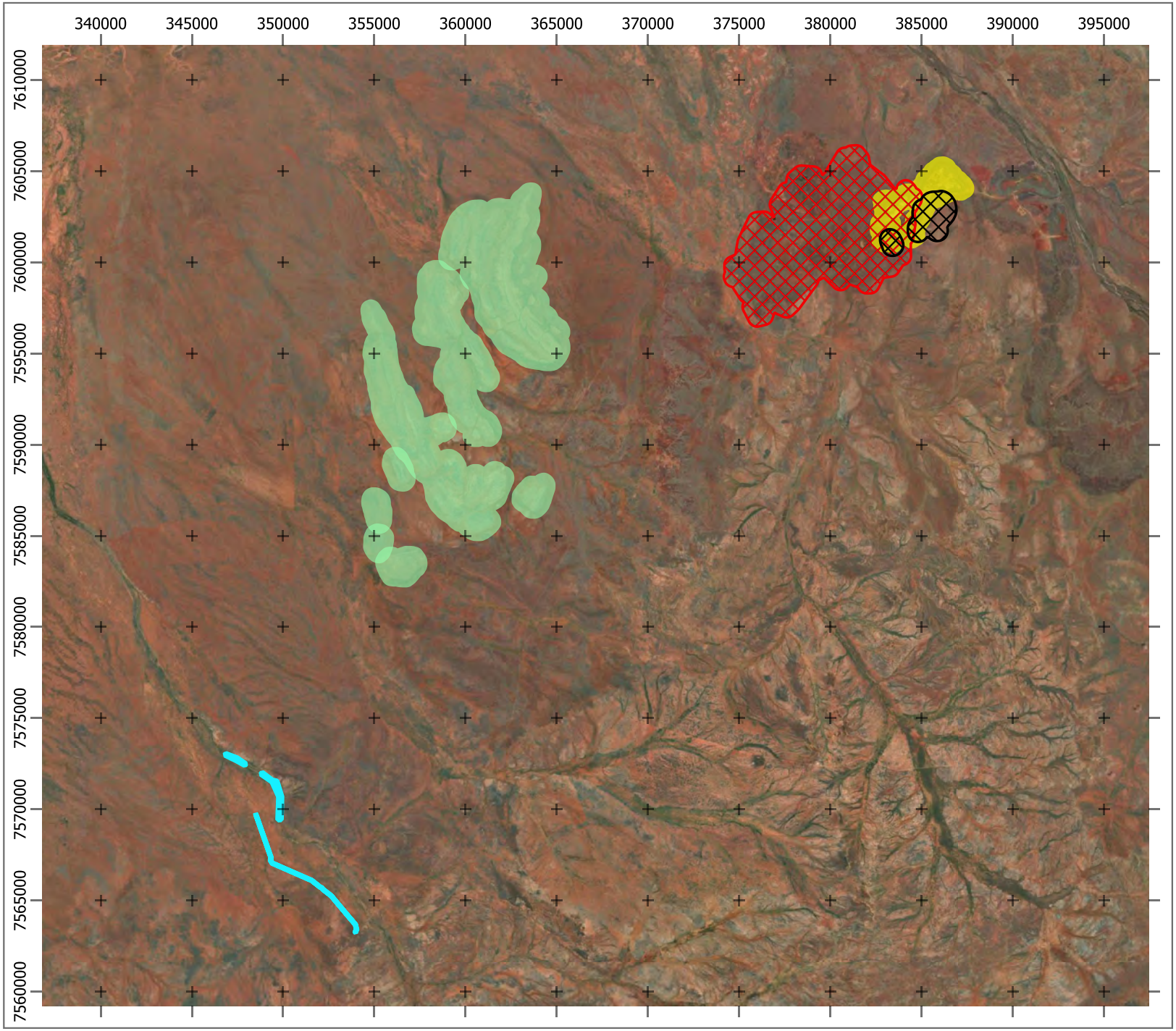
Table 4-1. Likelihood of occurrence assessment

Species	Conservation Code		Preferred Habitat	Likelihood of Occurrence
	BC Act	EPBC Act		
Abutilon sp. Onslow (F. Smith s.n. 10/9/61)	P1		Flat, stony plain habitats or disturbed areas such as roadside verges.	Potential to occur. Suitable habitat in VTa.
Eleocharis papillosa	P3	VU	Red clay over granite, open clay flats. Claypans. Ephemeral wetlands, predominantly freshwater and semi-saline swamps (DCCEEW 2022).	Unlikely
Eremophila forrestii subsp. *viridis*	P3		Prefers red sand dune habitats. Have been found growing in dry gullies on the scree slopes of weathered lateritic mesa.	Unlikely
Goodenia nuda	P4		Has been previously found in drainage lines of red-brown loamy sand or sandy loam and in disturbed roadside areas	Potential to occur. Suitable habitat in VTc.
Helichrysum oligochaetum	P1		Red clay. Alluvial plains.	Potential to occur. Suitable habitat in VTc.
Indigofera roseola	P1		Occurs on red sandy loams of the upper parts of sand dunes (Wilson and Rowe 2015).	Unlikely
Ptilotus mollis	P4		Stony hills and screes. Laterite.	Unlikely
Seringia exastia	T	CR	Occurs in a diversity of habitat types including relict desert dune swale or crests in deep red sand (pindan soil), or rocky scree slopes, or plateaus of ironstone gorges or sandstone outcrops, riverine open woodland and deciduous vine thicket (DCCEEW 2022)	Potential to occur. Suitable habitat in VTa, and VTc.
Solanum pycnotrichum	P2		Dry creeklines forming shallow gully on rocky siltstone hills. Red silty clay soil.	Unlikely
Triumfetta echinata	P3		Red sandy soils. Sand dunes. Often absent in vegetation that has not been exposed to fire in a number of years because its seeds require fire to germinate.	Unlikely

4.1.2 Threatened and Priority Ecological Communities

There are no TEC's listed under the BC Act or EPBC Act known to occur within the Survey Area.

Four Priority 1 Ecological Communities are located within 50 km of the Survey Area; Robe Valley Mesas, Robe Valley Pisolithic Hills, Sand Sheet vegetation (Robe Valley), and Tanpool (Figure 4-2).



Legend

- Survey Areas

Priority Ecological Communities

- Robe Valley Mesas
- Robe Valley Pisolitic Hills
- Sand Sheet vegetation (Robe Valley)
- Tanpool

Scale: @ A4
1: 30,000

0 2.5 5 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: TB Approved: SA Date: 25/05/2022

Priority Ecological Communities

Prepared for:
G.R Ladyman

Figure: 4-2

4.1.3 Introduced Flora Species

NatureMap returned 17 introduced flora species known to occur within 50 km of the Survey Area. Two species that are classed as declared pests in WA, and weeds of national significance were returned from this database search.

Six introduced flora species have been recorded adjacent to the Survey Areas by Astron Environmental Services during a flora and vegetation survey undertaken in 2013. These were *Cenchrus ciliaris, Cenchrus setiger, Euphorbia hirita, Malvastrum americanum, Setaria verticillata* and *Solanum nigrum.*

Table 4-2 lists the introduced flora species recorded within 50 km of the Survey Area.

Table 4-2. Introduced Flora Records within 50 km of the Survey Area

Species	Common Name	BAM Act Listing	WoNS*
Aerva javanica	Kapok Bush	S11 - Permitted	No
Alternanthera pungens	Khaki Weed	S11 - Permitted	No
Arivela viscosa (formerly Cleome viscosa)	Tickweed	S11 - Permitted	No
Cenchrus ciliaris	Buffel Grass	S11 - Permitted	No
Cenchrus setiger	Birdwood Grass	S11 - Permitted	No
Chloris barbata	Purpletop Chloris	S11 - Permitted	No
Cylindropuntia fulgida var. mamillata	Boxing Glove Cactus	S22 - Declared Pest (C3 Restricted)	Yes
Echinochloa colona	Awnless Barnyard Grass	S11 - Permitted	No
Euphorbia hirta	Asthma Plant	Not Listed	No
Flaveria trinervia	Speedy Weed	Not Listed	No
Malvastrum americanum	Spiked Malvastrum	S11 - Permitted	No
Passiflora foetida var. hispida	Stinking Passion Flower	S11 - Permitted	No
Prosopis pallida	Mesquite	S12 – Declared Pest (C2 Prohibited)	Yes
Setaria verticillata	Whorled Pigeon Grass	S11 - Permitted	No
Solanum nigrum	Black Berry Nightshade	S11 - Permitted	No
Sonchus oleraceus	Common Sowthistle	S11 - Permitted	No
Vachellia farnesiana	Mimosa Bush	S11 - Permitted	No

4.2 FIELD SURVEY

4.2.1 Flora

The flora of the Survey Area contains 105 taxa, including species, subspecies and varieties. This total is comprised of 99 native species and 6 introduced species. Four collections could not be identified beyond genus level due to the lack of flowering parts or fruiting bodies, or because they were only found in juvenile form. The mean species richness was 18 species per quadrat.

The Poaceae (grass family, 19 native, 3 introduced), Fabaceae (pea family, 17 native, one introduced), Amaranthaceae (14 native species) and Malvaceae (11 native species) were the most species-rich families recorded. Twenty-eight families were recorded across the Survey Area.

The complete list of plant species recorded within the Survey Area is presented in Appendix F. Floristic groups identified in the cluster analysis were organised into vegetation types and are discussed in the following section. No Threatened or Priority flora were recorded within the Survey Area.

The four introduced flora species recorded are detailed in Section 4.2.4.

4.2.2 Vegetation Types

Three vegetation types are described for the Survey Area and are summarised in Table 4-3 below. Each vegetation type is described in detail in the subsections below. Site characteristics and photos of the survey locations are included in Appendix C.

Table 4-3. Vegetation Types

Code	NVIS L3	NVIS L5	Landform	Releves	Extent (ha)	Photo
VTa	*Triodia* mid hummock grassland	*Corymbia hamersleyana* and *Acacia xiphophylla* low isolated trees; *Acacia bivenosa, Acacia synchronicia and Grevillea wickhamii* tall isolated shrubs; *Triodia epactia, Triodia basedowii* and *Paspalidium constrictum* mid open hummock grassland	Gently undulating stony plains	22, 23, 24, 25, 26	4.154	
VTb	*Eucalyptus camaldulensis* low open woodland	*Eucalyptus camaldulensis* and *Melaleuca argentea* low open woodland; *Melaleuca glomerata, Acacia trachycarpa, Vachellia farnesiana* tall sparse shrubland; *Cyperus vaginatus, Dichanthium sericeum* subsp. *sericeum, Eragrostis tenellula* low isolated tussock grasses/sedges.	Fluvial zone in stream channel with coarse sand	1, 7, 9, 16, 19	24.757	

Code	NVIS L3	NVIS L5	Landform	Releves	Extent (ha)	Photo
VTc	*Eucalyptus camaldulensis* low open woodland	*Eucalyptus camaldulensis* and *Melaleuca argentea* low open woodland; *Acacia trachycarpa, Melaleuca glomerata, Acacia pyrifolia* tall sparse shrubland; *Triodia epactia, Cenchrus setiger, Cenchrus ciliaris* mid sparse hummock/tussock grassland	Riparian zones with coarse sand and/or minor alluvium	2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 17, 18, 20, 21	40.092	
D	Disturbed	Cleared of vegetation	Cane River Access Road		5.074	

The distribution of vegetation types within the Survey Area are shown in Figure 4-2.

4.2.2.1 *Triodia* mid hummock grassland on gently undulating stony plains (VTa)

Overstorey Layer: 3.5 to 4 m tall (0.4% cover): The low isolated overstorey trees of this vegetation type are *Acacia xiphophylla* and *Corymbia hamersleyana*.

Shrub Layer: 3.5 m tall (5% cover): Tall sparse shrub layer of *Acacia bivenosa* and *Acacia synchronicia* and *Grevillea wickhamii* and the low shrub *Ptilotus obovatus* are also present.

Ground Layer: 0.2 to 1.5 m tall (10% cover): The ground layer is the dominant vegetation stratum and is characterised by *Triodia epactia* and *Triodia basedowii* hummock grasses. Tussock grasses such as *Aristida contorta*, *Aristida holathera* var*. holathera, Eriachne aristidea Paspalidium constrictum* and *Eragrostis tenellula* and forbs such as *Afrohybanthus aurantiacus, Amaranthus undulatus, Blumea* ?*tenella, Boerhavia burbidgeana, Euphorbia tannensis* subsp. *Eremophila, Portulaca oleracea* and *Ptilotus exaltatus* also occur frequently within this vegetation type.

Within the Survey Area this vegetation type occurs on gentle undulating stony plains with red loamy sand. It occurs along the length of the Access Road.

Impacts from cattle grazing are low in this vegetation type, and weeds are absent. The condition of this vegetation is generally Very Good except in the area near R26 where some effects of sheet erosion were evident. Within the Survey Area this vegetation type is limited to narrow strips adjacent to the Cane River Access Road. The road has been mapped separately as Disturbed and has a condition of Completely Degraded.

Total richness: 47 species

Introduced/exotic taxa: No introduced species were recorded in this vegetation type.

4.2.2.2 *Eucalyptus camaldulensis* low open woodland in the fluvial zone (VTb)

Overstorey Layer: 3.5 to 5 m tall (3.8% cover): The low isolated overstorey trees of this vegetation type are *Eucalyptus camaldulensis* and *Melaleuca argentea*.

Shrub Layer: 3 m tall (0.5% cover): Isolated tall shrubs to 3 m of *Melaleuca glomerata, Acacia trachycarpa, Sesbania cannabina* and the introduced species *Vachellia farnesiana*.

Ground Layer: 0.2 to 0.4 m tall (1% cover): low isolated sedges, tussock grasses, and forbs commonly containing *Cyperus vaginatus, Fimbristylis littoralis, Dichanthium sericeum* subsp. *sericeum, Eragrostis tenellula, Urochloa occidentalis* var*. ciliata*, *Vigna lanceolata, Ipomoea muelleri, Goodenia lamprosperma, Euphorbia tannensis* subsp. *Eremophila, Centipeda minima* and *Alternanthera nana.*

Within the Survey Area this vegetation type occurs in the active river channel or fluvial zone with coarse light brown sands. It occurs within all the prospecting tenement areas and is the area's most frequently inundated following substantial rain. Rocky areas occur and many pools and saturated areas were present at the time of survey. It is likely that as the surface water dries a greater cover of annual grasses and small shrubs is present. There are a few scattered trees but generally the areas are open and contain only annual or short-lived perennial flora as frequent disturbance from flooding prohibits the establishment of larger woody species.

Impacts from cattle grazing are low in this vegetation type, and weeds are a minor occurrence, however it is likely that the diversity and cover of weeds would increase as the surface water dries. The condition of this vegetation is generally Very Good.

Total richness: 23 species

Introduced/exotic taxa: *Vachellia farnesiana, Passiflora foetida.*

4.2.2.3 *Eucalyptus camaldulensis* low open woodland in the riparian zone (VTc)

Overstorey Layer: 3.5 to 5 m tall (6.7% cover): The low isolated overstorey trees of this vegetation type are *Eucalyptus camaldulensis* and *Melaleuca argentea*.

Shrub Layer: 3 m tall (3.2% cover): tall sparse shrubland of *Acacia trachycarpa, Melaleuca glomerata, Acacia pyrifolia, Jasminum didymum* subsp. *lineare, Acacia tumida* var. *pilbarensis, Acacia ancistrocarpa* and the introduced species *Vachellia farnesiana.*

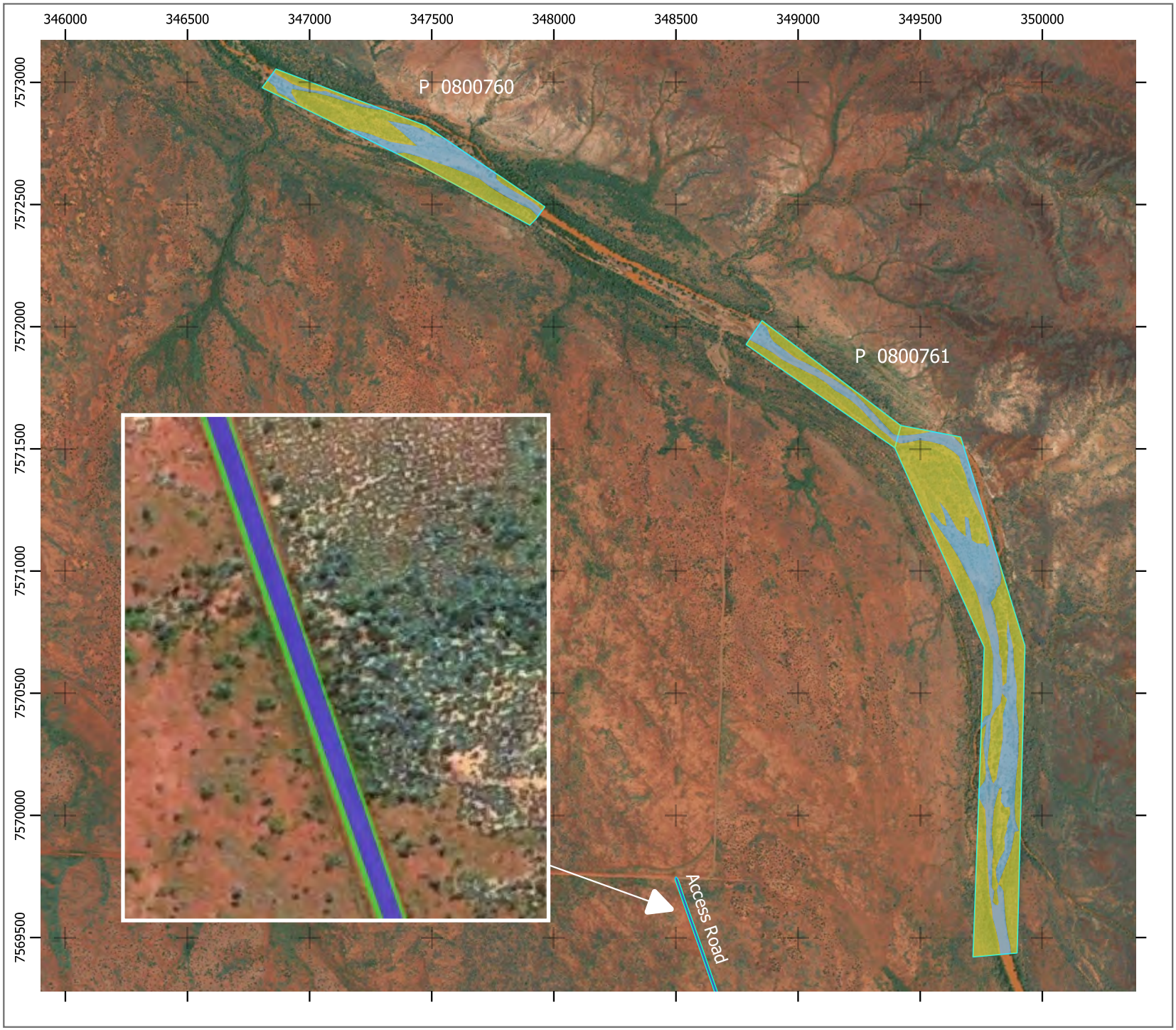
Ground Layer: 0.2 to 0.4 m tall (8% cover): mid sparse hummock grassland of *Triodia epactia,* with common occurrences of the introduced tussock grasses *Cenchrus setiger* and *Cenchrus ciliaris. Abutilon lepidum, Alternanthera nana, Amaranthus undulatus, Blumea ?tenella, Centipeda minima, Cleome uncifera* subsp. *uncerfera, Cyperus vaginatus, Euphorbia tannensis* subsp. *Eremophila, Ipomoea muelleri, Paspalidium clementii, Rhynchosia minima, , Sida rohlenae* subsp. *rohlenae* and *Vigna lanceolata* are also common.

Within the Survey Area this vegetation type occurs in the riparian or parafluvial zone on the banks of the active channels and in older channels that only flood during very high rainfalls. It occurs within all the prospecting tenement areas surrounding the VTb areas. The soil type is coarse brown alluvial sand but there is a greater accumulation of litter in this zone. Soils were moist from recent rainfall but not saturated and no surface water was present in this zone. The vegetation is thicker than in the active channels and large woody vegetation is the dominant strata.

Impacts from cattle grazing are moderate in this vegetation type, and weeds are a major occurrence, particularly the presence of *Cenchrus setiger* and *Cenchrus ciliaris,* aggressive agricultural grasses that increase fire risk. The condition of this vegetation is generally Good.

Total richness: 67 species

Introduced/exotic taxa: *Euphorbia hirta*, *Cenchrus setiger, Cenchrus ciliaris Passiflora foetida, Setaria verticillata,* and *Vachellia farnesiana.*



Legend

- VTa
- VTb
- VTc
- Disturbed

Scale: @ A4
1: 22,000

0 250 500 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 27/07/2022

Vegetation types

Prepared for:
G. R. Ladyman

Figure: 4-3

4.2.3 Conservation Significant Flora

No T or P flora was recorded in the Survey Areas. Four specimens were unable to be determined to species level, however, they have been considered in relation to the significant flora list and are unlikely to be T or P flora. The Threatened flora *Seringia exastia* has the potential to occur in the Survey Area.

Prior to 2020, *S. exastia* was known only from a highly restricted geographic area under threat from the Port of Broome and therefore ranked as CR under both WA and Commonwealth legislation. Based on molecular results and morphological re-assessment of herbarium specimens Binks *et al.* (2020), revised the taxonomy of *Seringia* to synonymise *S. elliptica* under *S. exastia.* Records of *S. exastia* in the Cane River area were *S. elliptica* prior to Binks *et al.* (2020). *Seringia elliptica* was not considered a T species under the BC Act or the EPBC Act.

Since the two species were merged, *S. exastia* is now widespread in Australia. It occurs in WA from Paynes Find, to the Broome region, then extends east into the Northern Territory to south of Tennant Creek and Alice Springs, and then south to the north-west of South Australia.

Following the merge *S. exastia* is known to occur in a diversity of habitat types including relict desert dune swale or crests in deep red sand (pindan soil), or rocky scree slopes, or plateaus of ironstone gorges or sandstone outcrops, riverine open woodland and deciduous vine thicket.

No *S. exastia* was recorded from the Study Area during detailed survey or Targeted Searches. In 2021 the species was nominated for delisting under the BC Act (DBCA 2021a). The species is no longer eligible for listing under the EPBC Act. The species has not been reassessed under either act at this time and retains its threatened status.

4.2.4 Introduced Flora

Six weeds were recorded across the Survey Area. None of the recorded weeds are Declared under the BAM Act or are considered WoNS. Weeds are listed in Table 4-4.

Table 4-4. Introduced Flora Recorded in the Survey Areas

Species	Description (Florabase 2022)
Cenchrus ciliaris	Tufted or sometimes stoloniferous perennial, grass-like or herb. 0.2 - 1.5 m high. Flowers purple from February to October. Grows on white, red, or brown sand, stony red loam, or black cracking clay.
Cenchrus setiger	Erect, tussocky, stoloniferous perennial, herb or grass-like. Grows to 0.5 m high. Flowers cream to purple from April to May. Grows on brown sands, red loam, or pindan soils on sand dunes, plains, rangelands, stony hillsides, or floodplains.
Euphorbia hirta	Erect or decumbent, much-branched annual, herb. 0.1-0.8 m high. Flowers yellow to green to white from January to October. Grows on alluvial soils, often along watercourses.
Setaria verticillata	Loosely tufted annual, grass-like or herb. 0.1-1.3 m high. Flowers December to June. Grows on sand, clay, and loam.

Vachellia farnesiana	Erect, spreading, thicket-forming, thorny tree or shrub. Grows to 4 m high. Bark dark grey and rough and leaves pinnate. Flowers yellow from June to August. Grows on stony sandy, clay or loam soils, or gravel in low-lying areas, river and creek banks, and disturbed sites.

5 TERRESTRIAL VERTEBRATE FAUNA RESULTS

5.1 DESKTOP STUDY

5.1.1 Significant Fauna

No Significant fauna have previously been recorded within the Survey Area. The DBCA database returned 43 species previously been recorded within 60 km of the Survey Area. Of these, four are listed as CR, one as Endangered (**EN**) and six as VU under the BC Act. Other specially protected species include four listed as Priority 4 (**P4**), 27 are listed as migratory (**Mi**) bird species and one listed as Other Specially Protected (**OS**).

One additional T and three additional Mi species were returned from the PMST that do not have DBCA database records within 60 km. The literature review identified no additional species within the locality.

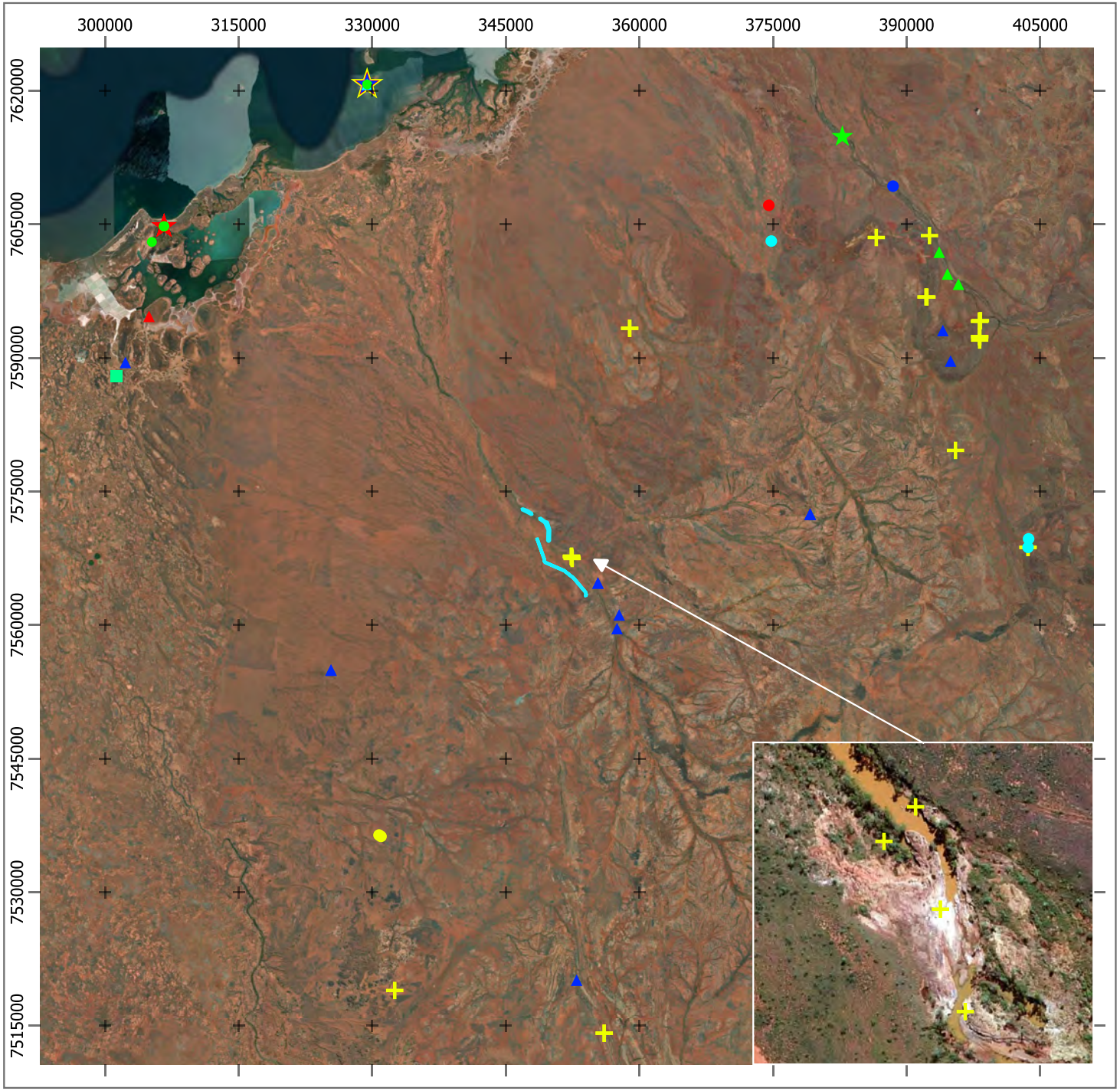
Locations of Threatened and Priority species recorded on the DBCA database in relation to the Survey Area are shown in Figure 5-1.

Significant fauna identified in the desktop study are listed in Table 5-1, with a summary of preferred habitat, and an assessment of likelihood of occurrence in the Survey Area based on these habitats.

5.1.2 Introduced Fauna

NatureMap records for 5 introduced fauna were returned and are listed below:

- Cat (*Felis cattus*);
- Cattle (*Bos taurus*);
- Dog/Dingo (*Canis lupus*);
- Horse (*Equus caballus*); and
- House Mouse (*Mus musculus*).



Legend

Survey Areas

Critically Endangered

- Curlew Sandpiper
- Eastern Curlew
- Great Knot
- Night Parrot

Endangered

- Northern Quoll

Vulnerable

- Fairy Tern
- Ghost Bat
- Greater Sand Plover
- Grey Falcon
- Pilbara Leaf-Nosed Bat
- Red Goshawk

Priority 4

- Fortescue Grunter
- Grey-tailed Tattler
- Lakeland Downs Mouse
- Pebble-Mound Mouse

Specially Protected

- Peregrine Falcon

Scale: @ A4
1: 650,000

0 10 20 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Animal Plant Mineral Pty Ltd

Author: TB Approved: SA Date: 07/07/2022

Threatened and Priority Fauna Records

Prepared for:
G.R Ladyman

Figure: 5-1

Table 5-1. Significant fauna database records and likelihood of occurrence

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
-- Birds --					
Actitis hypoleucos	Common Sandpiper	Mi	Mi	Edge of sheltered waters salt or fresh (*e.g.* estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations where low perches are available (Johnstone and Storr, 1998). Shallow, pebbly, muddy or sandy edges of rivers and streams coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers, waterways in mangroves or saltmarshes; mudflats: rocky or sand beaches; causeways, riverside lawns, drains, street gutters. (Pizzey and Knight, 2012).	**Potential to occur** - Eight of the nine database records were made in 2015 in an estuarine environment on the outskirts of Onslow (52 km west). However, another record exists proximal to the Ashburton River, near Nanutarra (60 km south). The fluvial zone, where water accumulates and remains in situ for longer periods, provides ideal habitat for this species. The presence in the Ashburton River confirms the likelihood of occurrence along the Cane River, as the micro-habitats are similar. Habitat within the Survey Area occurs where low perches are available, such as submerged fallen trees with extruding limbs, trees overhanging pools.
Apus pacificus	Fork-tailed Swift	Mi	Mi	Broadly distributed aerial species that is not specifically limited to any particular habitat type. Aerial: over open country, from semi-arid deserts to coasts, islands; sometimes over forests, cities. (Pizzey and Knight, 2012). Occurs over dry or open habitats comprising of riparian woodland, low scrub, heathland, or saltmarsh, also grasslands and sandplains with spinifex. (Morcombe, 2011).	**Potential to occur** - Three records were made from 2011 - 2015 on the outskirts of Onslow (52 km west). This species rarely comes to land. Suitable habitat occurs in the airspace above the Survey Area.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				Feeds on insects caught in flight and rarely lands except to roost for long periods or nest.	
Ardenna pacifica	Wedge-tailed Shearwater	Mi	Mi	Oceanic – foraging in the open ocean. Roosting/nesting in burrows excavated in sandy dune systems or under shoreline breakaways/cliffs.	**Unlikely** – A Seabird. No habitat in the Survey Area.
Arenaria interpres	Ruddy Turnstone	Mi	Mi	Tidal mud and reef flats, sheltered rocky coasts, stony and sea-weedy beaches and sandpits, dry coral ridges (Abrolhos) and pebbly shores of near-coastal saltlakes (including saltwork ponds). (Johnstone and Storr, 1998).	**Unlikely** – A coastal or near coastal species preferring saline environments. No habitat in the Survey Area.
Calidris acuminata	Sharp-tailed Sandpiper	Mi	Mi	Scarce to moderately common (much more plentiful near coasts than in interior). (Johnstone and Storr, 1998). Tidal mudflats, saltmarshes, mangroves; shallow fresh, brackish or saline inland wetlands; floodwaters, irrigated pastures and crops; sewage ponds, saltfields. Widespread summer migrant to coastal and inland Australia. (Pizzey and Knight, 2012).	**Unlikely** – No records within 50 km, PMST indicates suitable habitat may occur. This species prefers to forage in muddy/silty substrates, rather than sand or gravel as present in the Survey Area. Riverine habitats are not favoured.
Calidris alba	Sanderling	Mi	Mi	Mainly steeply shelving sandy beaches exposed to ocean swell. Also, sandy inlets, estuarine sandbanks and near-coastal salt lakes (including saltwork ponds). (Johnstone and Storr, 1998) Broad ocean beaches of firm sand 'where waves ebb and flow', depositing strands and heaps of seaweed; often near river mouths; also inlets, tidal mudflats, coastal lagoons. (Pizzey and Knight, 2012)	**Unlikely** – A coastal or near coastal species preferring saline environments. No habitat in the Survey Area.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Calidris ferruginea	Curlew Sandpiper	CR	CR, Mi	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds. (Johnstone and Storr, 1998) Tidal mudflats; saltmarsh, saltfields; fresh, brackish or saline wetlands; sewage ponds. (Pizzey and Knight, 2012)	**Potential to occur** - Database records for this species is limited to one from 2015 on an island offshore from Onslow, 53 km north-west of the Survey Area. Within the Survey Area, shallow surface water in the fluvial zone, during periods of inundation are suitable habitat. The habitat is unsuitable when surface water dries.
Calidris melanotos	Pectoral Sandpiper	Mi	Mi	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also, samphire flats around estuaries and saltlakes. (Johnstone and Storr, 1998) Shallow fresh waters, often with low grass or other herbage; swamp margins, flooded pastures, sewage ponds, occasionally tidal areas, saltmarshes. (Pizzey and Knight, 2012) Present in Australia from August to April.	**Potential to occur** - Despite the preference for freshwater habitats, the three records at Onslow (50 km west-north-west) are located in the supra-tidal zone. Within the Survey Area, larger open river pools in the fluvial zone, along the main channel of the river are suitable habitat.
Calidris ruficollis	Red-necked Stint	Mi	Mi	Edge of sheltered salt, brackish or fresh waters; mainly estuaries, beaches, near-coastal saltlakes (including saltwork ponds) and freshwater swamps and lakes (especially when drying); also inland saltlakes and fresh waters, sewage ponds and bore overflows. (Johnstone and Storr, 1998) Tidal mudflats, saltmarshes; sandy or shelly beaches; saline and freshwater wetlands, coastal and inland; saltfields, sewage ponds. (Pizzey and Knight, 2012)	**Unlikely** – The only record of this species in the vicinity is north of Onslow (52 km north-west) on the supra tidal zone adjacent a tidal channel. This species occupies predominantly open water bodies, when drying. It is unlikely that any of the habitats in the Survey Area are suitable as the riverine margins are too closed or confined for this species, and the banks are too steep.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Calidris tenuirostris	Great knot	CR	CR, Mi	Mud or sand flats in estuaries and on sheltered coasts. Also near-coastal saltlakes, including saltwork ponds. (Johnstone and Storr, 1998) Tidal mudflats; sandy ocean and bay shores; estuaries; shallow saline and freshwater wetlands. (Pizzy and Knight, 2012)	**Unlikely** – Database records for this species is limited to one from 2015 on an island offshore from Onslow, 53 km north-west of the Survey Area. This species prefers saline habitats. No habitat of value occurs in the Survey Area.
Charadrius leschenaultii	Greater Sand Plover	VU, Mi	VU, Mi	Mainly sandy beaches and tidal mud, reef and sand flats. Also shores of near-coastal saltlakes, including saltwork ponds. (Johnstone and Storr, 1998) Wide, sandy or shelly beaches; sandspits, tidal mudflats, reefs, sand bays, mangroves, saltmarsh, dune wilderness, bare paddocks, seldom far inland. (Pizzy and Knight, 2012)	**Unlikely** – All of the 11 records made at Onslow (50 km north-west) between 1992 and 2015 occur on the coast or in the estuarine biomes. No habitat occurs in the Survey Area.
Charadrius veredus	Oriental plover	Mi	Mi	Mainly occupies sparsely vegetated plains, including samphire and short-grass flats. Also beaches and tidal flats (especially during passage) and saltwork and sewage ponds (Johnstone and Storr, 1998). Open plains; bare, rolling country, often far from water; ploughed land; muddy or sandy wastes near inland swamps or tidal mudflats; bare claypans; margins of coastal marshes; grassy airfields, sportsfields, lawns. (Pizzy and Knight, 2012)	**Unlikely** – Database records for this species include two records from the supra tidal zone and samphire flats around Onslow (50 km north-west). It occupies a broad variety of environments from coastal margins to inland plains, however the common habitat attribute favoured by this species is open country. No suitable habitat occurs in the Survey Area.
Chlidonias leucopterus	White-winged Black Tern	Mi	Mi	Mainly estuaries and sheltered seas in the north, mainly freshwater lakes and swamps in the south; also samphire and short-grass flats, saltlakes, saltwork and sewage ponds and lucerne crops. Attracted to emerging dragonflies	**Unlikely** – Database records for this species is limited to one recorded close to the coast north of Onslow (53 km north-north-west).

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				(*Hemifax papuensis*), swarming locusts and grasshoppers and schools of tuna (*Kishinoella tonggol*). (Johnstone and Storr, 1998) Large wetlands, coastal and inland; saltfields sewage ponds, estuaries and coastal waters. (Pizzey and Knight, 2012)	The water bodies in the Survey Area are not suitable for this species.
Erythrotriorchis radiatus	Red Goshawk	VU	VU	Well-wooded country. (Johnstone and Storr, 1998) Open forests, woodlands, especially near rivers, wetlands; rainforest fringes (Pizzy and Knight, 2012).	**Potential to occur** - One individual was sighted at the Robe River / NW Coastal Highway Bridge in 2019 (53 km north-east). Eucalyptus species of a similar size and density occur within the Survey Area. The parafluvial habitat is suitable nesting habitat for red goshawk. All habitats in the Survey Area are suitable foraging habitat.
Falco hypoleucos	Grey Falcon	VU	VU	Mainly lightly wooded and coastal riverine flats. (Johnstone and Storr, 1998) Lightly treed and inland plains; gibber deserts, sandridges, pastoral lands, timbered watercourses; seldom in driest deserts (Pizzy and Knight, 2012).	**Potential to occur** - Two individuals were recorded 39 km south-south-west in open plains, in association (not proximal) with a wooded drainage line. The fluvial and parafluvial habitats within the Survey Area are suitable breeding habitat and all habitats are suitable for foraging.
Falco peregrinus	Peregrine Falcon	OS	-	Mainly about cliffs along coasts, rivers and ranges, and about wooded watercourses and lakes (Johnstone and Storr, 1998). Cliffs, gorges, timbered watercourses, environs of rivers, wetlands, plains, open woodlands, pylons, spires, buildings. (Pizzey and Knight, 2012)	**Potential to occur** - One individual was recorded south of Onslow, in the open plains in 2012 (51 km north-west). The parafluvial habitat is suitable nesting habitat and all habitats in the Survey Area are suitable foraging habitat.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Gelochelidon nilotica	Gull-Billed Tern	Mi	Mi	Shallow sheltered seas close to land (in north), estuaries, tidal creeks and near-coastal saltlakes (including saltworks), inundated samphire flats, freshwater swamps and lagoons (including sewage ponds and bore overflows) and river pools; flooded saltlakes, claypans and watercourses in interior; also dams and feeding over dry land (including grain crops). (Johnstone and Storr, 1998) Beaches, mudflats; fresh brackish wetlands, including far inland; grasslands, crops, ploughed fields, airfields. (Pizzey and Knight, 2012)	**Potential to occur** - Database records for this species is limited to one in 2012 in Onslow (52 km north-west), adjacent the salt works. The fluvial habitats are suitable at times where surface water pools are present. The habitat is unsuitable when pools have dried.
Glareola maldivarum	Oriental pratincole	Mi	Mi	Feeding in air and roosting on bare ground beside water, *e.g.* tidal flats and floodwaters. (Johnstone and Storr, 1998) Plains; shallow wet and dry edges of open bare wetlands; tidal mudflats, beaches. (Pizzey and Knight, 2012)	**Unlikely** – There are two records from Onslow (52 km north-west) made in 2002 and 2013. Another record was made near Mesa A (45 km north-west) in 2002. Local records occur within roadside verges. When containing surface water, roadside drainage verges provide open bare wetlands, the preferred habitat of the species. The habitats in the Survey Area are not suitable for this species.
Hirundo rustica	Barn swallow	Mi	Mi	Mainly towns and wetlands (sewage and saltworks ponds, river pools, swamps, tidal creeks and reservoirs). (Johnstone and Storr, 2004) Open country; agricultural land, especially near water; railyards, towns, overhead wires. (Pizzey and Knight, 2012)	**Unlikely** – This species tends to occupy settlements and the three records are all from the wharf at Onslow (52 km north-west).

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
					Though it can occupy natural habitats, it is unlikely to be found around the Survey Area and would not be specifically dependent upon it.
Limosa lapponica	Bar-tailed Godwit	Mi	Mi	Estuarine sand and mudflats and sandy and seaweedy beaches; also reef flats and near-coastal saltlakes (including saltwork ponds). (Johnstone and Storr, 1998) Tidal mudflats, estuaries, sandspits, shallow river margins, sewage ponds; inland on large shallow fresh or brackish waters. (Pizzey and Knight, 2012)	**Potential to occur** - Eleven records, from 1977 – 2015, were all made 52 km north-west, on offshore islands and at the Onslow wharf. The fluvial zone is suitable habitat when shallow water is available. The habitat is unsuitable when surface water has dried.
Motacilla cinerea	Grey Wagtail	Mi	Mi	Mainly banks and rocks in fast-running fresh water habitats; rivers, creeks, streams and around waterfalls, both in forest and open country; but occurs almost anywhere during migration. Flits from rock to rock, and often enters water after insects (Johnstone and Storr, 2004). In Australia, near running water in disused quarries; sandy, rocky streams in escarpments and rainforests; sewage ponds, ploughed fields, airfields. (Pizzey and Knight, 2012)	**Potential to occur** - No records within 50 km, PMST indicates suitable habitat may occur. The Atlas of Living Australia database shows the nearest record to be at the southern extent of the Kimberley, south and east of Roebuck Bay. Suitable habitat includes the fluvial and parafluvial habitats when surface water is present.
Motacilla flava	Yellow Wagtail	Mi	Mi	Damp short-grass flats: rice stubbles and edge of swamps, sewage ponds, bore overflows, grazed or mowed grass and irrigated areas. (Johnstone and Storr, 2004)	**Unlikely** – No records within 60 km, PMST indicates suitable habitat may occur. The Atlas of Living Australia database shows one record near the coast at Onslow (62 km north-west). The habitats in the Survey Area are not suitable for this species.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Numenius madagascariensis	Eastern Curlew	CR	CR, Mi	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds). (Johnstone and Storr, 1998) Estuaries, tidal mudflats, sandspits, saltmarshes, mangroves; occasionally fresh or brackish lakes; bare grasslands near water. (Pizzey and Knight, 2012)	**Unlikely** – One record, made in 1992 and 7 made from 2014 - 15 were all made nearshore at Onslow (52 km north-west). This species prefers predominantly saline habitats. The habitats in the Survey Area are not suitable for this species.
Numenius minutus	Little Whimbrel	Mi	Mi	Mainly short-grass plains, including sorghum stubble, airfields and sports grounds. Also burnt grasslands, dry riverbeds and tidal mud flats. (Johnstone and Storr, 1998) Dry grasslands, floodplains, margins of drying swamps; tidal mudflats, airfields, playing fields, crops, commercial saltfields, sewage ponds. (Pizzey and Knight, 2012)	**Unlikely** – Database records for this species is limited to one from the supra-tidal zone adjacent a tidal channel north of Onslow (52 km north-west). The habitat preferred by this species do not occur in the Survey Area.
Numenius phaeopus	Whimbrel	Mi	Mi	Mainly tidal mud and reef flats. Occasionally sandy beaches. Rarely near-coastal saltlakes, including saltwork ponds. (Johnstone and Storr, 1998) Estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, bare grasslands, sportsgrounds, lawns. (Pizzey and Knight, 2012)	**Unlikely** – Database records for this species is limited to one record, made in 1992 and 4 made from 2014 - 15 were all nearshore at Onslow (52 km north-west). This species prefers predominantly saline habitats. The habitat preferred by this species do not occur in the Survey Area.
Oceanites oceanicus	Wilson's storm-petrel	Mi	Mi	Oceanic – foraging in the open ocean.	**Unlikely** – A Seabird. No habitat occurs in the Survey Area.
Onychoprion anaethetus	Bridled Tern	Mi	Mi	Blue-water seas, generally close to breeding sites. (Johnstone and Storr, 1998)	**Unlikely** – A Seabird. No habitat occurs in the Survey Area.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				Tropical, subtropical seas; offshore islands; rarely coasts. (Pizzey and Knight, 2012)	
Pandion cristatus	Eastern Osprey	Mi	Mi	Moderately common to very common in sheltered seas around north and west-coast islands south to 31°S; uncommon to common on mainland coasts, estuaries and larger rivers north of tropic; rare to uncommon elsewhere. Usually single, occasionally in twos. Young birds banded on Rottnest I. have been recovered up to 600 km away (Johnstone and Storr, 1998). Coasts, estuaries, bays, inlets; islands and surrounding waters; coral atolls, reefs, lagoons, rock cliffs, stacks. Ascends larger rivers particularly in north; ventures far inland in the Finke River, Northern Territory (Pizzey and Knight, 2012).	**Potential to occur** - Twelve of the 17 records of this species were made near to the cost at Onslow (52 km north-west). Five records were made at the Robe River bridge on the NW Coastal Highway (53 km north-north-east). This species is noted as ascending large rivers inland from the coast. Suitable foraging habitat may occur in the fluvial zone when surface water is of sufficient quantity and duration to support prey. The habitat is unsuitable when surface water dries.
Pezoporus occidentalis	Night Parrot	CR	EN	Treeless or sparsely wooded spinifex *Triodia* spp. near water (including artesian bores) (Johnstone and Storr, 1998). Seeding spinifex on stony rises, breakaway country, sandy lowlands; shrubby glasswort, chenopods; succulents on flats around salt lakes; flooded claypans saltbush, bluebush, bassia associations (Pizzey and Knight, 2012).	**Unlikely** – One record was made in a riverine habitat 54 km north-north-west of the Survey Area in 1967. Night Parrot require a diversity of habitats including mature spinifex hummocks for sheltering and a diversity of food plants commonly including chenopods and grasses. No large mature hummock grasses suitable for night parrot shelter were observed in or surrounding the Survey Area. Chenopod species that provide forage for the Night Parrot were not recorded. The habitats in the Survey Area are not suitable for night parrot.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Pluvialis fulva	Pacific golden plover	Mi	Mi	Mainly salt or brackish marshes about estuaries and near-coastal saltlakes. Also near-coastal grassy flats, tidal mudflats, beaches, sewage and saltwork ponds and bore overflows. (Johnstone and Storr, 1998) Estuaries, mudflats, saltmarshes, mangroves; rocky reefs and stranded seaweed on ocean shores; margins of shallow open inland swamps; sewage ponds, short-grass paddocks, sportsgrounds, airfields, ploughed land. (Pizzey and Knight, 2012)	**Unlikely** – Database records for this species is limited to one record, made in 1977, from the supra-tidal zone adjacent a tidal channel north of Onslow (52 km north-west). This species favours saline habitats. Where it occupies freshwater habitats, it is generally in association with open grasslands. No suitable habitat occurs in the Survey Area.
Rostratula australis	Australian Painted-Snipe	EN	EN	Only a rare summer visitor to the North-west. Single birds recorded at man-made ponds in the Hamersley and Ophthalmia Ranges in December and January and a male recorded at Carnarvon in November. Commonly recorded in south and north-east Kimberley swampy plains before their degradation by cattle, but only five records since 1909. In arid interior a female about to lay collected at Brockman Creek in August 1896. In southwest evidently common in swamps of Swan Coastal Plain last century, but now only a very rare summer visitor (November to January); last breeding record in 1923 (near Moora) (Johnstone and Storr, 1998). Well-vegetated shallows and margins of wetlands, dams, sewage ponds; wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, open timber (Pizzey and Knight, 2012).	**Unlikely** – No records within 60 km, PMST indicates suitable habitat may occur. This is a very elusive species that occupies very dense vegetation around the margins of waterways. The habits in the Survey Area are not suitable for this species. The parafluvial zone is insufficiently dense to be suitable.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Sterna dougallii	Roseate Tern	Mi	Mi	Blue-water seas close to land (especially islands). (Johnstone and Storr, 1998) Offshore waters, islands, coral reefs, sand cays, beaches, tidal inlets. (Pizzey and Knight, 2012)	**Unlikely** – A Seabird. No suitable habitat occurs in the Survey Area.
Sterna hirundo	Common Tern	Mi	Mi	Sheltered seas, including estuaries; also near-coastal saltwork and sewage ponds. (Johnstone and Storr, 1998) Offshore waters, beaches, reefs, bays, estuaries, sandflats, saltfields, sewage ponds, freshwater wetlands. (Pizzey and Knight, 2012)	**Unlikely** – Two individuals were observed in 2015 at the Onslow wharf (52 km north-west). This species prefers predominantly saline habitats. No suitable habitat occurs in the Survey Area.
Sternula albifrons	Little Tern	Mi	Mi	Mainly sheltered seas, estuaries and mangrove creeks. Also near-coastal freshwater lagoons and saltwork ponds. (Johnstone and Storr, 1998) Coastal waters, bays, inlets, saline or brackish lakes, saltfields, sewage ponds near coast. (Pizzey and Knight, 2012)	**Unlikely** – Only one individual has been recorded and this was in a tidal lagoon at Onslow (52 km north-west). This species prefers predominantly saline habitats. No suitable habitat occurs in the Survey Area.
Sternula nereis	Australian Fairy tern	VU	VU	Sheltered blue-water seas close to land, estuaries (when free of silt) and near-coastal lakes. (Johnstone and Storr, 1998) Coastal waters, bays, inlets, saline or brackish lakes, saltfields, sewage ponds near coast. (Pizzey and Knight, 2012)	**Unlikely** – Only one individual has been previously recorded, on an island off the coast of Onslow (52 km north-west). There are no open water bodies in the Survey Area that are suitable for this species.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
Thalasseus bergii	Crested Tern	Mi	Mi	Mainly blue-water seas (especially within 3 km of land), including southern estuaries in summer and autumn (when free of silt); also tidal creeks in north, but not penetrating far into larger estuaries (Cambridge Gulf, Prince Regent River, King Sound). (Johnstone and Storr, 1998) Coastal, offshore waters; beaches, bays, inlets, tidal rivers, salt swamps, lakes, larger rivers. (Pizzey and Knight, 2012)	**Unlikely** – Five records have been made between 1979 and 2015, onshore and nearshore at Onslow (52 km north-east). Habitat descriptions note this species seldom ascends water ways beyond the estuarine environment. No suitable habitat occurs in the Survey Area.
Tringa brevipes	Grey-tailed Tattler	Mi, P4	Mi	Mainly tidal mud and reef flats. Also, estuarine sand flats, beaches and near-coastal fresh and brackish waters. (Johnstone and Storr, 1998) Estuaries, tidal mudflats, mangroves; wave-washed rocks and reefs; shallow river margins, coastal or inland. (Pizzey and Knight, 2012)	**Unlikely** – Only one individual has been recorded (1992) and this was on an island off the coast of Onslow (52 km north-west). This species prefers predominantly saline habitats. No suitable habitat occurs in the Survey Area.
Tringa glareola	Wood Sandpiper	Mi	Mi	Mainly shallow fresh waters (lagoons, swamps, claypans, river pools, dams, bore overflows and sewage ponds); occasionally brackish swamps, rarely saltlakes and estuaries (Johnstone and Storr, 1998). Muddy margins of wetlands; tidal mangroves; margins of tidal mudflats; saltmarshes, sewage ponds (Pizzey and Knight, 2012).	**Potential to occur** - One record was made at the Robe River bridge on the NW Coastal Highway (53 km north-north-east). As it utilises river pools, this species has the potential to occur in the Survey Area within the fluvial habitat when surface water is present. The habitat is unsuitable when surface water dries.
Tringa nebularia	Common Greenshank	Mi	Mi	Shallow fresh waters (claypans, lagoons, swamps, river pools, dams and sewage ponds) and salt waters (estuaries, mangrove creeks, lakes, samphire flats, reef flats and saltwork ponds). (Johnstone and Storr, 1998)	**Potential to occur** - One record, made in 1992, and 6 made in 2015 were all made nearshore or onshore at Onslow (52 km north-west).

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				Mudflats, estuaries, saltmarshes, margins of lakes; wetlands, claypans, fresh and saline; commercial saltfields, sewage ponds. (Pizzey and Knight, 2012)	Suitable habitat occurs within the fluvial habitat when surface water is present, although preferred habitat is saline environments. The habitat is unsuitable when surface water dries.
Tringa stagnatilis	Marsh Sandpiper, Little Greenshank	Mi	Mi	Mainly shallow fresh or brackish waters: swamps, lakes, river pools, soaks, sewage ponds and bore overflows. Occasionally estuaries and salt ponds, and rarely coasts (Johnstone and Storr, 1998). Salt, brackish or freshwater wetlands; sewage ponds, commercial saltfields, bore drains, mangroves, tidal mudflats, estuaries (Pizzey and Knight, 2012).	**Potential to occur** - Database records for this species is limited to one made in 1977, from the supra-tidal zone adjacent a tidal channel north of Onslow (52 km north-west). Suitable habitat occurs within the fluvial habitat when surface water is present. The habitat is unsuitable when surface water dries.
Xenus cinereus	Terek sandpiper	Mi	Mi	Mainly tidal flats, also saltwork ponds (Johnstone and Storr, 1998). Tidal mudflats, estuaries; shores and reefs of islands; coastal swamps, commercial saltfields (Pizzey and Knight, 2012).	**Unlikely** – Database records for this species is limited to one individual recorded in 1992 on an island off the coast of Onslow (52 km north-west). No suitable habitat occurs in the Survey Area.
				-- Fish --	
Leiopotherapon aheneus	Fortescue grunter	P4		Endemic to the Pilbara region. Recorded from the Ashburton River to the Fortescue River (Atlas of Living Australia). Found in rocky pools and slow flowing sections of streams. Requires permanent pools.	**Unlikely** – No permanent pools are present in the Cane River (Department of Water, 2011). No suitable habitat occurs in the Survey Area.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
-- Mammals --					
Dasyurus hallucatus	Northern Quoll	EN	EN	The Northern Quoll will usually den in hollow tree trunks (Hill & Ward, 2010) or in small caves and crevices in rocky outcrops. In the Pilbara region, the species tends to prefer the Rocklea, Macroy and Robe land systems (Biota Environmental Services 2008). These land systems comprise of basalt hills, mesas (and buttes of limonites), high and low plateaux, lower slopes, occasional tor fields and stony plains supporting either hard or soft spinifex grasslands (van Vreeswyk *et al.* 2004). The Northern Quoll has also been recorded in other land systems which comprise sandstone and dolomite hills and ridges, shrublands, sandy plains, clay plans and tussock grasslands and coastal fringes including dunes islands and beaches (Biota Environmental Services 2008).	**Potential to occur** - There are 24 database records for the northern quoll within 60 km of the Survey Area between 2009 – 2017. None of the land systems favoured by this species occur in the Survey Area. However, a portion of the Robe land system occurs 32 km south-south-east. Four records occur in the Cane River Conservation Reserve, in the Cane River channel less than 3 km from the Survey Area. Another 3 records occur in small outcrops adjacent plains and drainage lines in the Cane River Conservation Reserve (56 km south) and 1 record occurs in relatively flat open country at the water tank on Peedamulla station, 3 km east of a rocky ridgeline and 1.5 km west of a large drainage line. Hollow bearing trees within the parafluvial zone are suitable denning habitat. The parafluvial, floodplains and clay breakaways habitats are suitable foraging habitats.
Leggadina lakedownensis	Lakeland Downs Mouse	P4		Stony hummock grassland in the Pilbara (Menkhorst and Knight, 2010). Occupies a diverse range of environments from the monsoon tropical coast to semiarid climates, including spinifex and tussock grassland, samphire and sedgelands, *Acacia* Shrubland, tropical Eucalyptus and Melaleuca woodlands and stony ranges. Most habitats are seasonally	**Potential to occur** - One record was made near Onslow (52 km north-west) in 2003. Suitable habitat occurs in the parafluvial and floodplains habitats.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				inundated on red or white sandy-clay soils. (Van Dyck and Strahan, 2008)	
Macroderma gigas	Ghost Bat	VU	VU	Occupies a broad range of habitats including arid spinifex hillsides, black soil grasslands, monsoon forest, open savannah woodland, tall open forest, deciduous vine forest and tropical rainforest. Their distribution is influenced by the availability of suitable caves and mines for roost sites. (Churchill 2008). While it is daytime, they roost in deep, complex natural cave systems and rock fissures with stable temperatures of 23°–28° and a relative humidity of 50-100% (Woinarski *et al.* 2014). The Ghost Bat uses a surface foraging strategy in which it will perch on vegetation with vantage points to either ambush passing prey on the ground or in the air, or it will glean prey from the ground whilst in flight (Woinarski *et al.* 2014).	**Potential to occur** - Database records for this species is limited to one at Warramboo Borefield (43 km north-north-east). The location of the record is within proximity of a major drainage line. Suitable foraging habitat occurs in the parafluvial habitat type. No suitable roosting habitat is present.
Pseudomys chapmani	Pebble-mound Mouse	P4		Found on stony hillsides with hummock grassland (Menkhorst and Knight, 2009) Colonies occur on the gentler slopes of rocky ranges where the ground is covered by a stony mulch and vegetated by hard spinifex, often with sparse overstorey of Eucalypts and scattered shrubs, typically *Senna, Acacia* and *Ptilotus*. Mounds, however, are often sited close to narrow ribbons	**Potential to occur** - Fourteen records exist at varying distances from the Survey Area, but the majority occur near the mesa landforms to the north and east. Suitable habitat occurs in the Stony Plains habitat.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				of *Acacia* dominated scrub that grow along incised drainage lines. (Van Dyck and Strahan 2008)	
Rhinonicteris aurantia	Pilbara Leaf-Nosed Bat	P4	VU	Monsoon rainforest, tall open forest, open savannah woodland, black soil grassland and spinifex covered hills. They are more influenced by the availability of suitable roost caves than habitat type. During the dry (March to October) season they are dependent on cave systems that provide stable warm and humid conditions. Cave systems capable of providing these conditions are generally deep and complex. During the wet season (November to February) when ambient climatic conditions are hot and humid, it is thought that these bats become forest dwellers (Churchill 2008). During this time they roost in tree hollows. This species hunts by flying low to the ground in a zig zag pattern along corridors. As such, riverine sites provide ideal foraging habitat.	**Present** – Recorded during survey. Two of the three records occur 53 km west in the heavily dissected mesa country; one record was from Warramboo Borefield (39 km north-north-east) in a densely vegetated drainage line. Suitable wet season roosting habitat occurs in the parafluvial zone. Suitable foraging habitat occurs in the airspace above the fluvial and parafluvial zone.
				-- Reptiles --	
Liasis olivaceus subsp. *baronni*	Pilbara Olive Python	VU	VU	Recorded in areas with gorges and escarpments in close proximity to water holes (Doughty *et al.* 2011). During the cooler months they will typically hide in caves, crevices and fissures away from water sources. However, in the warmer months they become active and tend to stay near rocky outcrops and water.	**Potential to occur** - No records within 50 km, PMST indicates suitable habitat may occur. Suitable habitat occurs in the parafluvial zone, and the clay breakaways habitats.

Species	Common Name	Conservation Code		Relevant Habitat Preference	Likelihood of Occurrence
		BC Act	EPBC Act		
				Their preference for water holes is likely due to resulting abundance of prey, rather than a need for drinking water. This species readily swims in water holes to hunt prey.	

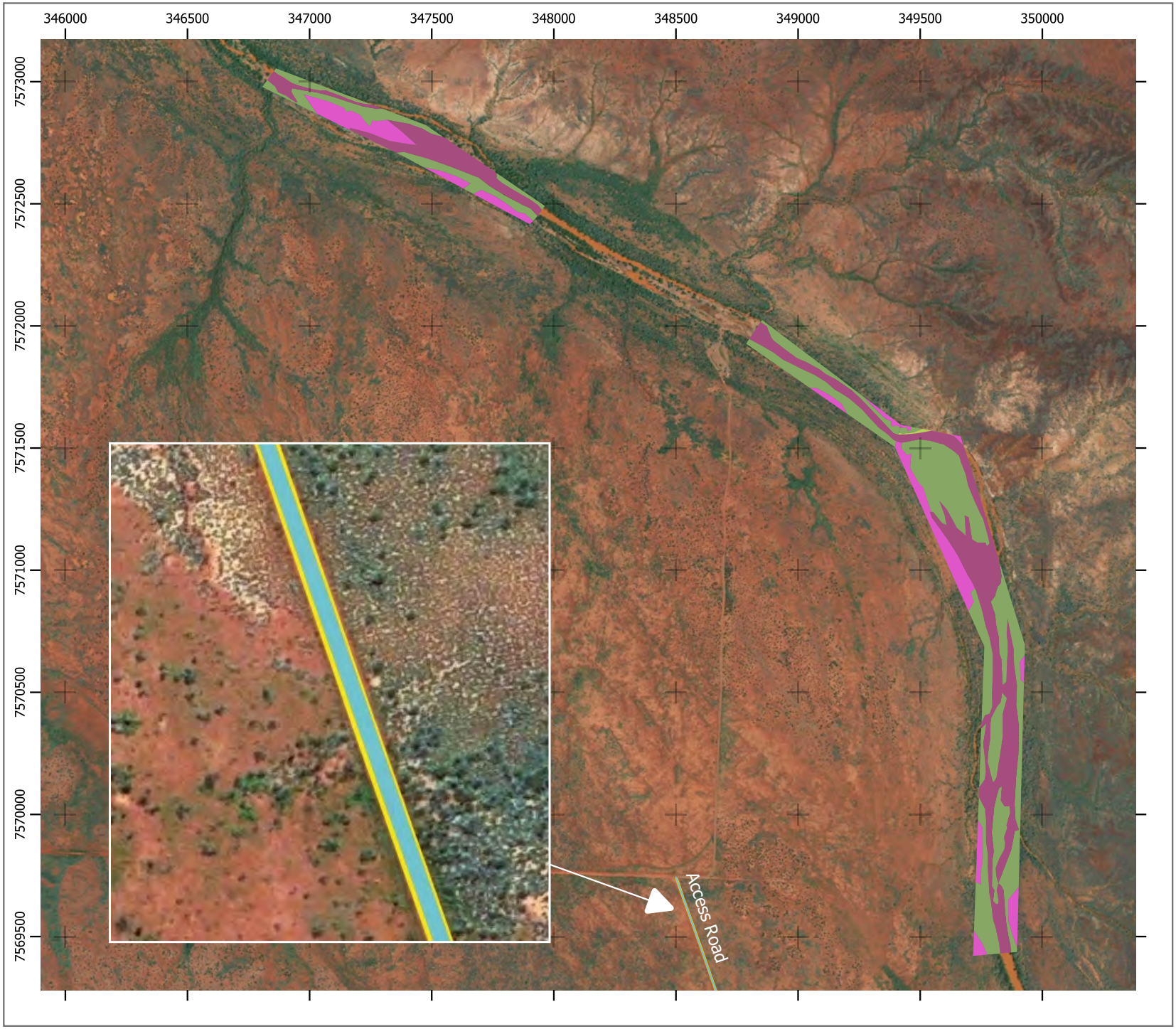
5.2 FIELD SURVEY

5.2.1 Fauna Habitats

Five fauna habitats are described for the Survey Area and are summarised in Table 5-2 below. Each fauna habitat is described in detail in the subsections below. The distribution of fauna habitats is shown in Figure 5-2. Photos of the habitat assessment locations are shown in Appendix D.

Table 5-2. Fauna Habitats within the Survey Area

Habitat Code	Name	Extent within Survey Area (ha)
FH1	Stony Plains	4.154
FH2	Fluvial Zone	24.757
FH3	Parafluvial Zone / Riverine Margins	31.079
FH4	Floodplains	8.916
FH5	Clay Breakaways	0.189
FH6	Disturbed	5.074



Legend

- Stony plains FH1
- Fluvial zone FH2
- Parafluvial zone/ Riverine margin FH3
- Floodplains FH4
- Clay Breakaways FH5
- Disturbed

Scale: @ A4
1: 22,000

0 250 500 m

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

Author: EH Approved: ML Date: 27/07/2022

Fauna habitat

Prepared for:
G. R. Ladyman

Figure: 5-2

5.2.1.1 FH1 Stony Plains

The Stony plains habitat occurs as gentle undulating stony plains with red loamy sand with hard and soft hummock grasses and isolated trees and tall shrubs. It occurs along the length of the Access Road. This area is within the Cane River Conservation Park.

Plate 5-1. FH1: Stony Plains Habitat (352989, 756438)

The Stony plains habitat outside of the Survey Area is in Excellent condition. The assessable area is in Good condition, it contains the existing gravel road and therefore is highly disturbed by vegetation clearing for the purposes of the track and vehicle movement along the track, however the vegetation along the sides of the track maintains structural integrity and there are no weeds. The track appears to be infrequently used.

5.2.1.2 FH2 Fluvial Zone

The Fluvial zone of the main channel consists of loose gravelly/stony and coarse alluvial sand substrate. This is the active river channel and substrate is moved and disturbed during flood periods. There is very little vegetation in this zone. *Melaleuca argentea, M. glomerata* and *Acacia trachycarpa* seedlings are present, however they do not establish as successive flooding disturbs the habitat and prohibits establishment of deep-rooted woody vegetation. Short-lived ephemeral grasses and herbs occur scattered through this zone which complete their life cycle within the interflow period.

Surface water is seasonally available and in the south of the Survey Area the semi-permanent Jabaddar Pool occurs. This is the most persistent surface water feature of the Cane River (Department of Water, 2011). During the Survey period surface water was present within the pools throughout the Survey Area.

During periods of inundation, shallow wading habitat, shallow pools and perches overhanging flowing and still water are present. These dry out to sandy bare river beds during the dry season.

Plate 5-2. FH2: Fluvial Zone Habitat (349743, 7570987)

The Fluvial zone habitats are in Excellent condition. The disturbances caused by periodic flooding are natural to the habitat. Weeds are uncommon and there is little evidence of cattle using this area, however that may increase as the surface water recedes to small pools.

5.2.1.3 FH3 Parafluvial Zone / Riverine Margin

The Parafluvial zone fringes the main drainage line along the length of the Survey Area. The vegetation in this zone consists of an open woodland of river red gum with a midstorey of occasional *Melaleuca argentea*, *Acacia trachycarpa, A. citrinoviridis* and *A. tumida*. The substrate is mostly of coarse alluvial sand with some patches of silty loamy sand present.

Due to the frequent flood disturbance of sediments and heavy cover of leaf litter and woody debris, the groundstorey vegetation in this area is relatively sparse. In areas where some alluvium has been retained, clumps of perennial grasses occur, such as soft spinifex (*Triodia epactia*), *Leptochloa digitata*, *Eulalia aurea*, as well as annual grasses and herbs such as *Goodenia lamprosperma*. The most abundant groundstorey vegetation is the introduced pastoral grasses *Cenchrus ciliaris* and *Cenchrus setiger*.

Plate 5-3. FH3: Parafluvial Zone / Riverine Margins Habitat (346872, 7573050)

The Parafluvial zone habitat is in Very Good condition. Disturbances are limited to the presence of weeds and moderate cattle grazing. The habitat retains its structural integrity and fire appears to be infrequent.

5.2.1.4 FH4 Floodplains

The Floodplains habitat is a back-channel zone where overbank floods flow through preferred pathways between the riparian area and the adjacent floodplain. This is a diverse habitat of undulating flood runner channels and depositional areas that flood only during overbank flow events. The substrate is a diverse mixture of silty loams through to coarse sand on undulating moisture shedding hummocks and moisture retaining depressions.

The vegetation consists of a very sparse number of smaller trees of river red gum with a midstorey of *Acacia trachycarpa* and other shrubby *Acacia* species and shrubs within the Malvaceae family. The understorey can include hummocks of soft spinifex (*Triodia epactia*) as well as other grasses including the native perennial grass *Dicanthium sericeum.* The introduced pastoral grasses *Cenchrus ciliaris, C. setiger* and *Setaria verticillata* are common. There is also a diverse though sparse mix of native and introduced annual herbs and grasses.

Flooding is a regular disturbance in this habitat. Many of these back-channel areas are also impacted by disturbances other than flooding, in particular livestock grazing. These areas can become dominated with introduced pasture grasses such *Cenchrus ciliaris* and *C. setiger* as well *Setaria verticillata* and *Enchinochloa colona*. These introduced grasses can be highly productive in this zone due to the loamy soils and higher soil moisture content and therefore attract higher densities of cattle than surrounding, less fertile areas. When these grasses dry out, their presence can result in increased fire frequency and intensity which presents a further risk to the native overstorey and shrub layer. This higher weed presence and the higher fire danger that promotes, causes this habitat quality to be assessed as Good condition.

Plate 5-4. FH4. Floodplains Habitat (348923, 7571969)

5.2.1.5 FH5 Clay Breakaways

The Clay breakaways habitat area is a rejuvenated high erosional zone on the inside of a river power bend, which exposes clay and soft rock sub-soils along the base of erosional cliff faces of 3 to 4 m high. In this area, recent flooding has exposed a large amount of clay and saprolite debris in the river channel with most coarse alluvial river sand, pebbles and stones removed downstream or deposited on the opposite bank, to form a depositional point bar at the outside of the channel bend.

Most of the vegetation in this area has been removed with the sediment during flooding. There are some larger trees of river red gum that have withstood the recent flooding which have exposed root masses and debris piles accumulating around the tree trunks thus creating new habitat.

In patches where soil has been retained, hummocks of soft spinifex (*Triodia epactia*) and *Cyperus* spp occur and on new exposed areas some annual herbs and grasses are scattered. In the depositional area on the opposite bank, seedlings of river red gum and *Melaleuca argentea* (silver paperbark), along with recently germinated annual herbs and grasses are sparsely scattered.

This habitat is in Excellent condition. Disturbances that lead to the exposure of this habitat are a natural occurrence in the river channel. Other than those impacts from flooding, there are no other disturbances evident in this habitat.

Plate 5-5. FH5: Clay Breakaways Habitat (349516, 7571574)

5.2.2 Conservation Significant Fauna

No fauna listed as T or P were recorded within the Survey Areas. One Great Egret *(Ardea modesta*) was observed foraging within one of the Cane River water bodies. Great Egrets are classed as migratory and protected under international agreement.

T and P fauna returned from the database searches (Table 5-1) are discussed in Sections 5.2.2.1 to 5.2.2.4 below in the context of the habitats available in the Survey Areas.

5.2.2.1 Northern Quoll

The Northern Quoll is a small carnivorous marsupial native to Australia. The species is a member of the family Dasyuridae and is listed as the smallest of the four quoll species. The fur is reddish brown with distinctive white spots on the back and a sparsely covered, unspotted tail (DAWE, 2022). Northern quolls are nocturnal, partially arboreal and omnivorous, primarily feeding on invertebrates, small mammals and reptiles (Schmitt *et al*. 1989). Northern quolls have an average of seven young per breeding season, with breeding success generally higher in animals that have a den near a creek line, however, these animals have a short lifespan, with most females only surviving one or two breeding seasons, and males only living for up to a year (DCCEEW 2022).

In the 2016 *EPBC Act Referral Guideline for the Endangered Northern Quoll* (*Dasyurus hallucatus)*, habitat determined as critical to the survival of the Northern Quoll occurs in three forms across the species distribution. These include:

- Rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines;

- Structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs; and
- Offshore islands where the Northern Quoll is known to exist.

The Parafluvial zone / Riverine margins fauna habitat (FH3) identified within the Survey Area was comprised of structurally diverse Eucalypt, *Melaleuca* spp. and *Acacia* spp. woodland with hollow-bearing trees of a large diameter within a major drainage line. The Parafluvial habitat is consistent with habitats described as critical for the survival of the Northern Quoll.

The Guidelines also state that foraging or dispersal habitat is recognised to be any land comprising predominantly native vegetation in the immediate area (i.*e.* within 1 km) of shelter habitat, quoll records, or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species. It has also been observed that when foraging within home ranges, male Northern quoll can travel up to 5 km per night while females can move up to 2.8 km per night (Henderson, 2015).

The nearest records of the Northern Quoll are less than 3 km from the Survey Area and were found within the major drainage line of the Cane River. One record was made in 2012, and three made in 2014 in the same area (Figure 5-1). Due to the proximity and the similarity in landform and habitat structure, the Survey Areas are considered foraging and/or dispersal habitat to the Northern Quoll individuals identified nearby.

The Guidelines state that a high-density population may be characterised by numerous camera triggers of multiple individuals across multiple cameras and or traps on the site. A low-density population may be characterised by infrequent captures of one or two individuals confined to one or two traps or where no trapping has identified a Northern Quoll, but latrine evidence remains. The nearby records qualify under the description of a low-density population.

During the survey, 16 cameras deployed for 120 trap nights, returned no captures of the species and ground-traverses undertaken to identify other potential evidence of northern quoll presence such as tracks or scats yielded no results.

No high-density or low-density population of northern quoll is present in the Survey Area. A low-density population was present in the adjoining Conservation Park as recently as 2014 and the Parafluvial, floodplains and Clay breakaways habitats of the Survey Area are suitable foraging and/or dispersal habitat for that low density population if it is persistent. No signs of northern quoll were recorded in the Survey Area.

The Parafluvial zone habitat is suitable for northern quoll denning and the Parafluvial, Floodplains and Clay breakaways habitats are suitable foraging habitats.

5.2.2.2 Bats

No calls of the Ghost Bat were detected in the recordings.

Two call sequences of the Pilbara Leaf-nosed Bat were detected, both from location 450007 in P0800801. Both calls were recorded on 20th June 2022, with the first call at 10:33 pm and the second call at 11:18 pm. Both call sequences were recorded well after sunset and therefore when the individual was out foraging away from a diurnal roost.

The Survey Area is a significant distance from both the type of geological terrain where caves might provide diurnal roosting habitat, and previous records of the species.

The Pilbara Leaf-nosed Bat has an obligate requirement for diurnal roosting in relatively warm, humid cave microclimates that are typically found in relatively deep caves (Churchill 1991; Armstrong 2001). There is no significant development of rocky outcrop within or close to the Survey Area. The nearest such rocky outcrop development is ironstone (Brockman Iron Formation), approximately 70 km to the east. Other nearby geological formations that form hills (Duck Creek Dolomite; Wyloo Group) are less likely to form the deep caves required by this species (Dr. Kyle Armstrong pers. comm 02/08/2022).

The nearest record of the species on the DBCA database is an acoustic recording observation at the Warramboo borefield, approximately 41 km north of the Survey Area. This record is also a significant distance from ironstone rocky outcrop that provides caves. Other nearby records include two that are relatively close to the Brockman Iron Formation (approximately 58 km east of the Survey Area) on Red Hill station (including a museum specimen that was collected in 1925). There is a well-known diurnal roost of the species in this general locality (Armstrong 2001) that contains several thousand individuals. While this diurnal roost is approximately 83 km from the Survey Area, it appears to be the most likely source of the individuals detected in the Survey Area, or at least the nearest major colony if there are transitory diurnal roosts (*sensu* Threatened Species Scientific Committee 2016; Conservation Advice for the species under the *EPBC Act 1999*) closer to the Survey Area.

The most reasonable explanation for the presence of the Pilbara Leaf-nosed Bat in the Survey Area is that the individuals detected were foraging a significant distance from their diurnal roost. There is a growing appreciation for the ability of this species to range several tens of kilometres while out on a nightly foraging bout (Bullen 2022, Ubello 2022, Reiffer 2022) The Conservation Advice for the species (Threatened Species Scientific Committee 2016) describes diurnal roosting habitat and foraging habitat and lists them in order of priority. There are no diurnal roosting habitats present within the Survey Area. Foraging habitats present within the Survey Area include:

- Major watercourses (Priority 4)—riparian vegetation on flat land plus the main gravelly or sandy channel of the river bed, sometimes containing pools that persist for weeks or months, and generally supporting higher productivity of biomass than the surrounding habitats; In the Survey Area this is described as Fauna Habitats FH2 and FH3.
- Open grassland and woodland (Priority 5)—dominated by *Triodia,* on lowland plains, colluvial slopes and hilltops. In the Survey Area this is described as Fauna Habitats FH1 and FH4.

5.2.2.3 Birds

Three water birds were observed during traverses, these were one Great Egret *(Ardea alba modesta*), and two plumed whistling ducks (*Dendrocygna eytoni*). One Australian Bustard *(Ardeotis australis)* was also observed along the Cane River Access track, and four observed approximately 500 m southwest of the boundary of P 0800761.

The Great Egret (migratory and protected under international agreement) was observed foraging in the Fluvial zone, in a shallow area where water was draining out of a major river pool. This is a spot where small fish would be easily targeted as they are being funnelled into a narrow area.

No wader or water bird species were recorded on the motion-triggered cameras positioned adjacent to the sandy and muddy banks of river pools. At the time of the field survey Cane River was flowing and many of the river pools were expansive, with shallow sand areas available for waders. Seasonal conditions were suitable for Threatened and Migratory shorebirds that utilise fresh water. The suitable habitat in the Cane River extends northwest toward the coast for approximately 36.8 km and southeast toward the rangelands for approximately 29.9 km. The abundance of available habitat reduces the likelihood of capturing individuals at specific locations.

Fourteen threatened and migratory bird species returned from the database searches have the potential to occur in the Survey Area due to the availability of suitable habitat. These are listed in Table 5-3. For 10 species, the availability of suitable habitat is temporally limited to times when surface water is present. The suitable habitat occurs in the Fluvial zone and is no longer suitable after pools have dried.

The four predatory bird species of conservation significance that may utilise the Survey Area are: Red Goshawk *(Erythrotriorchis radiatus)*, the Grey Falcon *(Falco hypoleucos),* the Peregrine Falcon *(Falco peregrinus)* and the Osprey *(Pandion cristatus).* Suitable nesting habitat is present in the Survey Area within the Parafulvial habitat. Suitable foraging habitat is available across all habitats within the Survey Area, except for the Osprey where prey is most likely to be sourced from the Fluvial zone during periods of inundation.

Table 5-3. Significant birds with suitable habitat in the Survey Area

Common Name	Conservation Code		Likelihood of Occurrence
	BC Act	EPBC Act	
--Temporally available habitat--			
Common Sandpiper	Mi	Mi	Suitable habitat occurs within the fluvial zone when surface water is present. The habitat is unsuitable after surface water dries. During periods of suitability the habitat is suitable for foraging and roosting. Excepting the Eastern Osprey, breeding occurs in the northern hemisphere.
Curlew Sandpiper	CR	CR, Mi	
Pectoral Sandpiper	Mi	Mi	
Gull-Billed Tern	Mi	Mi	
Bar-tailed Godwit	Mi	Mi	
Grey Wagtail	Mi	Mi	
Eastern Osprey	Mi	Mi	
Wood Sandpiper	Mi	Mi	

Common Name	Conservation Code		Likelihood of Occurrence
	BC Act	EPBC Act	
Common Greenshank	Mi	Mi	
Marsh Sandpiper	Mi	Mi	
--Not seasonally limited--			
Fork-tailed Swift	Mi	Mi	Suitable foraging habitat occurs in the airspace above the Survey Area. Breeding occurs in the northern hemisphere.
Red Goshawk	VU	VU	The fluvial and parafluvial habitats within the Survey Area are suitable breeding habitat and all habitats are suitable for foraging.
Grey Falcon	VU	VU	
Peregrine Falcon	OS	-	

5.2.2.4 Pilbara Olive Python

The Survey Area is on the western boundary of the modelled distribution as shown in the PMST portal. The Survey Area occurs within the area where the species may occur, and adjacent to areas within the Cane River Conservation Park where the species is likely to occur.

The Parafluvial zone / Riverine margins fauna habitat (FH3) identified within the Survey Areas was comprised of structurally diverse Eucalypt, *Melaleuca* spp. and *Acacia* spp. woodland with hollow-bearing trees of a large diameter within a major drainage line. These structural elements are valuable for the Pilbara Olive Python for providing habitat to potential prey.

A review of available literature on the Pilbara Olive Python identifies that this species will move through and utilise riverine habitats. However, refuge sites are typically more closely associated with caves or breakaway country. Foraging sites are more frequently described to be rock pools, or drainage lines in close association with cliffs or gorges, rather than river pools. The species adopts a 'sit and wait' predation strategy where individuals lay semi-submerged under the water and ambush prey that are drawn to these isolated water points that occur only sporadically in an otherwise dry landscape. This type of foraging strategy is unproductive in a riverine habitat where water holes can be expansive and prey-encounter rates would be significantly lower. Prey is also captured by ambush on animal trails.

No suitable wet season habitat is present within the Survey Area. Suitable dry season foraging habitat is available in the Parafluvial zone and Clay breakaways however higher quality rocky outcrop habitat is more readily available in the Cane River Conservation Park to the south.

5.2.2.5 Pilbara Pebble Mound Mouse

The Pilbara Pebble Mound Mouse is a burrowing and mound building rodent that is endemic to the Pilbara region of WA. It inhabits rocky hummock grasslands with an abundance of pebbles on the soil surface to use for nest and mound building. The species has been observed to prefer spurs and lower slopes of ridges where weathering has produced an abundance of pebbles (Dunlop & Pound, 1981).

Its vegetation preferences include stony landscapes of hummock grasslands with a sparse overstorey of Eucalypts and scattered shrubs, typically *Senna, Acacia* and *Ptilotus*. Mounds, however, they are often sited close to narrow ribbons of *Acacia* dominated scrub that grow along incised drainage lines. (Van Dyck and Strahan 2008).

Whilst individuals and colonies can persist away from rocky ranges, stony substrate is required for mound construction. Suitable habitat occurs in the Stony plains habitat (FH1) where pebbly substrate is present and a hummock grassland vegetation composition is present. Plate 5-6 demonstrates an area along the existing gravel road that may provide suitable habitat for the species.

Plate 5-6. Potential suitable habitat for the Pilbara Pebble Mound Mouse within FH1 (Flora Releve 24: 350368, 7566601)

Traverses were made along the existing gravel road and no evidence of Pilbara Pebble Mound Mouse activity was observed.

5.2.2.6 Fortescue Grunter

Endemic to the Pilbara region, this species has been recorded in the Ashburton, Robe and Fortescue Rivers (Atlas of Living Australia). The species is usually found in rocky pools and areas of slow flowing water suitable for demersal eggs that sit on the bottom of water bodies. The Ashburton, Robe and Fortescue Rivers all have permanent pools where slow flowing water is available throughout the year.

It is possible that suitable habitat for this species may occur in the Cane River, however there are no database records and there are no permanent pools in the Cane River (Department of Water, 2011). Morgan *et al.* (2003), undertook fish surveys in Northern WA rivers. They sampled one site within the Cane River Survey Area, the semi-permanent Jabaddar Pool at the southern end of the Survey Area. Two native freshwater fish species, *Nematalosa erebi* (bony bream) and *Leioptherapon unicolour* (spangled perch), were identified. Both are common and widespread species (Pusey *et al.* 2004; Beesley 2006).

If they were to occur in small unidentified upstream permanent pools from the Cane River, it is possible the Survey Area could contain foraging habitat during high flow when there is connectivity between the upper and lower river reaches.

6 DISCUSSION

The Survey Area included 9 km of existing gravel road through undulating gravelly plains and approximately 4 km of the Cane River.

Three vegetation types were described for the Study Area, ranging in condition from Good to Very Good. Disturbances included low to moderate grazing pressure and the presence of high-risk weeds from the *Cenchrus* genus. No weeds were recorded on the existing gravel road.

There are no TEC's or PEC's present in the Survey Area. No T or P flora were recorded in the Survey Area. One flora species listed as CR under the EPBC Act and BC Act has the potential to occur in the Survey Area. This is *Seringia exastia*. This species has recently been taxonomically revised and nominated for delisting. Prior to delisting it remains necessary to obtain permission to take this species if disturbance is proposed within areas where it is known to occur. No database records are present within the Survey Area and the small area was well traversed during a survey period with suitable conditions. The absence of this species is reported with a high level of certainty.

Five fauna habitats are described for the Survey Area. The condition of the fauna habitats ranged from Good to Very Good. Disturbances within this fauna habitat include low to moderate grazing pressure, the increased fire risk due to the presence of grassy weeds, historic vegetation clearing for the existing gravel road. Traffic movement along the existing gravel road also poses a risk to fauna susceptible to vehicle strike.

The Pilbara Leaf-nosed Bat was recorded in the Survey Area from acoustic bat detection devices. The Pilbara Leaf-nosed Bat is listed as Priority 4 under the BC Act and Vulnerable under the EPBC Act. No suitable diurnal roost habitat is present within the Survey Area. Suitable foraging habitat occurs in the airspace above the Survey Area. Foraging habitat available in the Survey Area is classified and prioritised in the EPBC Act Conservation Advice for the species (Threatened Species Scientific Committee 2016) as:

- Major watercourses (Priority 4)— In the Survey Area this is described as Fauna Habitats FH2 and FH3.
- Open grassland and woodland (Priority 5)—In the Survey Area this is described as Fauna Habitats FH1 and FH4.

The Survey Area contains suitable habitat for the Northern Quoll. The Northern Quoll is listed as Endangered under the BC Act and EPBC Act. Hollow bearing trees within the Parafluvial zone are suitable denning habitat. The Parafluvial, Floodplains and Clay breakaway habitats are suitable foraging habitats. Targeted searches for signs and deployment of camera traps determined that the Survey Area does not contain a high or low-density population of Northern Quoll. A low-density population was present in the adjoining Cane River Conservation Park as recently as 2014 and the Parafluvial, Floodplains and Clay breakaway habitats of the Survey Area are suitable foraging and/or dispersal habitat for that low density population if it is persistent.

One Great Egret *(Ardea modesta*), two wandering whistling ducks (*Dendrocygna arcuata*) and five Australian Bustard *(Ardeotis australis)* were recorded in the Survey Area during Targeted Searches.

The Great Egret (migratory and protected under international agreement) was observed foraging in the Fluvial zone, in a shallow area where water was draining out of a major river pool.

Fourteen threatened and migratory bird species returned from the database searches have the potential to occur in the Survey Area due to the availability of suitable habitat. For 10 species including the Critically Endangered Curlew Sandpiper, the availability of suitable habitat is temporally limited to times when surface water is present. The suitable habitat occurs in the Fluvial zone and is no longer suitable after pools have dried.

There are four predatory bird species of conservation significance that may utilise the Survey Area. These are the Red Goshawk, the Grey Falcon (both Vulnerable under the BC Act and EPBC Act), the Osprey (Migratory) and the Peregrine Falcon (Other Specially Protected). Suitable nesting habitat is present in the Survey Area within the Parafluvial habitat. Suitable foraging habitat is available across all habitats within the Survey Area, except for the Osprey where prey is most likely to be sourced from the Fluvial zone during periods of inundation.

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APPENDICES

APPENDIX A: CONSERVATION CATEGORIES

Conservation categories for threatened species and communities protected under Federal legislation are defined under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Environment Protection and Biodiversity Conservation Regulations 2000* are listed in Tables A.1. and A.2.

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

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

Table A.2: Definitions for Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999*.

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

For Section 182 of the EPBC Act and 179 of the EPBC Act Threatened Ecological Communities and Native species are in the Critically Endangered, Endangered or Vulnerable category if they meet any of the criteria for the category mentioned in Table A.3:

Table A.3: Criteria for listing Threatened Species and Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Regulations 2000*

Threatened Species				
Item	**Criterion**	**Category**		
		Critically Endangered	**Endangered**	**Vulnerable**
1	It has undergone, is suspected to have undergone, or is likely to undergo in the immediate future:	A very severe reduction in numbers	A severe reduction in numbers	A substantial reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is:	Very restricted	Restricted	limited
3	The estimated total number of mature individuals is: And: (a) Evidence suggests that the number will continue to decline at: or (b) The number is likely to continue to decline and its geographic distribution is:	Very low A very high rate Precarious for its survival	Low A high rate Precarious for its survival	limited A substantial rate Precarious for its survival
4	The estimated total number of mature individuals is:	Extremely low	Very low	low
5	The probability of its extinction in the wild is at least:	50% in the immediate future	20% in the near future	10% in the medium term future
Threatened Ecological Communities				
Item	**Criterion**	**Category**		
		Critically Endangered	**Endangered**	**Vulnerable**
1	Its decline in geographic distribution is:	Very severe	Severe	substantial
2	Its geographic distribution is: And the nature of its distribution makes it likely that the action of a threating process could cause it to be lost in:	Very restricted The immediate future	restricted The near future	limited The medium term future
3	For a population of a native species that is likely to play a major role in the community, there is a: To the extent that restoration of the community is not likely to be possible in:	Very severe decline The immediate future	Severe decline The near future	Substantial decline The medium term future
4	The reduction in its integrity across most of its geographic distribution is: As indicated by degradation of the community or its habitat, or disruption of important community processes, that is:	Very severe Very severe	severe severe	substantial substantial
5	The rate of continuing detrimental change is: As indicated by	Very severe	severe	substantial

	(a) A rate of continuing decline in its geographic distribution, or a population of a native species that is believed to play a major role in the community, that is: or	Very severe	severe	serious
	(b) Intensification, across most of its geographic distribution, in degradation, or disruption of important community processes, that is:	Very severe	severe	serious
6	A quantitative analysis shows that its probability of extinction, or extreme degradation over all its geographic distribution, is:	At least 50% in the immediate future	At least 20% in the near future	At least 10% in the medium term future

In Western Australia, the *Biodiversity Conservation Act 2016* (BC Act) provides for the statutory listing of Threatened Ecological Communities, under the categories listed in Table A.4.

Table A.4: Definitions and criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities. Department of Environment and Conservation (2013).

PD : Presumed Totally Destroyed
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or** B) All occurrences recorded within the last 50 years have since been destroyed.
CR : Critically Endangered
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
En : Endangered
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii) modification throughout its range is continuing such that in the short term future (within approximately

20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.
B) Current distribution is limited, and one or more of the following apply (i, ii or iii):
i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);
ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;
iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.
C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

VU : Vulnerable

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.
An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):
A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.
B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.
C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

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

Table A.5: Definitions and criteria for Priority Ecological Communities Department of Environment and Conservation (2013).

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

In Western Australia, the Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are listed in Table A.6.

The definition of flora includes algae, fungi and lichens. The definition of Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Table A.6: Conservation codes for Western Australian flora and fauna under the *Biodiversity Conservation Act 2016* (DBCA 2019).

Code	Conservation Category	Definition
Threatened species		
Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the Biodiversity Conservation Act 2016 (BC Act). Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.		
CR	**Critically Endangered**	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
EN	**Endangered**	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora
VU	**Vulnerable**	Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.
Extinct species		
Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.		

EX	**Extinct**	Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for extinct fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for extinct flora.
EW	**Extinct in the Wild**	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially protected species		
Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.		
MI	**Migratory Species**	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
CD	**Species of special conservation interest (conservation dependent fauna)**	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act). Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
OS	**Other Specially protected species**	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

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

Table A.7: Priority species under Western Australian *Biodiversity Conservation Act 2016*.

P1: Priority One – Poorly known taxa
Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2: Priority Two – Poorly known taxa
Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3: Priority Three – Poorly known taxa
Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4: Priority Four: Rare, near threatened and other taxa in need of monitoring
((a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

The management of introduced species in Western Australia is regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). The BAM Act seeks to establish a biosecurity regulatory scheme to prevent serious animal and plant pests from entering the State and becoming established, and to minimise the spread and impact of any that are already present within the State.

The list of declared pests is provided under the BAM Act. Declared animal and plant pests fall into three categories as Gazetted under the *Biosecurity and Agriculture Management Regulations 2013*. These categories are outlined in Table A.7.

Table A.8: Declared pests control categories as gazetted under the *Biosecurity and Agriculture Management Regulations 2013.*

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

References

Department of Biodiversity Conservation and Attractions (2019) Conservation Codes for Western Australian Flora and Fauna. Last updated 3 January 2019. Accessed 25/04/20. https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation%20code%20definitions.pdf

Department of Environment and Conservation (2013). Definitions, categories and criteria for threatened and priority ecological communities. Accessed 25/04/20 https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf

APPENDIX B: PMST SEARCH RESULTS

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 16-Jun-2022

Summary

Matters of National Environment 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 (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	46

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

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 Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	77
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	3

Extra Information

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

State and Territory Reserves:	2
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	15
Key Ecological Features (Marine):	None
Biologically Important Areas:	10
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species			[Resource Information]
Status of Conservation Dependent and Extinct are not MNES under the EPBC Act. Number is the current name ID.			
Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area	In buffer area only
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Rostratula australis			
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
Sternula nereis nereis			
Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Thalassarche carteri			
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area	In buffer area only
FISH			
Thunnus maccoyii			
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area	In buffer area only
MAMMAL			
Balaenoptera musculus			
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Dasyurus hallucatus			
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area	In feature area
Eubalaena australis			
Southern Right Whale [40]	Endangered	Species or species habitat may occur within area	In buffer area only
Macroderma gigas			
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Rhinonicteris aurantia (Pilbara form)			
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
Aipysurus apraefrontalis			
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area	In buffer area only
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area	In buffer area only
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area	In buffer area only
SHARK			
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area	In buffer area only

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area	In buffer area only
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat may occur within area	In buffer area only
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area	In buffer area only
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Thalassarche carteri](#) Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Migratory Marine Species			
[Anoxypristis cuspidata](#) Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area	In buffer area only
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat may occur within area	In buffer area only
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In buffer area only
[Carcharhinus longimanus](#) Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area	In buffer area only
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area	In buffer area only
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Breeding known to occur within area	In buffer area only
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area	In buffer area only
[Dugong dugon](#) Dugong [28]		Species or species habitat known to occur within area	In buffer area only
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area	In buffer area only
[Eubalaena australis as Balaena glacialis australis](#) Southern Right Whale [40]	Endangered	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In buffer area only
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area	In buffer area only
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area	In buffer area only
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In buffer area only
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Species or species habitat likely to occur within area	In buffer area only
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area	In buffer area only

Migratory Terrestrial Species

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
[Calidris canutus](#) Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area	In buffer area only
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat likely to occur within area	In feature area
[Charadrius leschenaultii](#) Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area	In feature area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat may occur within area	In buffer area only
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In buffer area only
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Commonwealth Lands [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.

Commonwealth Land Name	State	Buffer Status
Unknown		
Commonwealth Land - [52238]	WA	In buffer area only

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area	In buffer area only
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Ardenna carneipes as Puffinus carneipes](#) Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat may occur within area	In buffer area only
[Bubulcus ibis as Ardea ibis](#) Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
[Calidris canutus](#) Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area overfly marine area	In buffer area only
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Calonectris leucomelas](#) Streaked Shearwater [1077]		Species or species habitat may occur within area	In buffer area only
[Chalcites osculans as Chrysococcyx osculans](#) Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
[Charadrius leschenaultii](#) Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Fregata ariel](#) Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area	In buffer area only
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area	In feature area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area overfly marine area	In feature area
[Limnodromus semipalmatus](#) Asian Dowitcher [843]		Species or species habitat may occur within area overfly marine area	In buffer area only
[Limosa lapponica](#) Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In buffer area only
[Macronectes giganteus](#) Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area	In feature area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat known to occur within area	In buffer area only
[Phaethon lepturus](#) White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only
[Rostratula australis as Rostratula benghalensis (sensu lato)](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area	In feature area
[Sternula albifrons as Sterna albifrons](#) Little Tern [82849]		Species or species habitat may occur within area	In buffer area only
[Thalassarche carteri](#) Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area	In buffer area only
[Thalasseus bengalensis as Sterna bengalensis](#) Lesser Crested Tern [66546]		Breeding known to occur within area	In buffer area only
Fish			
[Bulbonaricus brauni](#) Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area	In buffer area only
[Campichthys tricarinatus](#) Three-keel Pipefish [66192]		Species or species habitat may occur within area	In buffer area only
[Choeroichthys brachysoma](#) Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area	In buffer area only
[Choeroichthys suillus](#) Pig-snouted Pipefish [66198]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area	In buffer area only
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area	In buffer area only
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area	In buffer area only
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area	In buffer area only
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area	In buffer area only
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area	In buffer area only
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area	In buffer area only
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area	In buffer area only
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area	In buffer area only
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area	In buffer area only
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area	In buffer area only
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area	In buffer area only
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area	In buffer area only
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area	In buffer area only
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area	In buffer area only
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area	In buffer area only
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area	In buffer area only
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area	In buffer area only
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area	In buffer area only
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area	In buffer area only
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area	In buffer area only
Mammal			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Dugong dugon Dugong [28]		Species or species habitat known to occur within area	In buffer area only
Reptile			
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area	In buffer area only
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area	In buffer area only
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area	In buffer area only
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area	In buffer area only
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area	In buffer area only
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area	In buffer area only
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area	In buffer area only
Chitulia ornata as Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [87377]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area	In buffer area only
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area	In buffer area only
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area	In buffer area only
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area	In buffer area only
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area	In buffer area only
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area	In buffer area only
Leioselasma czeblukovi as Hydrophis czeblukovi Fine-spined Seasnake, Geometrical Seasnake [87374]		Species or species habitat may occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area	In buffer area only
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area	In buffer area only

Whales and Other Cetaceans		[Resource Information]	
Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area	In buffer area only

Current Scientific Name	Status	Type of Presence	Buffer Status
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area	In buffer area only
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area	In buffer area only
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat may occur within area	In buffer area only
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area	In buffer area only
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In buffer area only
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In buffer area only
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Species or species habitat likely to occur within area	In buffer area only
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area	In buffer area only
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area	In buffer area only
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area	In buffer area only

Current Scientific Name	Status	Type of Presence	Buffer Status
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area	In buffer area only

Habitat Critical to the Survival of Marine Turtles			
Scientific Name	Behaviour	Presence	Buffer Status
Aug - Sep			
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur	In buffer area only
Dec - Jan			
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur	In buffer area only
Nov - May			
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur	In buffer area only

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Cane River	Conservation Park	WA	In feature area
Cane River (Mount Minnie and Nanutarra)	NRS Addition - Gazettal in Progress	WA	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Ashburton Infrastructure Project	2021/9064	Controlled Action	Guidelines Issued	In buffer area only
Construct and operate LNG & domestic gas plant including onshore and offshore facilities - Wheatston	2008/4469	Controlled Action	Post-Approval	In buffer area only
Extension of Mesa A/Warramboo Iron Ore Project, west of Pannawonica, WA	2016/7843	Controlled Action	Post-Approval	In buffer area only
Greater Gorgon Development - Optical Fibre Cable, Mainland to Barrow Island	2005/2141	Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Proposed West Pilbara Iron Ore Project	2009/4706	Controlled Action	Post-Approval	In buffer area only
Yannarie Solar Salt Project	2004/1679	Controlled Action	Completed	In feature area
Not controlled action				
Construction and Operation of Iron Ore Mine	2006/2698	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Onslow Power Infrastructure Upgrade Project, Onslow, WA	2014/7314	Not Controlled Action	Completed	In buffer area only
Onslow Rare Earths Plant	2021/9046	Not Controlled Action	Completed	In buffer area only
Onslow Water Supply Infrastructure Upgrade Project, Onslow, WA	2014/7329	Not Controlled Action	Completed	In buffer area only
Not controlled action (particular manner)				
2D and 3D seismic surveys	2005/2151	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Buckland Iron Ore Mining Project, Pilbara region, WA	2013/6867	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Macedon Gas Field Development	2008/4605	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Ocean Bottom Cable Seismic Survey	2005/2017	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only

Biologically Important Areas			
Scientific Name	Behaviour	Presence	Buffer Status
Marine Turtles			
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Foraging	Known to occur	In buffer area only

Scientific Name	Behaviour	Presence	Buffer Status
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur	In buffer area only
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur	In buffer area only
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur	In buffer area only
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur	In buffer area only
Seabirds			
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur	In feature area
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur	In buffer area only
Whales			
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur	In buffer area only
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and 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

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a 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 detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

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

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

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

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

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.

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

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APPENDIX C: DETAILED VEGETATION SURVEY SITES

Appendix C. Detailed Vegetation Survey Sites

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR1	**Botanist**	Neil Pettit
WP-Easting		**Northing**		**Age since last fire**	>5 yrs	**Landform**	River channel. Fluvial/parafluvial zone
Seasonal Conditions		Isolated pools in river channel		**Surface Rocks Size/Shape**		Round alluvial rocks 1-200mm	
Soil Type		Alluvial Sand		**Surface Rocks % cover**		50	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Open redgum and M.argentea riparian woodland with large bare areas of fluvial zone					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		5		5		E.camaldulensis, M. argentea	
Understorey							
Ground		1		2		Cyperus and grasses	

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR2	**Botanist**	Neil Pettit
WP-Easting		**Northing**		**Age since last fire**	>5 yrs	**Landform**	Riparian island in channel
Seasonal Conditions		Recent rain, sand moist		**Surface Rocks Size/Shape**		Rounded 10-300mm	
Soil Type		Alluvial Sand		**Surface Rocks % cover**		5	
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Red gum open woodland with spinifex					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		20		E.camaldulensis	
Understorey		3		5		A. trachycarpa	
Ground		1.2		20		Triodia epacita	

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR3	**Botanist**	Neil Pettit
WP-Easting		**Northing**		**Age since last fire**	>5 yrs	**Landform**	Parafluvial stream channel
Seasonal Conditions		Recent rain, soil moist		**Surface Rocks Size/Shape**		Round 1-10cm	
Soil Type		Alluvial Sand		**Surface Rocks % cover**		2	
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Open riparian woodland with hummoch grass understorey					
Condition/Disturbances/Notes							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4		2		E.camaldulensis	
Understorey		2.5		5		Acacia spp.	
Ground		1.5		15		Triodia epacita	

Appendix C. Detailed Vegetation Survey Sites

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR4	**Botanist**	Neil Pettit
WP-Easting		**Northing**		**Age since last fire**	>5 yrs	**Landform**	Fluvial channel with flood scouring
Seasonal Conditions		Recent rain and flooding, Moist soil		**Surface Rocks Size/Shape**		1-10cm round	
Soil Type		Alluvial Sand		**Surface Rocks % cover**		40	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Open riparian redgum woodland with open understorey					
Condition/Disturbances/Notes							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		5		E.camaldulensis, M. argentea	
Understorey		2.5		2		A. trachycarpa, A. tumida	
Ground		1.5		10		Triodia epacita, Cenchrus spp.	

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR5	**Botanist**	Neil Pettit
WP-Easting		**Northing**		**Age since last fire**	>5 yrs	**Landform**	Stream channel. Fluvial zone
Seasonal Conditions		Recent flooding, moist soil		**Surface Rocks Size/Shape**		Rounded 1-10cm	
Soil Type		Alluvial sand (coarse)		**Surface Rocks % cover**		10	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Very open Acacia shrubland with hummock grasses					
Condition/Disturbances/Notes							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		3		5		A. trachycarpa, A round lf	
Understorey							
Ground		1.5		10		Triodia epacita, Cenchrus spp.	

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR6	**Botanist**	Neil Pettit
WP-Easting	347515	**Northing**	7572787	**Age since last fire**	>5 yrs	**Landform**	Mid channel island
Seasonal Conditions		Recent flooding moist soil		**Surface Rocks Size/Shape**		Rounded 1-5cm	
Soil Type		Coarse sand		**Surface Rocks % cover**		1	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Open red gum woodland with mixed grass understorey					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		5		15		E.camaldulensis	
Understorey		3		20		M.glomerata, A.tumida	
Ground		1		10		Cenchrus spp.	

Plate 1. Releve 6 (347515, 7572787)

Appendix C. Detailed Vegetation Survey Sites

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR7	**Botanist**	Neil Pettit
WP-Easting	347735	**Northing**	7572616	**Age since last fire**	>5 yrs	**Landform**	Fluvial zone in stream channel
Seasonal Conditions		Recent flooding moist soil		**Surface Rocks Size/Shape**		Rounded 10-20cm	
Soil Type		Alluvial coarse sand		**Surface Rocks % cover**		60	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Open fluvial plain with occasional trees of Euc. camaldulensis, Acacia trachycarpa, annual herbs and grasses					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey							
Understorey							
Ground							

Plate 2. Releve 7 (347735, 7572616)

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR8	**Botanist**	Neil Pettit
WP-Easting	347850	**Northing**	7572473	**Age since last fire**	>5 yrs	**Landform**	Riparian/parafluvial
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**		Rounded 0.1-20cm	
Soil Type		Coarse alluvial sand		**Surface Rocks % cover**		70	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Open E.camaldulensis woodland with understorey of Acacia spp and Triodia epacita					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		6		10		E.camaldulensis	
Understorey		2.5		5		A. Trachycarpa, A.round lf	
Ground							

Plate 3. Releve 8 (347850, 7572473)

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR9	**Botanist**	Neil Pettit
WP-Easting	348872	**Northing**	7571958	**Age since last fire**		**Landform**	Parafluvial zone of the stream channel
Seasonal Conditions		Recent flooding, moist soil		**Surface Rocks Size/Shape**		Rounded 0.1-10cm	
Soil Type		Coarse alluvial sand		**Surface Rocks % cover**		40	
Soil Colour		Light Brown		**Slope Aspect**			
Vegetation Description		Open sandy and rocky parafluvial area with scattered trees and grasses					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		1		E.camaldulensis, M.argentea, M.glomerata	
Understorey							
Ground		0.5		1		Annual grasses	

Plate 4. Releve 9 (348872, 7571958)

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR10	**Botanist**	Neil Pettit
WP-Easting	349019	**Northing**	7571854	**Age since last fire**	>5yrs	**Landform**	Sediment island with open woodland
Seasonal Conditions		Recent rain soil moist		**Surface Rocks Size/Shape**		Rounded 0.1-20cm	
Soil Type		Alluvial sand		**Surface Rocks % cover**		30	
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Open woodland of E.camaldulensis and Acacia spp.					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		2		E.camaldulensis	
Understorey		3		5		Acacia spp., M.glomerata	
Ground		0.5		10		Annual grasses and sedges	

Plate 5. Releve 10 (349019, 7571854)

Appendix C. Detailed Vegetation Survey Sites

Job	GRL001	**Date**	21/06/2022	**Site Code**	CR11	**Botanist**	Neil Pettit
WP-Easting	349172	**Northing**	7571717	**Age since last fire**	>5yrs	**Landform**	Riparian bank
Seasonal Conditions		Recent rain wet soil		**Surface Rocks Size/Shape**			
Soil Type		Fine alluvial sand/loam		**Surface Rocks % cover**			
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Riparian gully of red gum forest with mixed Acacia midstorey and grass understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		10		E.camaldulensis	
Understorey		3		5		Acacia spp.	
Ground							

Plate 6. Releve 11 (349172, 7571717)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR12	**Botanist**	Neil Pettit
WP-Easting	349345	**Northing**	7571559	**Age since last fire**	>5yrs	**Landform**	Riparian riverbank
Seasonal Conditions		Recent rain, moist sand		**Surface Rocks Size/Shape**			
Soil Type		Fine alluvial loamy sand		**Surface Rocks % cover**			
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Open riparian woodland of E.camaldulensis with Acacia spp. And M. glomerata midstorey. Mixed grass understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		5		E.camaldulensis	
Understorey		3		1		Acacia trachycarpa, M.glomerata	
Ground		1.5		10		Mixed grasses	

Plate 7. Releve 12 (349345, 7571559)

Appendix C. Detailed Vegetation Survey Sites

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR13	**Botanist**	Neil Pettit
WP-Easting	349648	**Northing**	7571464	**Age since last fire**	>5yrs	**Landform**	Highly eroded parafluvial zone
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**		Rounded and angular 0.1 – 25cm	
Soil Type		Coarse alluvial		**Surface Rocks % cover**		50	
Soil Colour		Light brown		**Slope Aspect**			
Vegetation Description		Melaleuca argentea scattered trees. Some grasses as scattered understorey, mostly bare sand and gravel					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey							
Understorey							
Ground							

Plate 8. Releve 13 (349648, 7571464)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR14	**Botanist**	Neil Pettit
WP-Easting	349606	**Northing**	7571279	**Age since last fire**	>5yrs	**Landform**	Stream floodplain area of deposition
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**		Rounded and angular 0.1 – 20cm	
Soil Type		Loamy sand		**Surface Rocks % cover**		2	
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Very open E.camaldulensis woodland with Triodia and other grass sparse understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		5		5		E. camaldulensis	
Understorey		2.5		1		Acacia trachycarpa	
Ground		1.5		5		Triodia epacita	

Plate 9. Releve 14 (349606, 7571279)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR15	**Botanist**	Neil Pettit
WP-Easting	349767	**Northing**	7571131	**Age since last fire**	>5yrs	**Landform**	Parafluvial zone of stream channel
Seasonal Conditions		Recent rain soil moist		**Surface Rocks Size/Shape**		Angular and round, 1-20cm	
Soil Type		Coarse alluvial sand		**Surface Rocks % cover**		60	
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Very open E.camaldulensis woodland with midstorey of Acacia spp and M. glomerata with scattered mixed grass understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		5.5		5		E. camaldulensis	
Understorey		2.5		5		A. tumida, A.trachycarpa, M.glomerata	
Ground		1.5		0.5		Triodia epacita	

Plate 10. Releve 15 (349767, 7571131)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR16	**Botanist**	Neil Pettit
WP-Easting	349785	**Northing**	7570904	**Age since last fire**	>5yrs	**Landform**	Stream edge of fluvial zone of stream channel
Seasonal Conditions		Recent flooding, moist soil		**Surface Rocks Size/Shape**		Rounded 0.1-10cm	
Soil Type		Coarse alluvial sand		**Surface Rocks % cover**		40	
Soil Colour		Light brown		**Slope Aspect**			
Vegetation Description		Open Melaleuca woodland with scattered annual forb and grass understorey					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4		5		M. argentea, E. camaldulensis	
Understorey							
Ground		1.5		2		Dicanthium, Cyperus sp.	

Plate 11. Releve 16 (349785, 7570904)

Appendix C. Detailed Vegetation Survey Sites

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR17	**Botanist**	Neil Pettit
WP-Easting	349834	**Northing**	7570654	**Age since last fire**	>5yrs	**Landform**	Stream channel island
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**		Rounded 0.1-20cm	
Soil Type		Alluvial sand		**Surface Rocks % cover**		10	
Soil Colour		Light brown		**Slope Aspect**			
Vegetation Description		Open riparian woodland of E.camaldulensis and M.argentea with sparse mixed grass and forb understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		5.5		10		E. camaldulensis, M.argentea	
Understorey		3		2		M. glomerata	
Ground		1		2		Dicanthium, Cyperus sp.	

Plate 12. Releve 17 (349834, 7570654)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR18	**Botanist**	Neil Pettit
WP-Easting		**Northing**		**Age since last fire**	>5yrs	**Landform**	Stream mid channel island
Seasonal Conditions		Recent flooding, moist soil		**Surface Rocks Size/Shape**		Rounded 1-30cm	
Soil Type		Fine alluvial sand		**Surface Rocks % cover**		20	
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Sparse open woodland of redgum with spinifex understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		4.5		5		E. camaldulensis	
Understorey							
Ground		1.5		10			

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR19	**Botanist**	Neil Pettit
WP-Easting	349810	**Northing**	7570100	**Age since last fire**	>5yrs	**Landform**	Stream fluvial channel
Seasonal Conditions		Recent rain, moist soil, water in pools		**Surface Rocks Size/Shape**		Rounded 0.1-30cm	
Soil Type		Coarse sand		**Surface Rocks % cover**		70	
Soil Colour		Light brown		**Slope Aspect**			
Vegetation Description		Dense thicket of Melaleuca glomerata in highly disturbed fluvial channel. Recent flooding and sediment deposit, erosion					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		2.5		30		M. glomerata	
Understorey							
Ground		1.2		2		Cyperus sp., Dichanthium	

Plate 13. Releve 19 (349810, 7570100)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR20	**Botanist**	Neil Pettit
WP-Easting	349838	**Northing**	7568966	**Age since last fire**	>5yrs	**Landform**	Stream channel parafluvial zone
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**		Rounded and angular 0.5-30cm	
Soil Type		Coarse sand		**Surface Rocks % cover**		60	
Soil Colour		Light brown		**Slope Aspect**			
Vegetation Description		Open E.camuldensis woodland with spinifex understorey					
Condition/Disturbances/Notes VeryGood							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		6.8		15		E. camaldulensis	
Understorey		2		2		Acacia trachycarpa	
Ground		1.8		5		Triodia epacita	

Plate 14. Releve 20 (349838, 7569866)

Job	GRL001	**Date**	22/06/2022	**Site Code**	CR21	**Botanist**	Neil Pettit
WP-Easting	349787	**Northing**	7569543	**Age since last fire**	>5yrs	**Landform**	Big riparian bank adjacent to large river pool
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**			
Soil Type		Sandy loam alluvium		**Surface Rocks % cover**			
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Riparian woodland of E. camaldulensis with mixed grass understorey					
Condition/Disturbances/Notes Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		8		15		E. camaldulensis	
Understorey		2.5		1		Acacia trachycarpa	
Ground		0.8		20		Cenchrus ciliarus and mixed spp.	

Plate 15. Releve 21 (349787, 7569543)

Job	GRL001	**Date**	23/06/2022	**Site Code**	CR22	**Botanist**	Neil Pettit
WP-Easting	353633	**Northing**	7564080	**Age since last fire**	>5yrs	**Landform**	Open hummock grassland on red soil plain
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**			
Soil Type		Loamy sand		**Surface Rocks % cover**			
Soil Colour		Red		**Slope Aspect**		Flat	
Vegetation Description		Open hummock grassland					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		0		0			
Understorey		1.8		5		Acacia ovate lf	
Ground		1.5		15		Triodia sp.	

Plate 16. Releve 22 (353633, 7564080)

Job	GRL001	**Date**	23/06/2022	**Site Code**	CR23	**Botanist**	Neil Pettit
WP-Easting	352420	**Northing**	7565422	**Age since last fire**	>5yrs	**Landform**	Drainage line in broad flat plain
Seasonal Conditions		Recently dry, soil moist		**Surface Rocks Size/Shape**		Angular 0.1-10cm	
Soil Type		Loamy sand		**Surface Rocks % cover**		5	
Soil Colour		Red		**Slope Aspect**		Flat	
Vegetation Description		Drainage line of scattered trees with mixed herb and grass understorey					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		3.5		2		Corymbia hamerslyana	
Understorey		2.5		4		Grevillia wickhamii, Acacia spp.	
Ground		1		25		Triodia and mixed grasses	

Plate 17. Releve 23 (352420,7565422)

Job	GRL001	**Date**	23/06/2022	**Site Code**	CR24	**Botanist**	Neil Pettit
WP-Easting	350368	**Northing**	7566601	**Age since last fire**	3-4 yrs	**Landform**	Flat open gravelly plain
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**		Angular 0.1-5cm	
Soil Type		Loamy sand		**Surface Rocks % cover**		5	
Soil Colour		Red		**Slope Aspect**		-	
Vegetation Description		Low very open Acacia woodland with hummock grass understorey					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey		3		1		Acacia spp.	
Understorey							
Ground		1.5		2		Triodia spp.	

Plate 18. Releve 24 (350368, 7566601)

Job	GRL001	**Date**	23/06/2022	**Site Code**	CR25	**Botanist**	Neil Pettit
WP-Easting	349185	**Northing**	7567757	**Age since last fire**	3-4 yrs	**Landform**	Flat open red sand plain. Some crusting
Seasonal Conditions		Recent rain, moist soil		**Surface Rocks Size/Shape**			
Soil Type		Loamy sand		**Surface Rocks % cover**			
Soil Colour		Red		**Slope Aspect**			
Vegetation Description		Low hummock grassland with occasional Acacia shrub					
Condition/Disturbances/Notes Very Good							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey							
Understorey		2.5		0.5		Acacia spp.	
Ground		0.6		5		Triodia spp.	

Plate 19. Releve 25 (349185, 7567757)

Job	GRL001	**Date**	23/06/2022	**Site Code**	CR26	**Botanist**	Neil Pettit
WP-Easting	348644	**Northing**	7569310	**Age since last fire**	>5yrs	**Landform**	Flat open sandy plain with sand crusts
Seasonal Conditions		Recent rain, surface soil dry		**Surface Rocks Size/Shape**			
Soil Type		Loamy sand		**Surface Rocks % cover**			
Soil Colour		Red		**Slope Aspect**		Flat	
Vegetation Description		Sparse hummock grassland with occasional emergent low tree/shrubs					
Condition/Disturbances/Notes Poor. Sheet erosion exposing grass roots.							
		Height (m)		**Cover (%)**		**Dominant Species**	
Overstorey							
Understorey		2		0.5		Acacia spp.	
Ground		0.5		2		Triodia spp.	

Plate 20. Releve 26 (348644, 7569310)

APPENDIX D: FAUNA HABITAT ASSESSMENT SITES

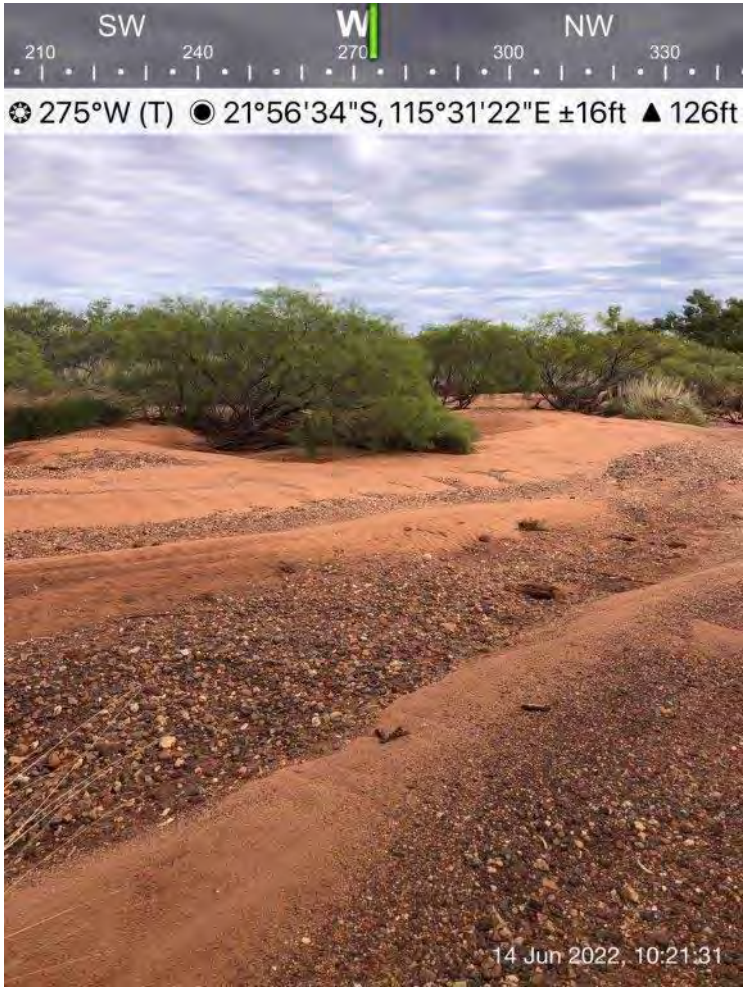

Plate 3. GRLFS03 (347460, 7572762)

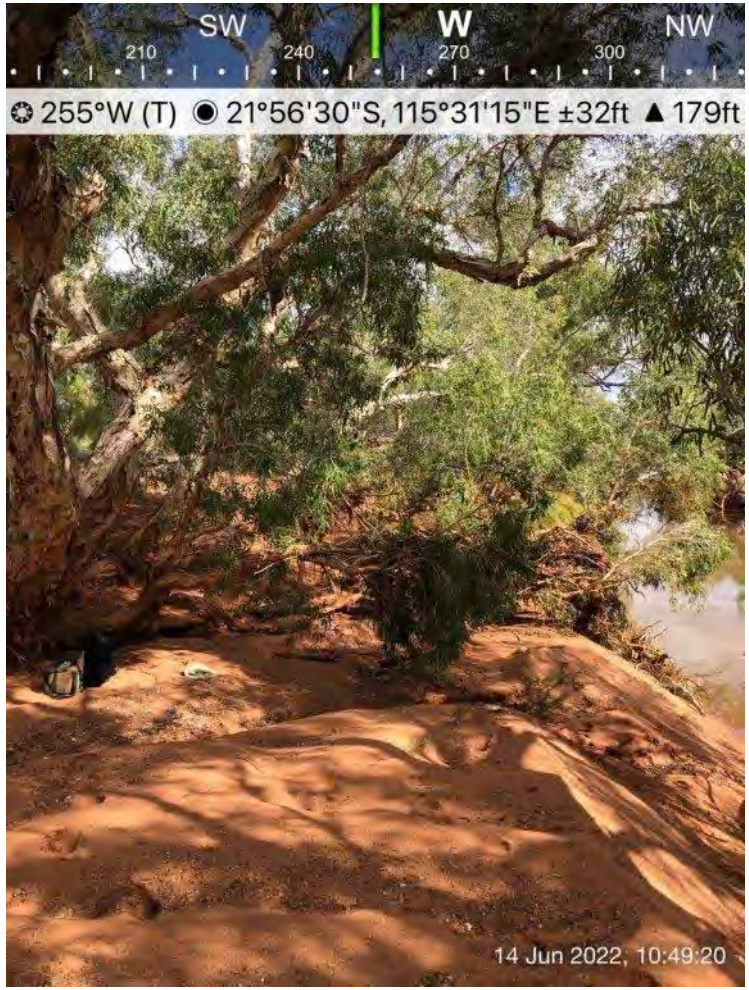

Plate 4. GRLFS04 (347256, 7572883)

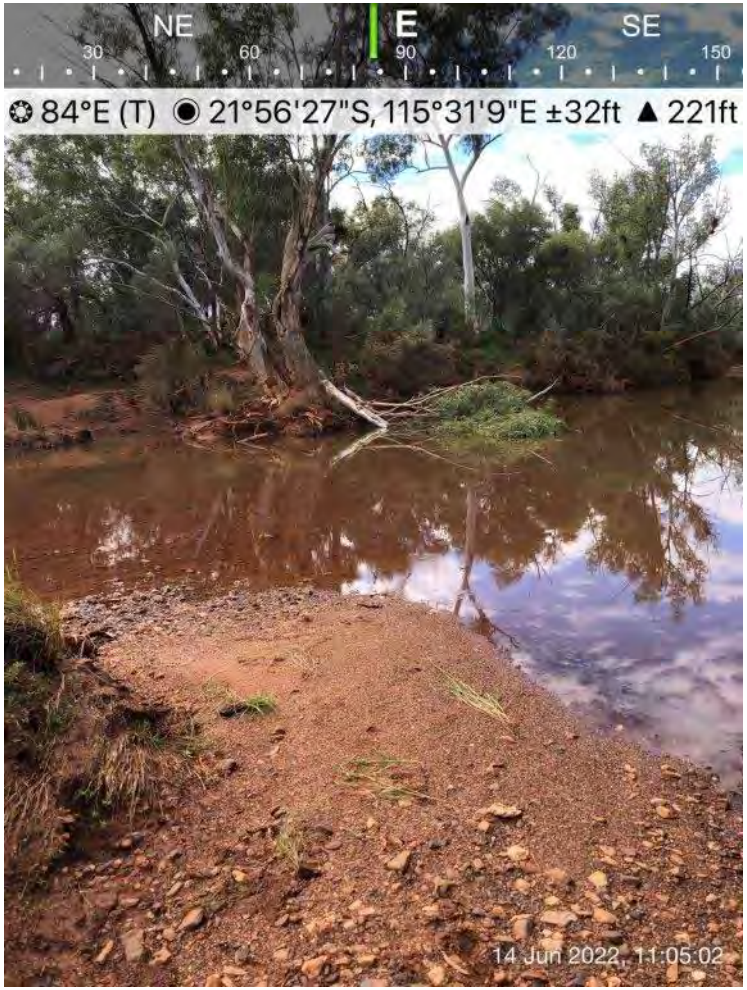

Plate 5. GRLFS05 (347079, 7572948)

Plate 6. GRLFS06 (346938, 7572974)

Plate 7. GRLFS07 (346872, 7573050)

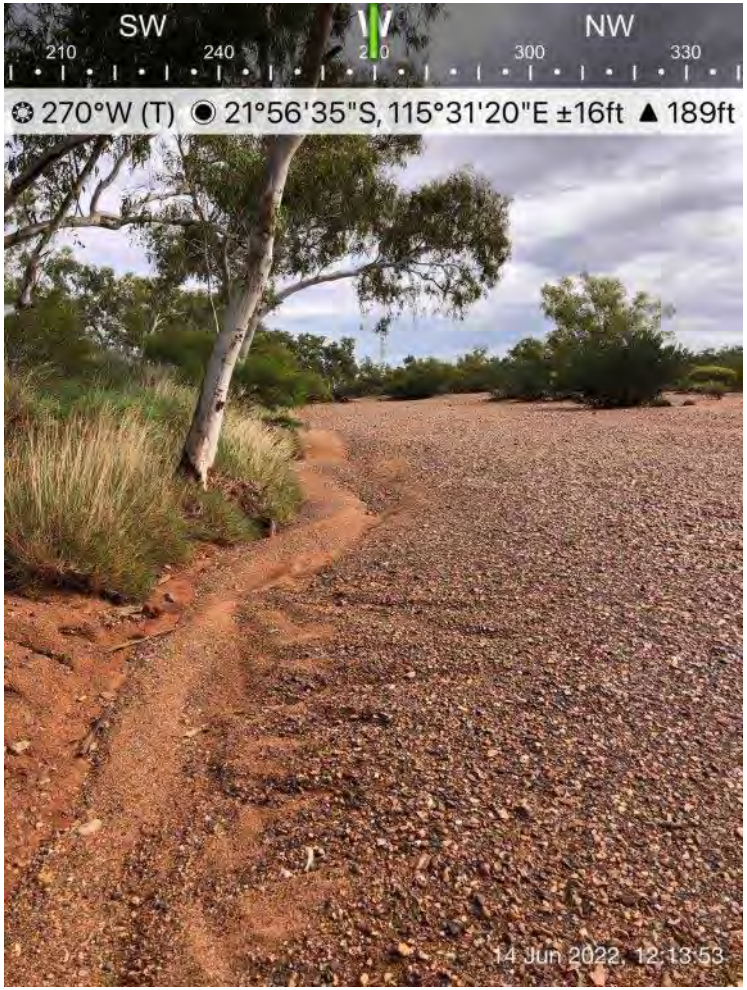

Plate 8. GRLFS08 (347388, 7572712)

Plate 9. GRLFS09 (347641, 7572672)

Plate 10. GRLFS10 (347708, 7572591)

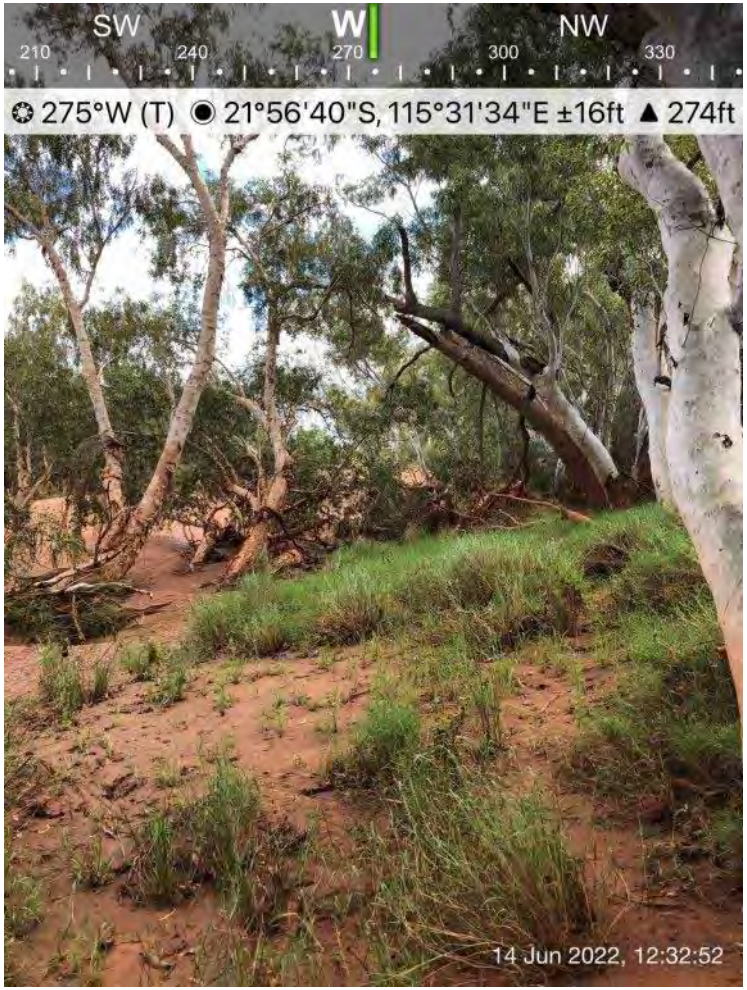

Plate 11. GRLFS11 (347823, 7572581)

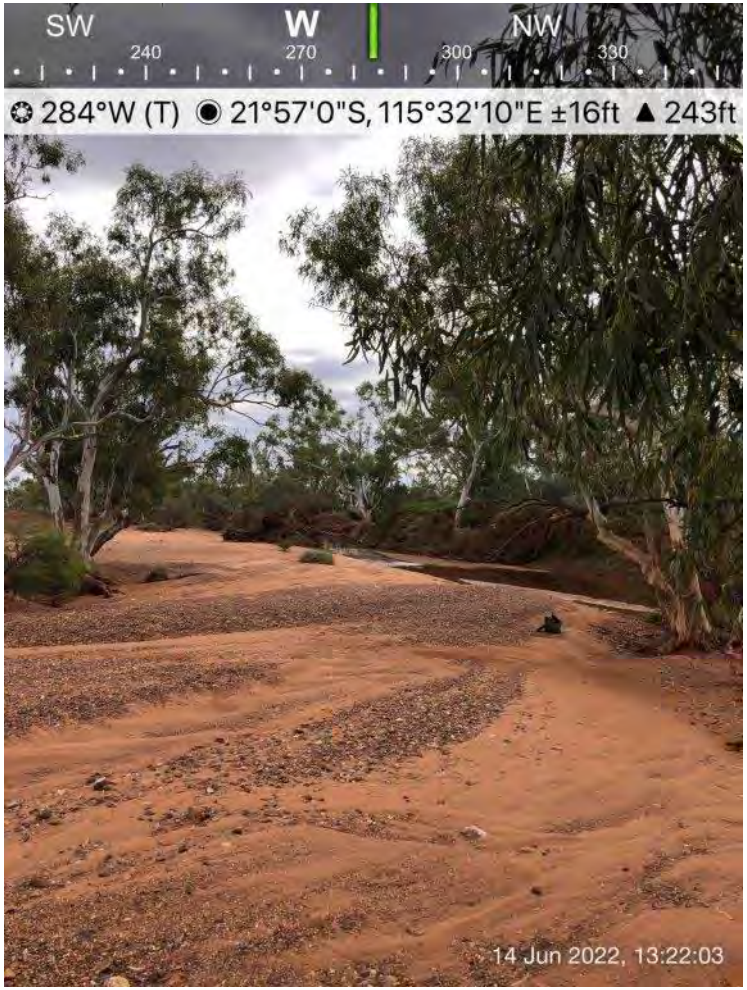

Plate 12. GRLFS21 (348853, 7571998)

Plate 13. GRLFS22 (348923, 7571969)

Plate 14. GRLFS23 (349023, 7571866)

Plate 15. GRLFS24 (349053, 7571851)

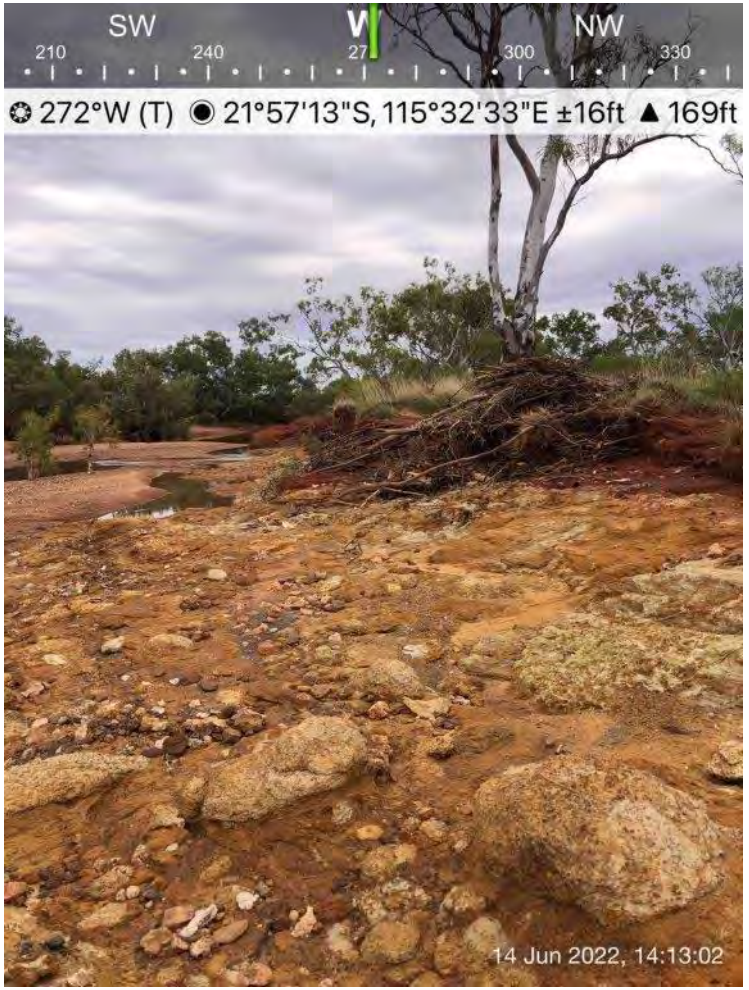

Plate 16. GRLFS25 (349516, 7571574)

Plate 17. GRLFS26 (349633, 7571461)

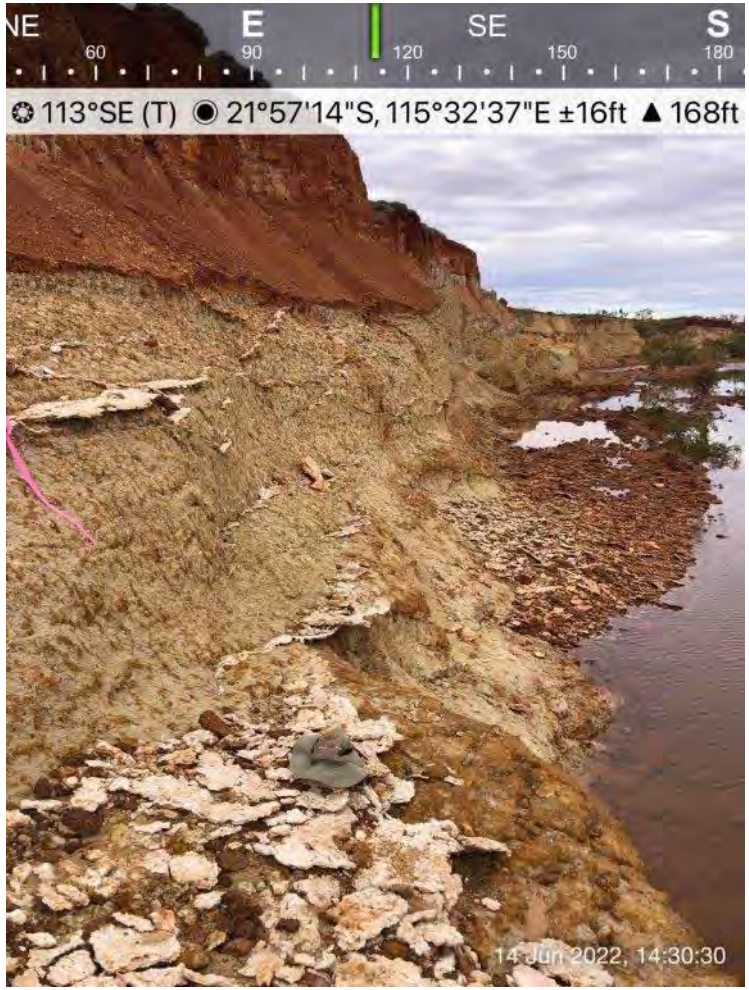

Plate 18. GRLFS27 (349641, 7571541)

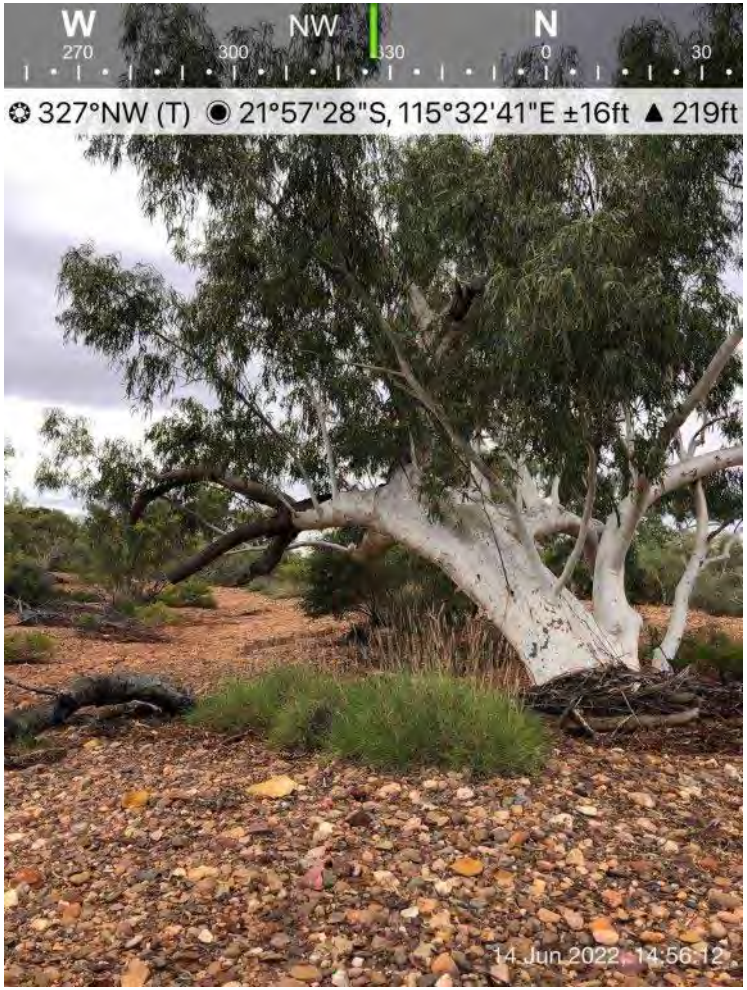

Plate 19. GRLFS28 (349755, 7571122)

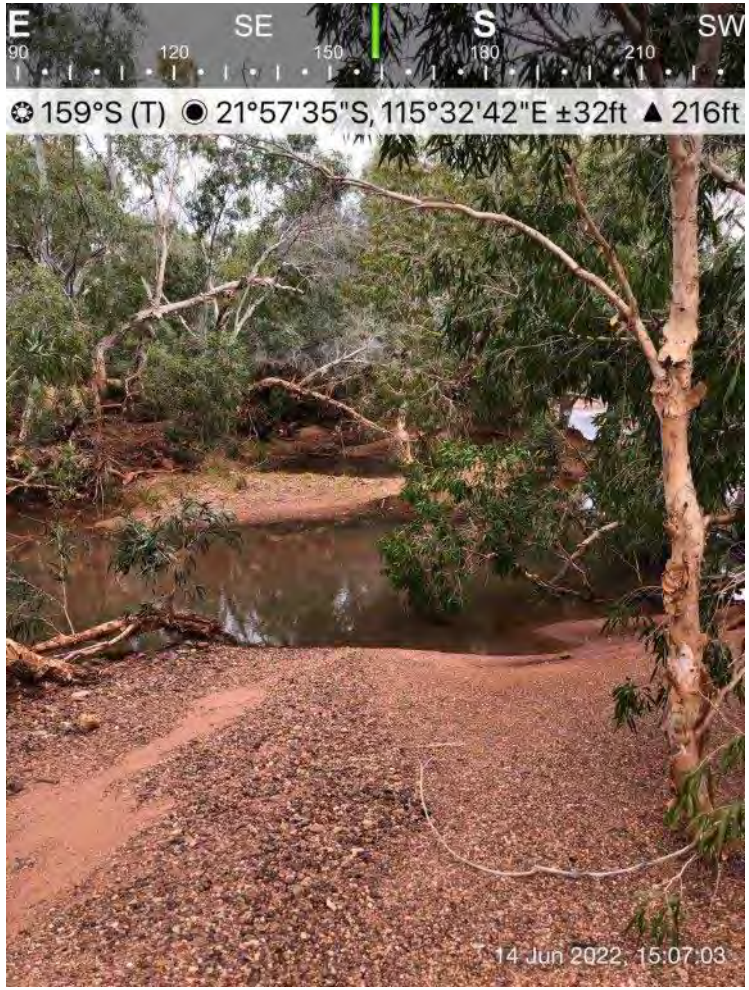

Plate 20. GRLFS29 (349787, 7570912)

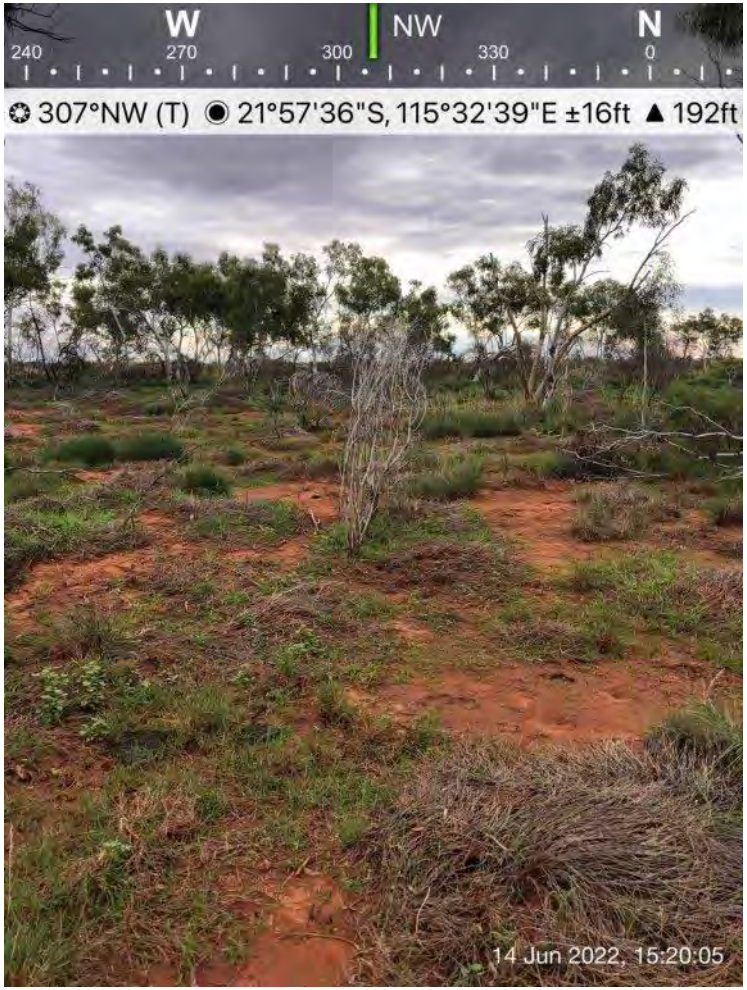

Plate 21. GRLFS30 (349707, 7570885)

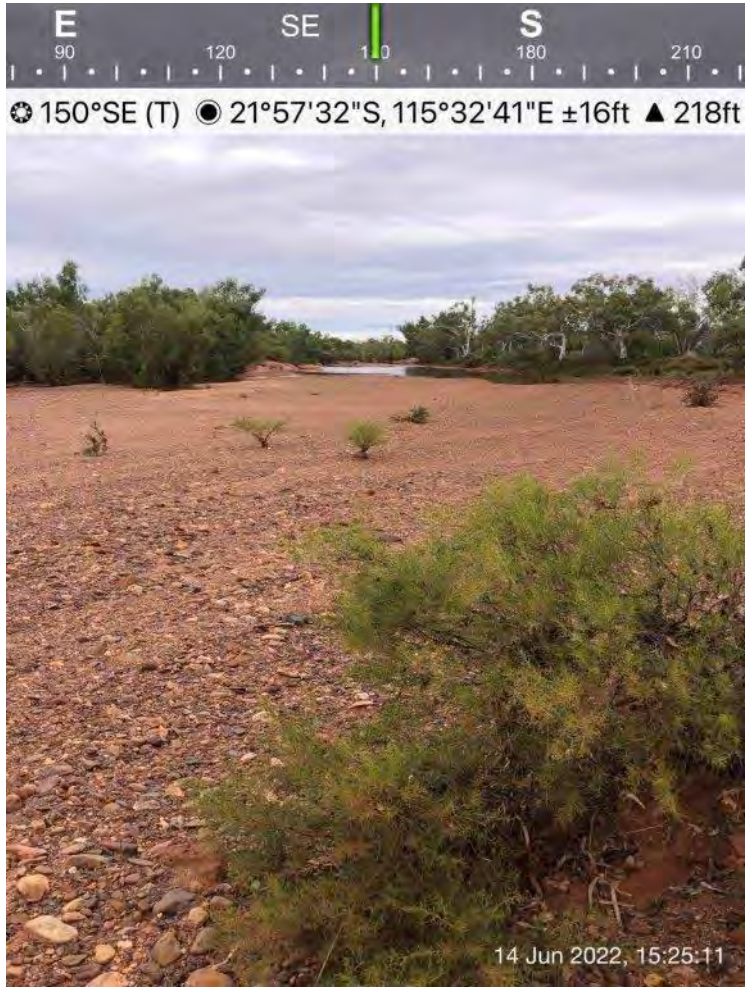

Plate 22. GRLFS31 (349744, 7570987)

Plate 23. GRLFS32 (349616, 7571286)

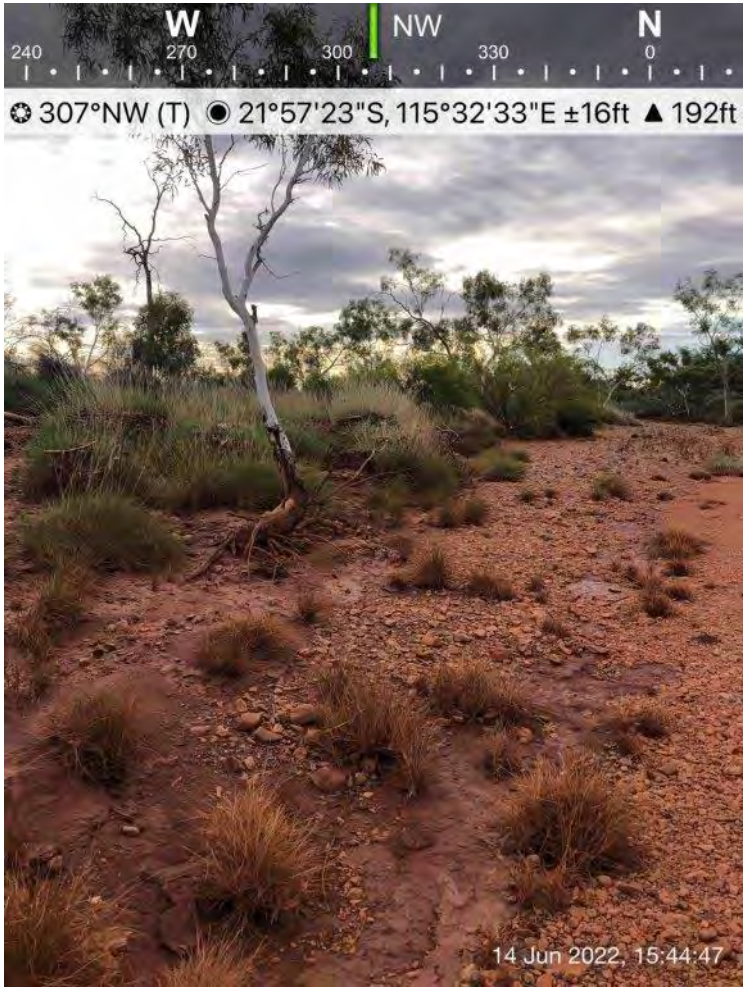

Plate 24. GRLFS33 (349524, 7571262)

Plate 25. GRLFS34 (349551, 7571394)

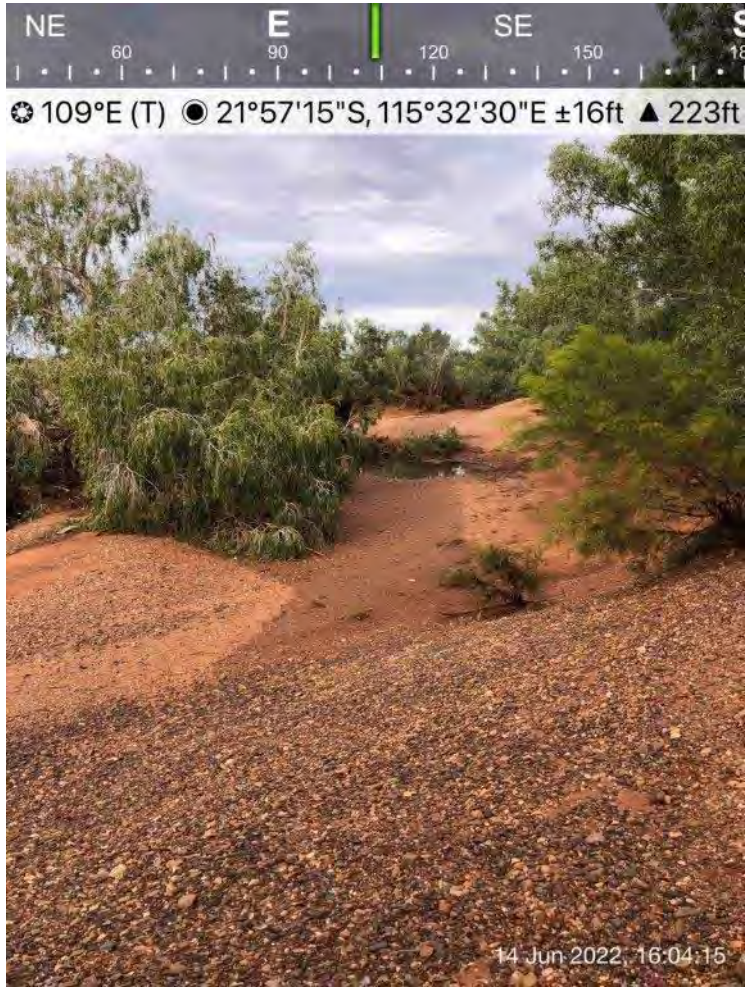

Plate 26. GRLFS35 (349411, 7571518)

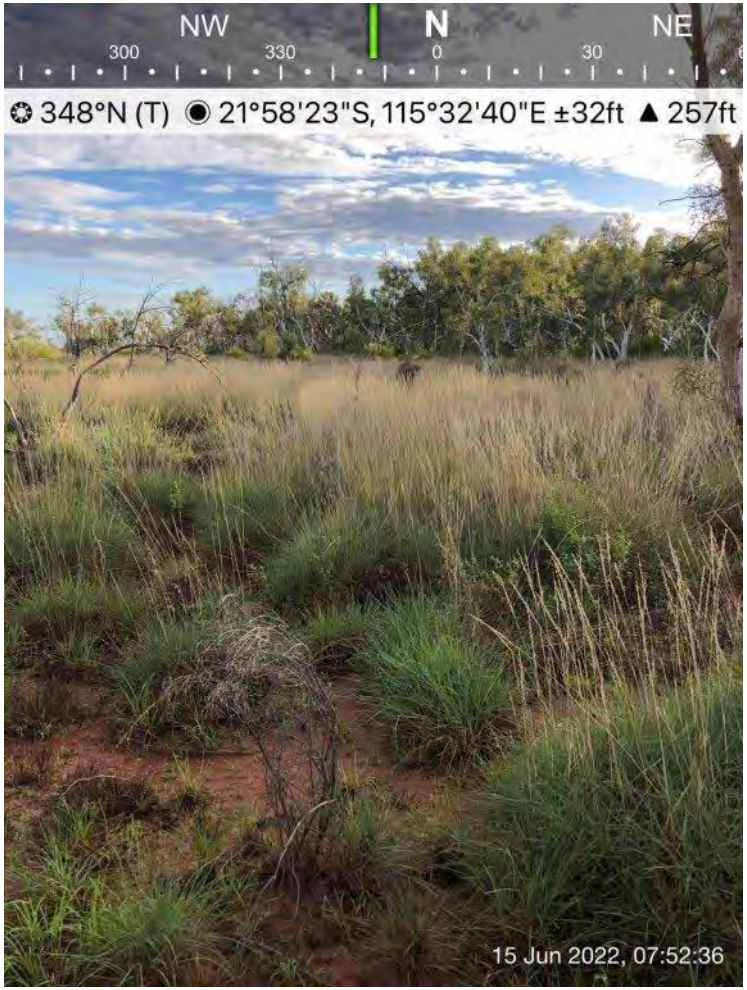

Plate 27. GRLFS36 (349749, 7569428)

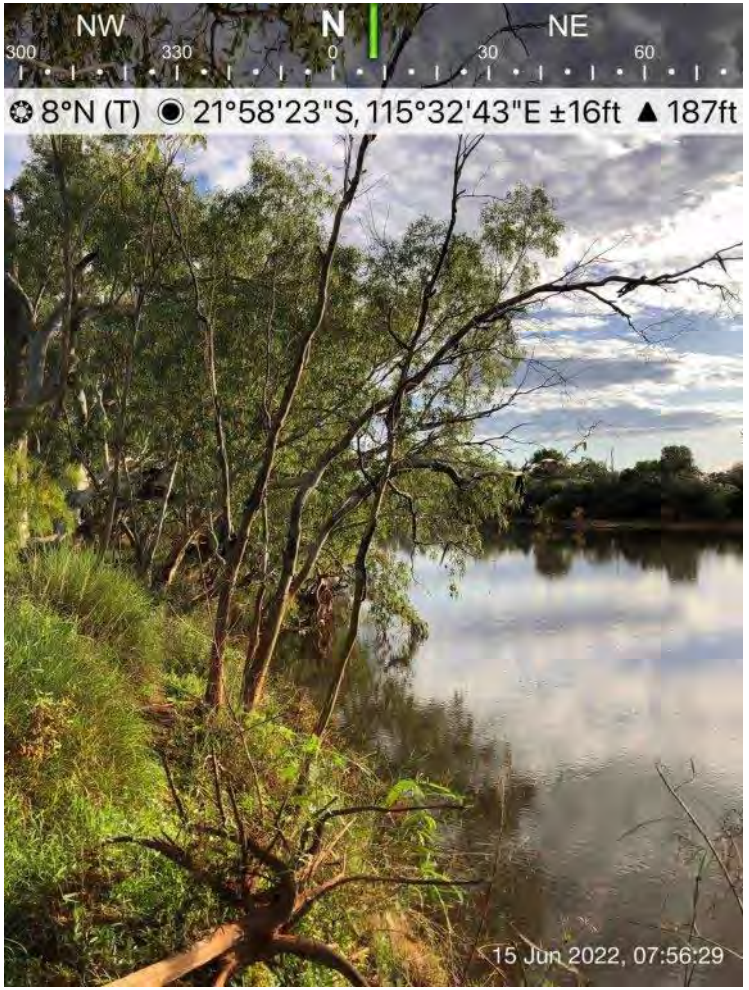

Plate 28. GRLFS37 (349820, 7569443)

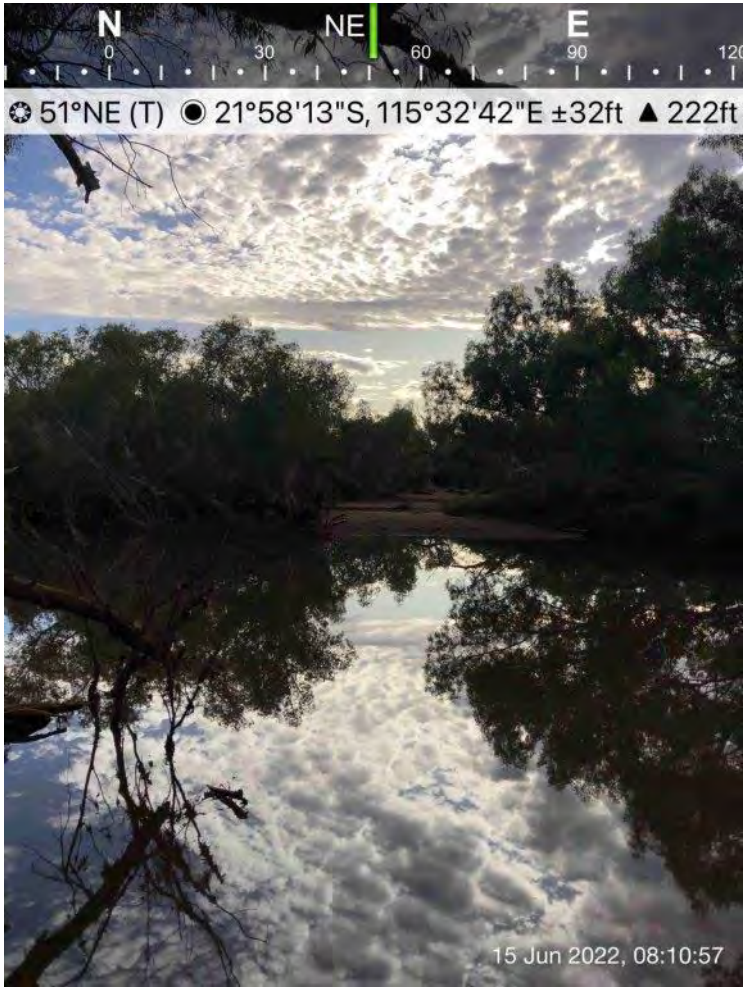

Plate 29. GRLFS38 (349846, 7569736)

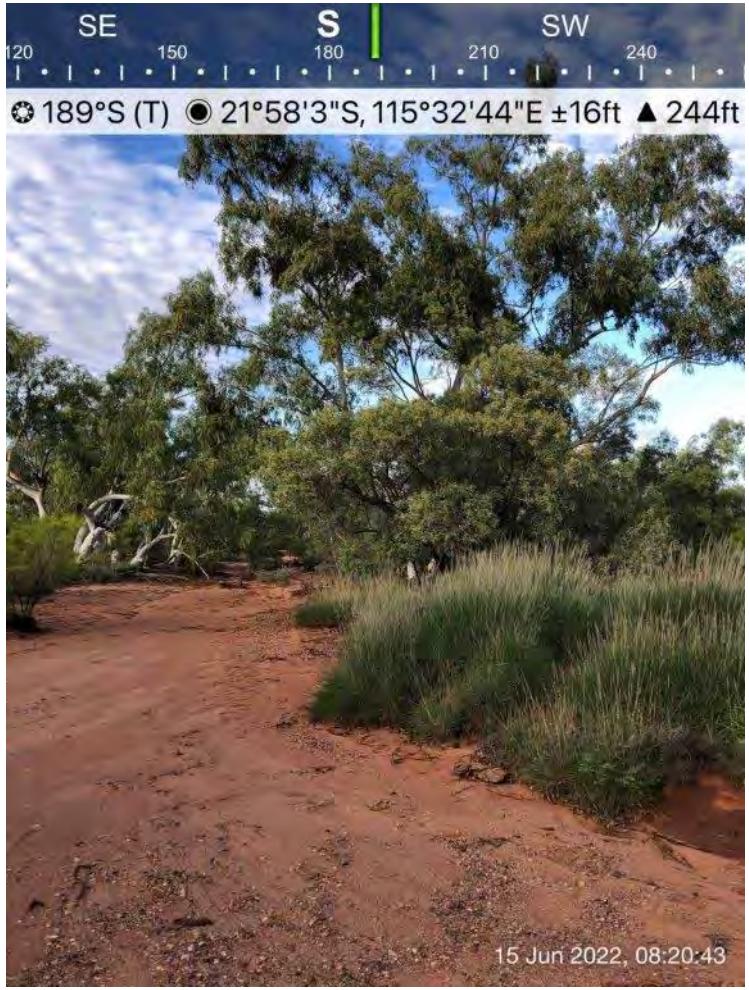

Plate 30. GRLFS39 (349845, 7570055)

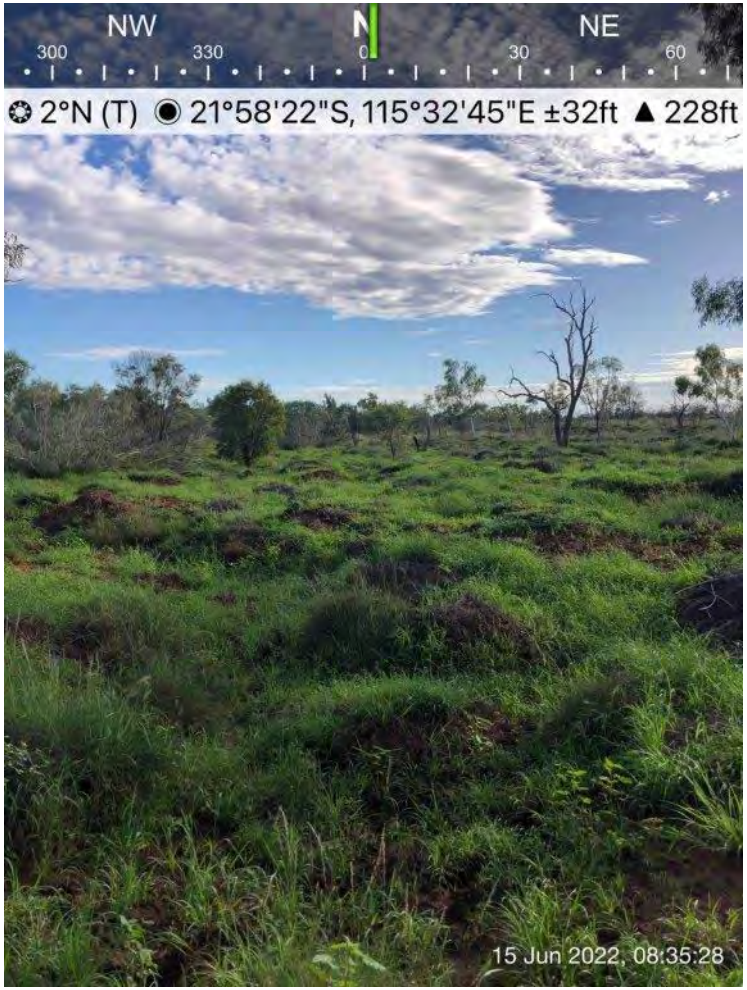

Plate 31. GRLFS40 (349894, 7569442)

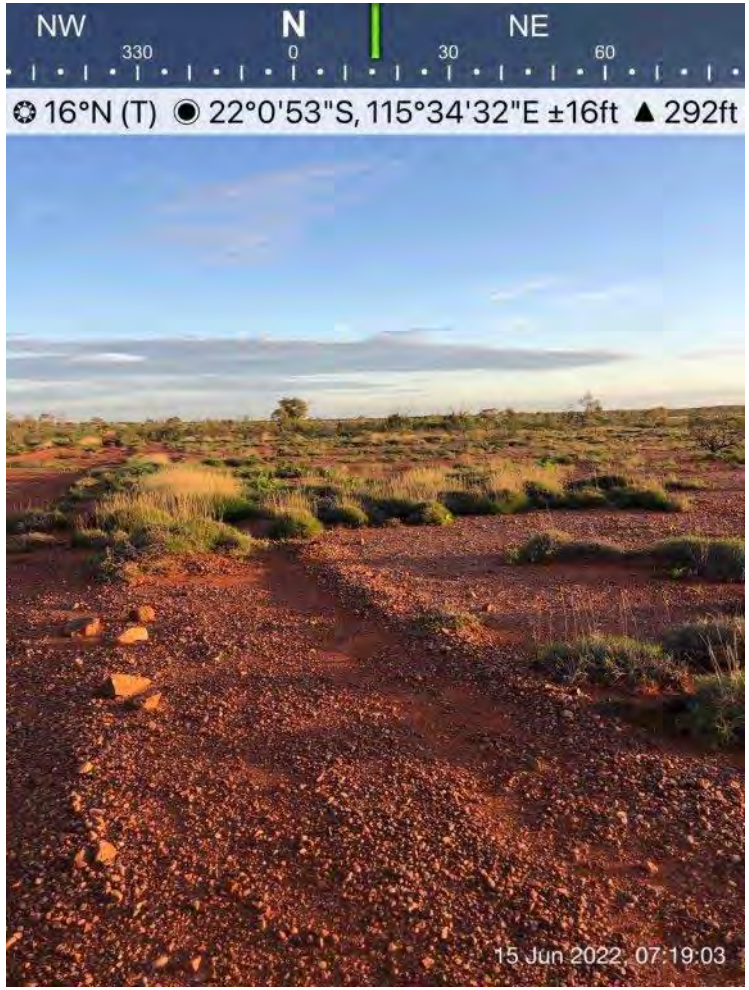

Plate 32. GRLFS41 (352990, 7564838)

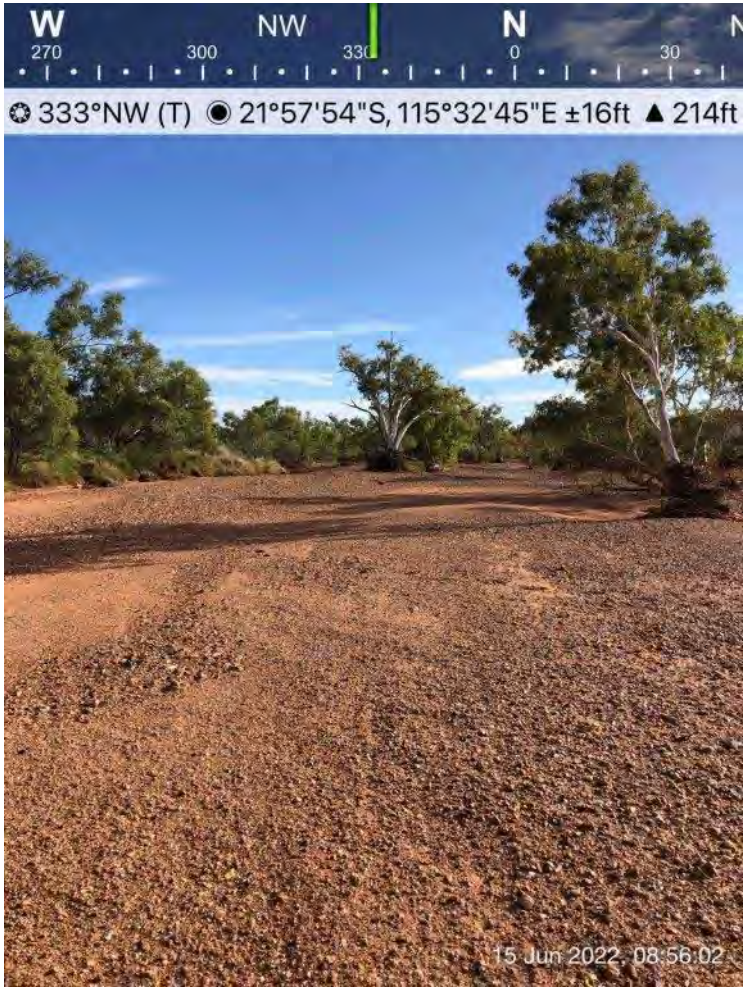

Plate 33. GRLFS42 (349863, 7570301)

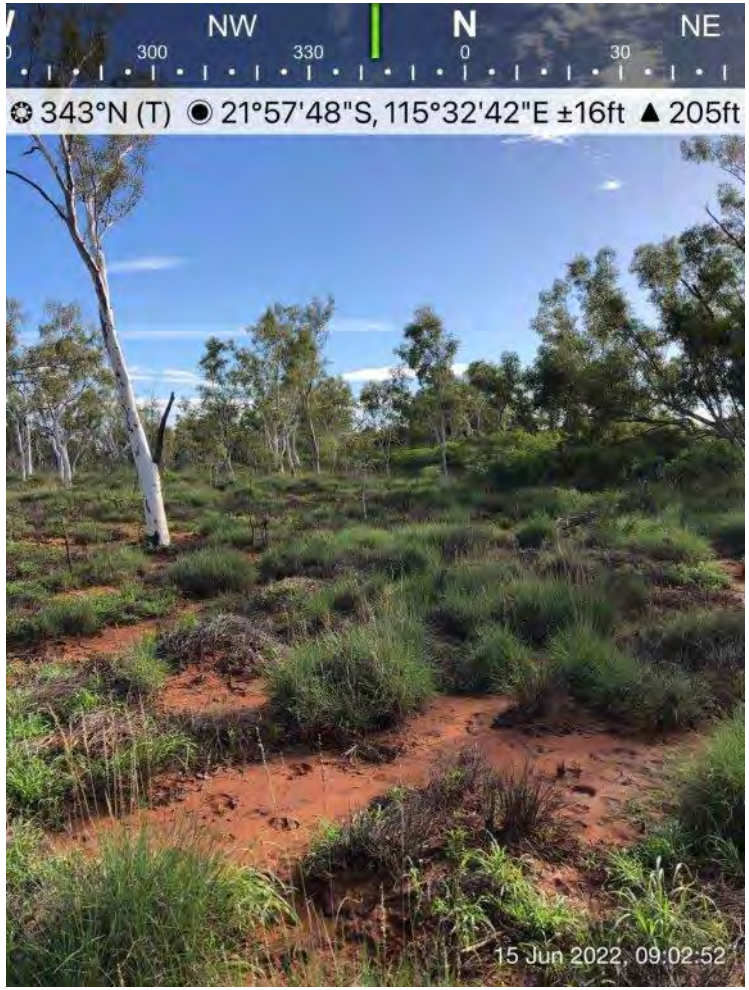

Plate 34. GRLFS43 (349775, 7570490)

APPENDIX E: TECHNICAL REPORT: BAT ACOUSTIC ANALYSIS (SPECIALISED ZOOLOGICAL 2022)

Acoustic analysis and bat call identification from Cane River, Western Australia

Prepared for **Animal Plant Mineral Pty Ltd**

Version **21 July 2022**

SZ project reference **SZ623**

Prepared by **Dr Kyle Armstrong and Yuki Konishi**

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2022). Acoustic analysis and bat call identification from Cane River, Western Australia. Unpublished report by Specialised Zoological for Animal Plant Mineral Pty Ltd, 21 July 2022, project reference SZ623.

Summary

The outcome of the analysis of acoustic (bat detector) recordings made at Cane River, in the Pilbara region of Western Australia is provided. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics.

The scope of the analysis was limited to the detection of the Threatened-listed Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae). The recording dataset comprised a total of 29 recording nights from four bat detector units (**Table 1**).

Two call sequences of the Pilbara Leaf-nosed Bat were detected (bat detector serial, date and time):

- 450007_2022-06-20_22-33-08 (illustrated in **Figure 1**)
- 450007_2022-06-20_23-18-36

Both call sequences were recorded were well after sunset and therefore when the individual was out foraging away from a diurnal roost.

No calls of the Ghost Bat were observed in the recordings.

Further details are available should verification be required.

Methods

The data provided were recorded in full spectrum WAV format with Titley Scientific Anabat Swift bat detectors (sampling rate 500 kHz, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong et al. 2021a,b) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language application that performed three tasks:

1. undertook a Discriminant Function Analysis on training data from representative echolocation calls of Pilbara cave-roosting bat species;

2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over ellipses representing one standard deviation of the variation for the defined call types; and

3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition version 22.

Species were identified based on information in Armstrong and Coles (2007) and the author's own unpublished material.

References

Armstrong, K.N. and Coles, R.B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonicteris aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* 88: 94–104. http://dx.doi.org/10.1644/06-MAMM-A-115R1.1

Armstrong K.N., Broken-Brow J., Hoye G., Ford G., Thomas M. and Corben C. (2021a). Effective detection and identification of sheath-tailed bats of Australian forests and woodlands. *Australian Journal of Zoology* 68: 346–363. https://doi.org/10.1071/ZO20044

Armstrong K.N., Clarke S., Linke A., Scanlon A., Roetman P., Hitch, A.T. and Donnellan S.C. (2021b). Citizen science implements the first intensive acoustics-based survey of insectivorous bat species across the Murray-Darling Basin of South Australia. *Australian Journal of Zoology* 68: 364–381. https://doi.org/10.1071/ZO20051

DEWHA (2010). Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment, Water, Heritage and the Arts, Canberra.

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of two target bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.
9. The most reliable way of detecting the Ghost Bat with bat detectors is to place the equipment with the microphone facing into a potential cave roosting site. The echolocation calls of this species are of low amplitude, and therefore most detectable when a Ghost Bat flies close to the bat detector as it exits the underground structure. If there is uncertainty about whether Ghost Bats are present in a cave, then video recordings can be a useful addition to the survey. The detection of Ghost Bats with bat detectors away from cave entrances is less reliable.
10. Predictions about whether the Pilbara Leaf-nosed Bat roosts within a particular surveyed cave (where a bat detector was placed at the entrance), or somewhere nearby, based on the time of first detection should be considered indicative only. If unambiguous information of diurnal roosting of this species is required, diurnal roosting should be confirmed using the entrance sheeting method described in DEWHA (2010).

Table 1. Summary of bat detector recordings analysed.

Swift serial	Night of	Latitude	Longitude
450007	14/06/2022	21.955162 S	115.543862 E
	15/06/2022	21.954307 S	115.541613 E
	16/06/2022	21.954222 S	115.542183 E
	17/06/2022	21.954307 S	115.541753 E
	18/06/2022	21.954370 S	115.541682 E
	19/06/2022	21.954235 S	115.541700 E
	20/06/2022	21.954018 S	115.541865 E
	21/06/2022	21.954315 S	115.541655 E
450083	14/06/2022	21.941252 S	115.519232 E
	15/06/2022	21.941255 S	115.519197 E
	16/06/2022	21.941048 S	115.519268 E
	17/06/2022	21.940957 S	115.519262 E
	18/06/2022	21.941222 S	115.519300 E
	19/06/2022	21.941255 S	115.519167 E
	20/06/2022	21.941203 S	115.519213 E
642022	14/06/2022	21.949767 S	115.536352 E
	15/06/2022	21.949890 S	115.536263 E
	16/06/2022	21.949802 S	115.536258 E
	17/06/2022	21.949802 S	115.536258 E
	18/06/2022	21.949802 S	115.536258 E
	19/06/2022	21.949962 S	115.536215 E
	20/06/2022	21.949860 S	115.536375 E
642149	14/06/2022	21.943915 S	115.524248 E
	15/06/2022	21.943047 S	115.523870 E
	16/06/2022	21.942663 S	115.523955 E
	17/06/2022	21.943202 S	115.523993 E
	18/06/2022	21.943120 S	115.524357 E
	19/06/2022	21.943012 S	115.524105 E
	20/06/2022	21.942777 S	115.524062 E

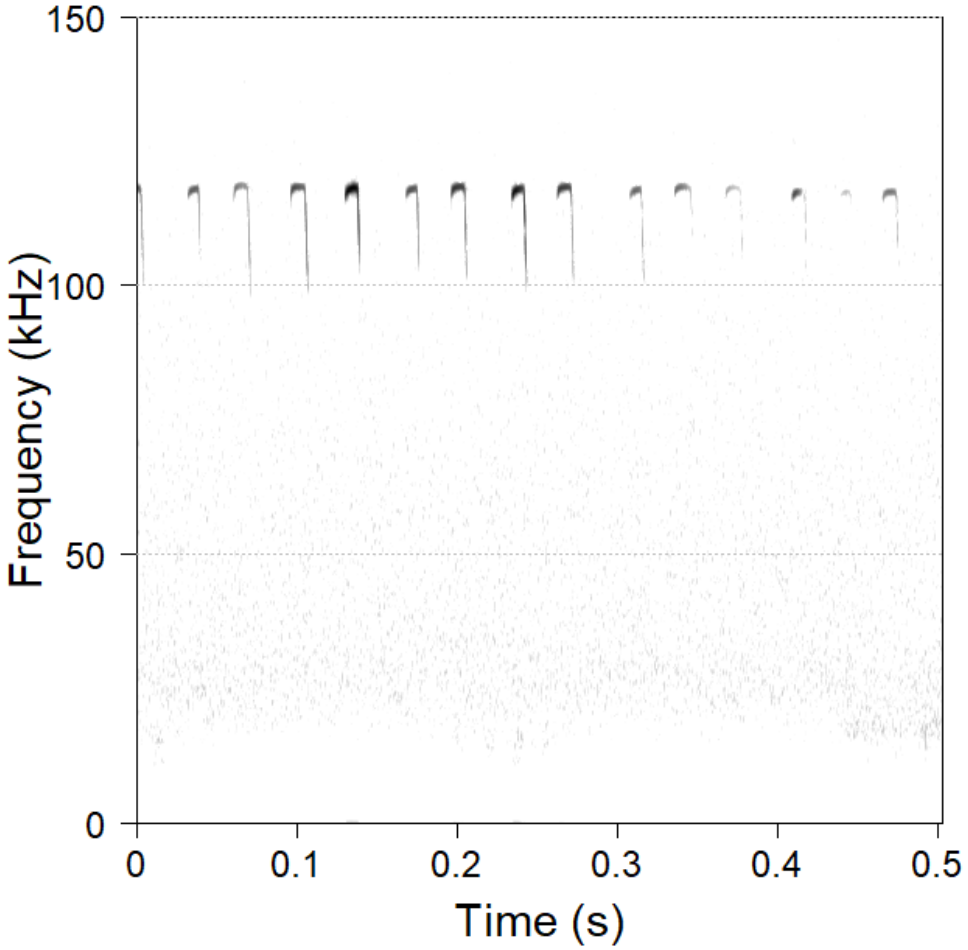

Figure 1. Example of an echolocation call sequence of the Pilbara Leaf-nosed Bat (file 450007_2022-06-20_22-33-08.wav).

APPENDIX F: FLORA SPECIES BY SITE MATRIX

Appendix F. Flora Species by Site Matrix

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	OC
Amaranthaceae																												
Achyranthes aspera	NT														0.1													
Alternanthera nana	NT									0.1	0.1	0.1	0.1		0.1		0.1	0.1		0.1		0.1		0.1				
Alternanthera nodiflora	NT									0.1																		
Amaranthus undulatus	NT								0.1						0.1							0.1				0.1	0.1	
Gomphrena affinis subsp. *pilbarensis*	NT																									0.1		Y
Gomphrena cunninghamii	NT																											Y
Ptilotus aervoides	NT			0.1																			0.1		0.1	0.1		Y
Ptilotus auriculifolius	NT																						0.1			0.1		Y
Ptilotus axillaris	NT																											Y
Ptilotus exaltatus	NT					0.1																	0.1	0.1	0.1	0.1		Y
Ptilotus fusiformis	NT					0.1																				0.1	0.1	Y
Ptilotus gomphrenoides	NT											0.1	0.1															
Ptilotus obovatus	NT																						0.1					
Ptilotus xerophilus	NT																											Y
Asteraceae																												
Asteraceae annual herb																									0.1	0.1	0.1	
Blumea ?tenella	NT		0.1			0.1	0.1		0.1			0.1		0.1	0.1							0.1	0.1	0.1	0.1	0.1	0.1	
Centipeda minima	NT	0.1						0.1			0.1	0.1	0.1			0.1	0.1	0.1	0.1	0.1								
Pterocaulon sphaeranthoides	NT			0.1											0.1								0.1			0.1		
Streptoglossa odora	NT																					0.1						
Boraginaceae																												
Heliotropium ammophilum	NT																											Y
Caryophyllaceae																												
Polycarpaea corymbosa	NT																									0.2		
Chenopodiaceae																												
Rhagodia eremaea	NT														0.1													
Cleomaceae																												
Arivela uncifera	NT		0.1	0.5		0.1								0.1														
Convolvulaceae																												
Bonamia media	NT																				0.1							
Evolvulus alsinoides var *villosicalyx*	NT																							0.1		0.1		
Ipomoea muelleri	NT		0.1		0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1	
Curcurbitaceae																												
Cucumis melo	NT																											Y
Cyperaceae																												
Cyperus vaginatus	NT	0.1						0.1			0.5	0.1		0.1			0.1	0.1	0.1	0.1		0.1						
Fimbristylis littoralis	NT															0.1	0.1		0.1	0.1								
Isolepis ?marginata	NT			0.1											0.1									0.1	0.1	0.1	0.1	
Euphorbiaceae																												
Euphorbia hirta	INT										0.1	0.1																
Euphorbia tannensis subsp. *eremophila*	NT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1				0.1	0.1	0.1		0.1	0.1		0.1	0.2	

Appendix F. Flora Species by Site Matrix

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	OC
Fabaceae																												
Acacia ancistrocarpa	NT		0.1								1	0.1			0.5	1		0.1	0.5									
Acacia bivenosa	NT														0.1								0.5				0.5	
Acacia pyrifolia	NT		0.5	0.5		1			0.1												0.1							
Acacia synchronicia	NT																						0.5			0.5		
Acacia trachycarpa	NT	*2*	0.5	1	1	5	0.5	0.1	5		5	5	0.5	0.1	2	2		0.1	0.5	0.5	2							
Acacia tumida var *pilbarensis*	NT				0.5		1																					Y
Acacia xiphophylla	NT																							0.5	1			Y
Indigofera boviperda subsp. *boviperda*	NT													0.1												0.1		Y
Indigofera linifolia	NT																				0.1							
Indigofera petraea	NT																											Y
Rhynchosia minima	NT		0.1	0.1	0.1		0.1			0.1	0.1	0.1		0.1				0.1	0.1		0.1	0.1		0.1				
Senna artemisioides subsp. *oligophylla*	NT																											Y
Senna glutinosa subsp. *glutinosa*	NT																											Y
Senna notabilis	NT													0.1	0.1						0.1		0.1	0.1				
Sesbania cannabina	NT				0.2		0.1	0.1		0.1			0.1	0.1			0.1	0.1	0.1	0.1								
Tephrosia supina	NT																							0.1				Y
Vachellia farnesiana	INT				0.1		0.5			0.1	0.1		0.5			0.1	0.1	0.1		0.1		0.1						
Vigna lanceolata	NT			0.1			0.1			0.1	0.1	0.1	0.1					0.1		0.1	0.1	0.5						
Goodeniaceae																												
Goodenia forrestii	NT																									0.1		Y
Goodenia lamprosperma	NT	0.1						0.1								0.1	0.1	0.1		0.1								
Scaevola pulchella	NT																											Y
Lauraceae																												
Cassytha capillaris	NT																				0.1							
Lythraceae																												
Ammannia multiflora	NT															0.1												
Malvaceae																												
Abutilon amplum	NT		0.1		0.1		0.1																					
Abutilon cunninghamii	NT																										0.1	Y
Abutilon fraseri	NT															0.1			0.1									
Abutilon lepidum	NT								0.1		0.1	0.1			0.1			0.1				0.1						
Corchorus incanus ssp *incanus*	NT			0.1	0.1				0.1												0.1			0.1				
Corchorus laniflorus	NT															0.1												
Corchorus sidoides subsp. *vermicularis*	NT																											Y
Gossypium robinsonii	NT		0.1													0.5		0.5										
Hibiscus leptocladus	NT																								0.1			
Sida rohlenae ssp *rohlenae*	NT			0.1					0.1		0.1	0.1			0.1	0.1		0.1	0.1		0.1	1.5		0.1				
Triumfetta maconochieana	NT																							0.1				
Montiaceae																												
Calandrinia sp															0.1								0.1			0.1		

Appendix F. Flora Species by Site Matrix

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	OC
Corymbia hamersleyana	NT																							0.5				
Eucalyptus camaldulensis	NT	5	5	0.1	6		10	0.5	10	2	2	5	5	0.5	5	2	2	5	2	0.5	15	15						
Melaleuca argentea	NT	5	5	2	4					2				0.5		0.5	2	5				2						
Melaleuca glomerata	NT						5			2	5		0.5	0.1		1		0.5	0.5	20								
Nyctaginaceae																												
Boerhavia burbidgeana	NT																						0.1	0.1		0..1	0.1	
Oleaceae																												
Jasminum didymum ssp *lineare*	NT										0.1										0.1							
Passifloraceae																												
Passiflora foetida	INT									0.1	0.1	0.1	0.1	0.1	0.1	0.1					0.1	0.2						
Phyllanthaceae																												
Nellica maderaspatensis	NT		0.1	0.1	0.1		0.1		0.1	0.1																		
Poaceae																												
Aristida contorta	NT																						0.5					Y
Aristida holathera var *holathera*	NT																						1		0.1	0.5	0.1	
Cenchrus ciliaris	INT		2	2	0.5	0.5			0.1			2		0.5	2	0.5		0.5	0.5		0.1	1						
Cenchrus setiger	INT		0.1	5	1.5	0.5					5		2		2													
Chloris pectinata	NT											0.1																
Dactyloctenium radulans	NT			0.1	0.1																					0.1		
Dichanthium sericeum ssp *sericeum*	NT							0.1				0.1	5				0.1	1.5		0.5		0.1						
Enneapogon caerulescens	NT																											Y
Enteropogon ramosus	NT																					0.1						
Eragrostis cumingii	NT											0.1		0.1				0.2										
Eragrostis tenellula	NT							0.1		0.1			0.1			0.1	0.1	0.1		0.1						0.1	0.1	
Eriachne aristidea	NT																						0.5			0.5	0.1	Y
Eriochloa pseudoacrotricha	NT									0.1	0.1	0.1	0.5	0.1						0.1		0.1						
Leptochloa digitata	NT										0.5											0.1						
Panicum australiense	NT																									0.1		
Paraneurachne muelleri	NT																		0.1									
Paspalidium clementii	NT	0.2	0.5		0.1	0.1	0.2							0.1	0.1				0.1									
Paspalidium constrictum	NT			0.1																			0.5	0.1	0.2	0.2	0.1	
Setaria verticillata	INT		1	1	0.5	0.5	0.5		0.1		1	1			0.5			0.1	0.5			0.2						
Triodia basedowii	NT																						5		0.5	1	1.5	Y
Triodia epactia	NT		10	10	5	5	0.1		5				6	0.5	10	0.5		0.5	5		5		10	15	1.5	4	0.5	
Urochloa occidentalis var *ciliata*	NT							0.1		0.1		0.1	0.1	0.2		0.1		0.1	0.2			0.1						
Portulaceae																												
Portulaca oleracea	Mixed																								0.1	0.1	0.1	
Grevillea wickhamii	NT																							0.5				
Pteridaceae																												
Cheilanthes sieberi subsp. *sieberi*	NT																								0.1			
Scrophulariaceae																												
Eremophila cuneifolia	NT																											Y

Appendix F. Flora Species by Site Matrix

Species	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	OC
Solanaceae																												
Solanum cleistogamum	NT			0.1											0.1									0.1				
Solanum diversiflorum	NT																											Y
Solanum lasiophyllum	Mixed																											Y
Violaceae																												
Afrohybanthus aurantiacus	NT			0.1		0.1															0.1			0.1		0.1	0.1	Y
Zygophyllaceae																												
Tribulus astrocarpus	NT																											Y
Tribulus hirsutus	NT																								0.1	0.1		Y

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