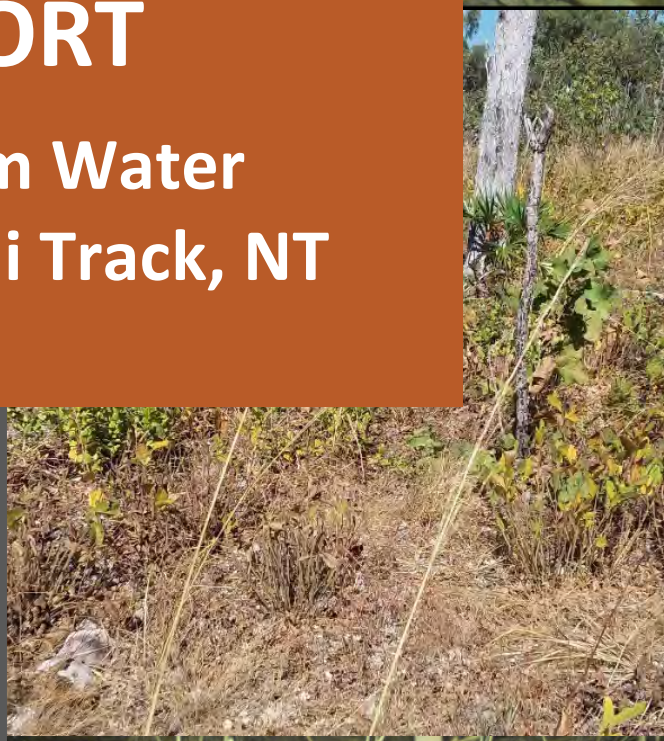

THREATENED SPECIES ASSESSMENT REPORT

Adelaide River Off-stream Water Storage Project, Marrakai Track, NT

Prepared for:
GHD Pty Ltd

16 April 2024

Document Information and Control

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0.1 (draft)	Mihkel Proos, Principal Environmental Consultant, Connect Environmental	10/10/23	Laura McCallion, Technical Director – Ecology, GHD	20/10/23
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Contact Information

Information	Details
Organisation	Connect Environmental (Legal Entity 'Vaino Mihkel Proos')
ABN	31 693 727 483
Address	PO Box 40444, Casuarina, NT, 0811
Contact Person	Mihkel Proos
Phone	0411 019 569
Email	mproos@connectenvironmental.com.au

Photo on front cover (from top to bottom): Northern Quoll, *Helicteres macrothrix*¸ Black-footed Tree-rat. All photos were taken by Connect Environmental.

Contents

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Figures

1 Introduction

1.1 Background and Scope of This Report

Connect Environmental was engaged to prepare a significant impact assessment for threatened species potentially impacted by the Adelaide River Off-stream Water Storage (AROWS) project. The AROWS project has been selected as the preferred medium-term augmentation option for the Darwin Region Water Supply System. This project will involve an off-stream water storage to be built adjacent to the Adelaide River (refer to **Figure 1**).

As part of the environmental investigation process, threatened species surveys were conducted from 2019 to 2022 by Connect Environmental. The 2019 and 2020 surveys focused on the AROWS basin and intake corridor only. The 2021 and 2022 surveys included the AROWS basin and intake corridor as well as:

- A linear area just outside the basin (a subset of vegetation attributes only).
- Two infrastructure corridor options (Byers Road and Acacia Gaps Road).
- A potential diversion route for the Marrakai Track (along Chinner and Heather's Lagoon Roads).

The surveys conducted within the AROWS basin, intake and offtake corridors were informed by the *Threatened Species Survey Plan* (EcOz, 2018) whereas a separate likelihood of occurrence assessment was conducted for the additional survey areas outside of the basin including Byers and Acacia Gap Roads and the Marrakai Track diversion option (south of Lake Bennett) (Connect Environmental, 2022).

While substantial survey effort was completed during the surveys, some information gaps remained because of access restrictions (e.g., landholder permissions not granted), the timing being inappropriate for some seasonally detectable species or species not initially considered to occur were recommended to be included following observations of habitats in the basin. The additional field survey requirements are planned to be addressed as part of a subsequent field survey program, which is currently under development.

This report is focused on the AROWS basin and intake corridor only, as shown in **Figure 1**, in line with the current referral being prepared by GHD Pty Ltd. It is understood that the locations of the components outside the basin have not been finalized (and which may have changed since the surveys were conducted).

This report provides:

- A summary of the terrestrial ecological surveys conducted from 2019 to 2022 within the AROWS basin.
- An updated threatened species likelihood of occurrence assessment.
- A migratory species likelihood of occurrence assessment.
- An assessment of impacts to relevant threatened species.
- Information gaps and recommendations.

It is recommended that this report is reviewed in detail following the completion of all flora and fauna surveys that are relevant to the AROWS basin and intake corridor.

1.2 Existing Reports

Reports that are relevant to the assessment include:

- *Threatened species survey plan* (EcOz, 2018).
- *Threatened Species Survey Report* (Connect Environmental, 2019).
- *Threatened Species Survey Report – 2020* (Connect Environmental, 2020).
- *2022 Flora and Fauna Survey Report, Adelaide River Off-stream Water Storage Project, NT* (Connect Environmental, 2022 draft).

Figure 1 - AROWS basin and intake corridor

Key

- AROWS basin (32 m inundation line) and intake corridor
- NT government roads

Background - Google Maps

N

0 0.5 1 1.5 2 2.5 km

1:65,000

Client: GHD Pty Ltd
Author: M. Proos
Geodatum: GDA94 / Z52
10 October 2023

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2 Survey Effort and Results to Date

2.1 Survey Effort

A summary of the survey areas, timing, staffing and report titles are shown in **Table 1**. The target species and survey effort are shown in **Table 2**, noting:

- The distance walked is a combined total of all ecologists (e.g., if two ecologists each walked 3 km of adjacent transects searching for individuals of a species, then the total kilometres walked is 6 km).
- Some species not included in the *Threatened Species Survey Plan* (EcOz, 2018) were nominated following analysis of additional species in February 2022 (prior to the 2022 surveys). Conclusions made of the likelihood of occurrence of these species are based on the previous survey results.
- Those species concluded as being 'possible' to occur though were not detected despite sufficient ('complete') survey effort may still be present occasionally or in small pockets not physically surveyed. Suitable habitat for these species may occur over time, even seasonally, because of variations in climatic conditions and threatening processes.
- The terms 'AROWS basin' or 'the basin' were used over the period 2019 to 2022 to include both the area within the 32 m AHD inundation boundary and the intake corridor. However, in this report, both areas have been discreetly stated to avoid confusion.

The 2019 and 2020 survey reports were provided to the NT Department of Environment, Parks and Water Security (DEPWS) to seek their endorsement of the survey effort and any outstanding information gaps to sufficiently inform the impact assessment. The DEPWS response is summarised in **Table 3**.

Table 1 Summary of surveys conducted in the AROWS basin and intake corridor from 2019 to 2022

Consultancy	Survey area	Period	No. ecologists	Report title / author / year
Supplementary vegetation community survey	AROWS basin, intake corridor	May to August 2019	3	Supplementary Vegetation Survey Report, Adelaide River Off-Stream Water Storage (AROWS) Project. Astrebla Ecological Services and Connect Environmental, 2019.
Threatened species surveys (2019)	AROWS basin, intake corridor	May to October 2019	6	Threatened Species Survey Report, Adelaide River Off-Stream Water Storage (AROWS) Project. Connect Environmental, 2019.
Threatened species surveys (2020)	AROWS basin, intake corridor	March to June 2020	4	Threatened Species Survey Report - 2020, Adelaide River Off-Stream Water Storage (AROWS) Project. Connect Environmental, 2020.
Threatened species surveys (2022)	AROWS basin	March to June 2022	3	2022 Flora and Fauna Survey Report, Adelaide River Off-Stream Water Storage Project, NT. Connect Environmental, 2022.

Table 2 Target species, survey effort and compliance with Government survey guidelines

Species	Included in 2018 survey schedule[1]?	Approx. total survey area	Survey effort				Compliance with Government survey guidelines[2]		
			2019	2020	2022	Total	Guideline and effort	Compliance	NT Government response (June 2022)
Vegetation communities									
Vegetation communities	No[3]	Entire basin	Entirety of basin with a focus on previously unmapped areas: ▪ 45 full characterisation sites ▪ 797 check sites	None	None	All	*Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst *et al*., 2007): ▪ Full characterisation sites, check sites and road notes.	Expected to comply (and exceed guidance)	Not applicable
Flora									
Cleome insolata	No	<1 km^2	None	None	<1 km^2 (parallel transects)	<1 km^2	*Northern Territory guidelines for targeted surveys of threatened and significant plant species* (Cuff *et al*., 2020)[4]	Incomplete	Not included in the request for advice[5]
Cycas armstongii	Yes	530 ha	215 km walking traverses (40 m width)	None	None	215 km walking		Expected to comply	Sufficient
Goodenia quadrifida	Yes	12.8 ha	7.7 km walking (random meander)	None	None	7.7 km walking			Sufficient
Helicteres macrothrix	Yes	510 ha	67 km walking (random meander)	40 km walking (parallel transects)	54 km walking[6] (parallel transects)	161 km walking			Further survey recommended[7]
Ptychosperma macarthurii	No	15 ha	None	None	6 km walking (parallel transects)	6 km walking			Not included in the request for advice[8]
Stylidium ensatum	Yes	53 ha	2 person days (random meander)	None	None	2 person days			Sufficient
Typhonium praetermissum[9]	No	3 ha	None	None	1 person day[10] (random meander)	1 person day	*Northern Territory guidelines for targeted surveys of threatened and significant plant species* (Cuff *et al*.,	Incomplete	DWPWS to revise species modelling.

[1] *EcOz (EcOz Pty Ltd), 2018b. AROWS Threatened Species Survey Plan. Unpublished report commissioned by Power and Water Corporation.*

[2] *The surveys followed (and often exceeded) the 'Threatened Species Survey Plan' (EcOz', 2018) as required by the Power and Water Corporation. This column indicates compliance with available government survey guidelines.*

[3] *Vegetation communities were mapped in 2018 by EcOz though this mapping was revised in 2019 by Astrebla Ecological Services and Connect Environmental to address any gaps.*

[4] *This guidelines was not available at the commencement of the surveys in 2019. The survey methodology followed the 'Threatened Species Survey Plan (EcOz, 2018).*

[5] *Cleome insolata was not identified as a target species in the Threatened Species Survey Plan (EcOz, 2018) and only a limited reconnaissance survey was conducted in a small area of potential habitat in 2022. Consequently, the species was not included in the list that was submitted to DEPWS to seek advice on survey adequacy.*

[6] *Includes 'scouting' transects further south searching for potentially suitable habitat.*

[7] *This has now been completed.*

[8] *Ptychosperma macarthurii was not identified as a target species in the Threatened Species Survey Plan (EcOz, 2018) and, consequently, the species was not included in the list that was submitted to DEPWS to seek advice on survey adequacy. However, a survey was subsequently conducted in June 2022 in potential habitat identified in the south of the basin. The species was not detected.*

[9] *Typhonium praetermissum was not identified as a target species during the 2019 and 2020 surveys.*

[10] *Only a small 'sample area' was surveyed to determine whether the species occurs there.*

Species	Included in 2018 survey schedule[1]?	Approx. total survey area	Survey effort				Compliance with Government survey guidelines[2]		
			2019	2020	2022	Total	Guideline and effort	Compliance	NT Government response (June 2022)
Utricularia singeriana	Yes	145 ha	11 km walking (random meander)	55 km walking (parallel transects)	None	66 km walking	2020)[11]	Incomplete	Further survey recommended
Fauna									
Partridge Pigeon	Yes	798 ha	Surveys on 25 days comprised of: 198 km walking (primary[12]) 105 km walking (secondary[13]) 200 km driving[14] 32 cameras[15] (set for four weeks)	None[16]	None	Surveys on 25 days comprised of: 198 km walking (primary) 105 km walking (secondary) 200 km driving 32 cameras (set for four weeks)	*Survey guidelines for Australia's threatened birds* (DEWHA, 2010): ▪ Flushing surveys: 15 hours over 5 days (areas less than 50 ha). ▪ Targeted waterhole searches: 20 hours over 10 days.	Expected to comply	Sufficient
Masked Owl	Yes	326 ha	26 call playback sessions at 10 sites over six nights	11 call playback sessions at five sites over four nights	None	37 call playback sessions over ten nights	*Survey guidelines for Australia's threatened birds* (DEWHA, 2010): ▪ Broadcast surveys: 8 hours on 4 nights. *Survey protocol for masked owls in the NT* (NRETAS, 2010): ▪ 1 km intervals along tracks on multiple nights.	Expected to comply	Sufficient
Northern Quoll	Yes	419 ha	16 cameras (464 camera nights)	20 cameras (753 camera nights)	None	36 cameras (1,217 camera nights)	*EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus* (DoE, 2016): Trapping: Varies (transects or grids depending on habitat type) Cameras: Transects of ten cameras 100 m apart for four nights, or 1 per 100 m in linear habitats.	Uncertain[17]	Sufficient
Fawn Antechinus	Yes	419 ha		None[18]	None	16 cameras (464 camera nights)	None available. Survey followed (and generally exceeded) the *Threatened Species Survey Plan* (EcOz, 2018a).	N/A	Sufficient

[11] *This guideline was not available at the commencement of the surveys in 2019. The survey methodology followed the 'Threatened Species Survey Plan (EcOz, 2018).*

[12] *Primary surveys involved walking transects where Partridge Pigeons were the focus of the transect.*

[13] *Secondary surveys were utilised where Partridge Pigeons may not have been the primary focus of the transect, such as when surveying for other species (e.g. cycads), though were still searched for some of the time.*

[14] *Driving transects were utilised when driving around the site during the day.*

[15] *Including 18 cameras in well-drained or imperfectly drained eucalypt woodlands (potential breeding and foraging habitat) and 14 cameras on or near late dry season waterholes.*

[16] *Though the species was opportunistically searched for when conducting surveys for other species.*

[17] *The individual detected on the escarpment to the west of the basin may require further survey to determine the population size along that escarpment (i.e., cameras were mostly placed within the basin rather than on the escarpment) and consideration of potential impacts including loss of potential foraging habitat and a potential shift or increase in Cane Toad distribution or density.*

[18] *Though cameras deployed for the Northern Quoll could have also detected the Fawn Antechinus*

Species	Included in 2018 survey schedule[1]?	Approx. total survey area	Survey effort				Compliance with Government survey guidelines[2]		
			2019	2020	2022	Total	Guideline and effort	Compliance	NT Government response (June 2022)
Black-footed Tree-rat	Yes	495 ha	55 cameras (1,277 camera nights)	None[19]	None	55 cameras (1,277 camera nights)	None available. Survey followed (and generally exceeded) the *Threatened Species Survey Plan* (EcOz, 2018a).	N/A	Sufficient
Pale Field-rat	Yes	252 ha	39 cameras (813 camera nights)	None	None	39 cameras (813 camera nights)			Not addressed
Northern Brushtail Possum (north-western)	No[20]	495 ha	55 cameras (1,277 camera nights)	None[21]	None	55 cameras (1,277 camera nights)			Not addressed
Merten's Water Monitor	Yes	58 ha	23 km of 'active' searching Habitat assessment of all other 'dry' drainage lines 39 cameras (813 camera nights)	None[22]	None	23 km of 'active' searching Habitat assessment of all other 'dry' drainage lines 45 cameras (1,137 camera nights)			Sufficient
Mitchell's Water Monitors	Yes			6 cameras (324 camera nights)	None				Sufficient

[19] *Though cameras deployed for other species could have (and did) also detected the Black-footed Tree-rat*

[20] *The species was listed as Vulnerable under the EPBC Act (as Trichosurus vulpecula arnhemensis) on effective 11-May-2021.*

[21] *Though cameras deployed for other species could have (and did) also detected the Northern Brushtail Possum (north-western)*

[22] *Though cameras deployed for Mitchell's Water Monitor could have also detected Merten's Water Monitor*

Table 3 Summary of the DEPWS response in relation to survey effort for threatened species within the AROWS basin

Species	Common name	DEPWS' conclusion
Threatened flora		
Cleome insolata	Spider Flower	[Surveys not conducted to date within the AROWS basin]
Cycas armstrongii	Darwin Cycad	Sufficient
Goodenia quadrifida	-	Sufficient
Helicteres macrothrix	-	Satisfied with the survey methodology though recommends the survey area be extended to suitable habitat on the private property to the south of Koolpinyah Station, to provide density estimates within and outside of the 32 m AHD inundation zone to better contextualise the plants located within the basin.
Stylidium ensatum	-	Sufficient
Typhonium praetermissum	-	[Surveys not conducted to date within the AROWS basin] Revised modelling may indicate high likelihood of presence within the project area. The Division will attempt to revise modelling later but has no further recommendations at this stage.
Utricularia singeriana	-	Satisfied with the survey methodology though recommends that surveys be undertaken within suitable habitat in parts of the project area to the south of Koolpinyah Station.
Threatened fauna		
Antechinus bellus	Fawn Antechinus	Satisfied with the sampling method and effort.
Dasyurus hallucatus	Northern Quoll	
Mesembriomys gouldii	Black-footed Tree-rat	
Tyto novaehollandiae	Masked Owl	
Varanus mertensi	Merten's Water Monitor	
Varanus mitchelli	Mitchell's Water Monitor	

2.2 Results

2.2.1 Vegetation Communities

The surveys conducted by Connect Environmental from 2019 to 2022 within the AROWS basin and intake corridor were based on the *Threatened species survey plan, AROWS* (EcOz, 2018a). That plan was informed by vegetation mapping which produced 14 vegetation communities into 38 polygons (EcOz, 2018b). However, it did not cover the entire proposed inundation area, with approximately 50 ha in the far south of the basin remaining unsurveyed. The vegetation mapping was subsequently updated by Astrebla Ecological Services and Connect Environmental in 2019 (AES and Connect Environmental, 2019) to:

- Include the area previously not surveyed.
- Produce a seamless vegetation mapping product that was internally consistent.
- Reflect the general ground truthing observations made during the 2019 surveys.

As a result, five new vegetation communities were described making a total of 19 vegetation communities for the entire basin and offtake corridors mapped into 132 polygons within the AROWS basin and a further 41 within the offtake corridors (AES and Connect Environmental, 2019).

2.2.2 Threatened Species

Two threatened flora and three threatened fauna species were detected within the AROWS basin and intake corridor:

- Darwin Cycad (*Cycas armstrongii*)
- *Helicteres macrothrix*
- Black-footed Tree-rat (*Mesembriomys gouldii*)
- Northern Brushtail Possum (north-west) (*Trichosurus vulpecula arnhemensis*)
- Merten's Water Monitor (*Varanus mertensi*)

One flora species was also detected that is suspected to be a threatened species:

- *Typhonium praetermissum* (unconfirmed).

Three additional threatened species were detected immediately adjacent to the AROWS basin and are expected to occasionally occur within the basin:

- Partridge Pigeon
- Gouldian Finch (not a survey target species)
- Northern Quoll.

The abundance and distribution of these species' detections are briefly described in the following sections.

Table 4 Target species and summary of survey results in the AROWS basin (and intake corridor) from 2019 to 2022

Species	Survey conducted[23]			Result
	2019	2020	2022	
Flora				
Cleome insolata	X	X	✓	No individuals detected.

[23] ✓ = surveyed for, X = not surveyed for, ^ = not targeted though was observed for incidentally / opportunistically.

Species	Survey conducted[23]			Result
	2019	2020	2022	
Cycas armstongii	✓	X	X	11,880 individual adult Darwin cycads recorded[24]
Goodenia quadrifida	✓	X	X	No individuals detected.
Helicteres macrothrix	✓	✓	✓	Approx. 25,000 plants recorded within the AROWS basin and approx. 14,000 more outside the basin adjoining the basin population.
Ptychosperma macarthurii	X	X	✓	No individuals detected.
Stylidium ensatum	✓	X	X	No individuals detected within the AROWS basin. No suitable habitat identified.
Typhonium praetermissum[25]	X	X	✓	Six unconfirmed individuals detected.[26]
Utricularia singeriana	✓	✓	X	No individuals detected.
Fauna				
Partridge Pigeon	✓	^	^	No individuals detected within the AROWS basin, though two individuals were observed just to the east of the basin.
Gouldian Finch[27]	^	^	^	No individuals detected within the AROWS basin, though two individuals were observed within the intake corridor.
Masked Owl	✓	✓	X	No individuals detected, though several suspect (distant and infrequent) calls were heard in 2019. Recorded calls were unable to be verified by government or external experts.
Northern Quoll	✓	✓	X	No individuals detected within the AROWS basin, though one individual was observed along the escarpment (near the Marrakai Track) to the immediate west of the AROWS basin.
Fawn Antechinus	✓	^	X	No individuals detected.
Black-footed Tree-rat	✓	^	X	Detected by 22 cameras in 2019 and one camera in 2020.
Pale Field-rat	✓	X	X	No individuals detected.
Northern Brushtail Possum (north-western)	✓	^	X	Detected by 16 cameras in 2019 and four cameras in 2020.
Merten's Water Monitor	✓	^	X	Detected by two cameras in 2019 within the AROWS basin (the intake corridor) as well as by Ecologists the Marrakai Track in 2020, just to the west of the AROWS basin (in Bamboo Springs).
Mitchell's Water Monitors	✓	✓	X	No individuals detected.

[24] This figure represents approximately 80-90% of the total population present within the AROWS basin. Therefore, it is possible that up to 14,250 Darwin cycads may occupy the area of the AROWS basin below the 32 m inundation line.

[25] Typhonium praetermissum was not identified as a target species during the 2019 and 2020 surveys.

[26] Samples were not collected or genetically analysed, though were assumed to be T. praetermissum based on the individual located near Lake Bennett that was confirmed to be T. praetermissum.

[27] Not a target species during the surveys though was incidentally observed for.

2.2.2.1 Darwin Cycad (Cycas armstrongii)

A total population of 11,880 individual adult Darwin Cycads were recorded within the 32 m inundation line (Connect Environmental, 2019). This is expected to represent 80-90% of the total population within the basin. Therefore, it is possible that up to 14,250 Darwin Cycads occur within the AROWS basin. The following density characteristics were observed within the AROWS basin (including the intake corridor; **Figure 2**):

- Very high or high density: no sub-populations.
- Moderate density: 22 ha, comprising 4,370 cycads.
- Low density: 310 ha, comprising 7,461 cycads.
- Not present or present in low density (estimated): 642 ha.
- Not present: 829 ha.

The following terms for density are used in accordance with definitions adopted by the NT Herbarium (Nicholas Cuff, pers. comm. 12/9/2019):

- None – cycads are absent.
- None/Low (predicted): Those areas that weren't surveyed though are unlikely to contain cycads, or relatively few per hectare.
- Low – less than 130 adults per hectare (an adult is defined as a plant with an above-ground stem of at least 50 cm height).
- Moderate – 131-400 adults per hectare.
- High – 401-700 adults per hectare.
- Very high – greater than 700 adults per hectare.

2.2.2.2 Helicteres macrothrix

The mapped distribution of the entire sub-population within and adjacent to the AROWS basin is shown in **Figure 3**. A total of approximately 14,000 individuals outside of the 32 m inundation boundary and approximately 25,000 plants within the 32 m inundation boundary were detected (Connect Environmental, 2020).

2.2.2.3 Partridge Pigeon (Geophaps smithii smithi)

The Partridge Pigeon was not confirmed from within the AROWS basin, despite over 500 km of survey transects (primary, secondary and driving – refer to **Section 2.1**) and the deployment of 23 cameras in well-drained eucalypt sites and 14 cameras at late dry season water holes. However, two individuals were detected together on 24 August 2019 about 550 m to the east of the 32 m boundary (between the project area and the Adelaide River; refer to **Figure 4**). One other unconfirmed observation of the species was made on 27 September 2019 about 170 m south of the Marrakai Track within the AROWS basin (**Figure 4**).

2.2.2.4 Gouldian Finch (Erythrura gouldiae)

The Gouldian Finch was detected in the intake corridor only (**Figure 4**). It was not targeted during the surveys, as per the TSSP, because there is no breeding habitat within the survey area (EcOz, 2018). The *Survey Guidelines for Australia's Threatened Birds* (DEHWA, 2010) focusses on breeding habitat and nearby waterholes. Breeding habitat is comprised of wooded hills with hollow-bearing Snappy Gums (*Eucalyptus brevifolia* and *E. leucophloia*) or Salmon Gums (*E. tintinans*) (DEPWS, 2021). The absence of suitable breeding habitat within the basin was verified during the vegetation, flora and fauna surveys conducted by Connect Environmental from 2019 to 2022. Suitable foraging habitat is present within the basin.

2.2.2.5 Masked owl (northern mainland) (Tyto novaehollandiae kimberli)

The Masked Owl was not confirmed within the AROWS basin, however infrequent calls were heard which resembled that from a *Tyto* owl (e.g., a Barn Owl or Masked Owl).

2.2.2.6 Northern Quoll (Dasyurus hallucatus)

No Northern Quolls were detected in the AROWS basin although one individual was detected on one camera on the escarpment to the immediate west of the AROWS basin (refer to **Figure 4**). No other individuals were detected. It is unclear whether this individual is part of the population in that area, or if a population exists.

2.2.2.7 Black-footed Tree-rat (Mesembriomys gouldii)

The Black-footed Tree-rat was detected on 22 cameras in 2019 and one camera in 2020 (Connect Environmental, 2020; refer to **Figure 4**).

2.2.2.8 Northern Brushtail Possum (Trichosurus vulpecula arnhemensis)

The Northern Brushtail Possum was not targeted for surveys initially because it was not listed as a threatened species. It was listed as a Vulnerable species under the EPBC Act on 11 May 2021. It was detected on 16 cameras in 2019 and four cameras in 2020.

2.2.2.9 Merten's Water Monitor (Varanus mertensi)

The Merten's Water Monitor was detected on two cameras, both located in the billabong in the central intake corridor (refer to **Figure 4**). It was also detected along the Marrakai Track adjacent to Bamboo Springs (i.e., the permanent creek that crosses the Marrakai Track at the western side entry to the AROWS basin).

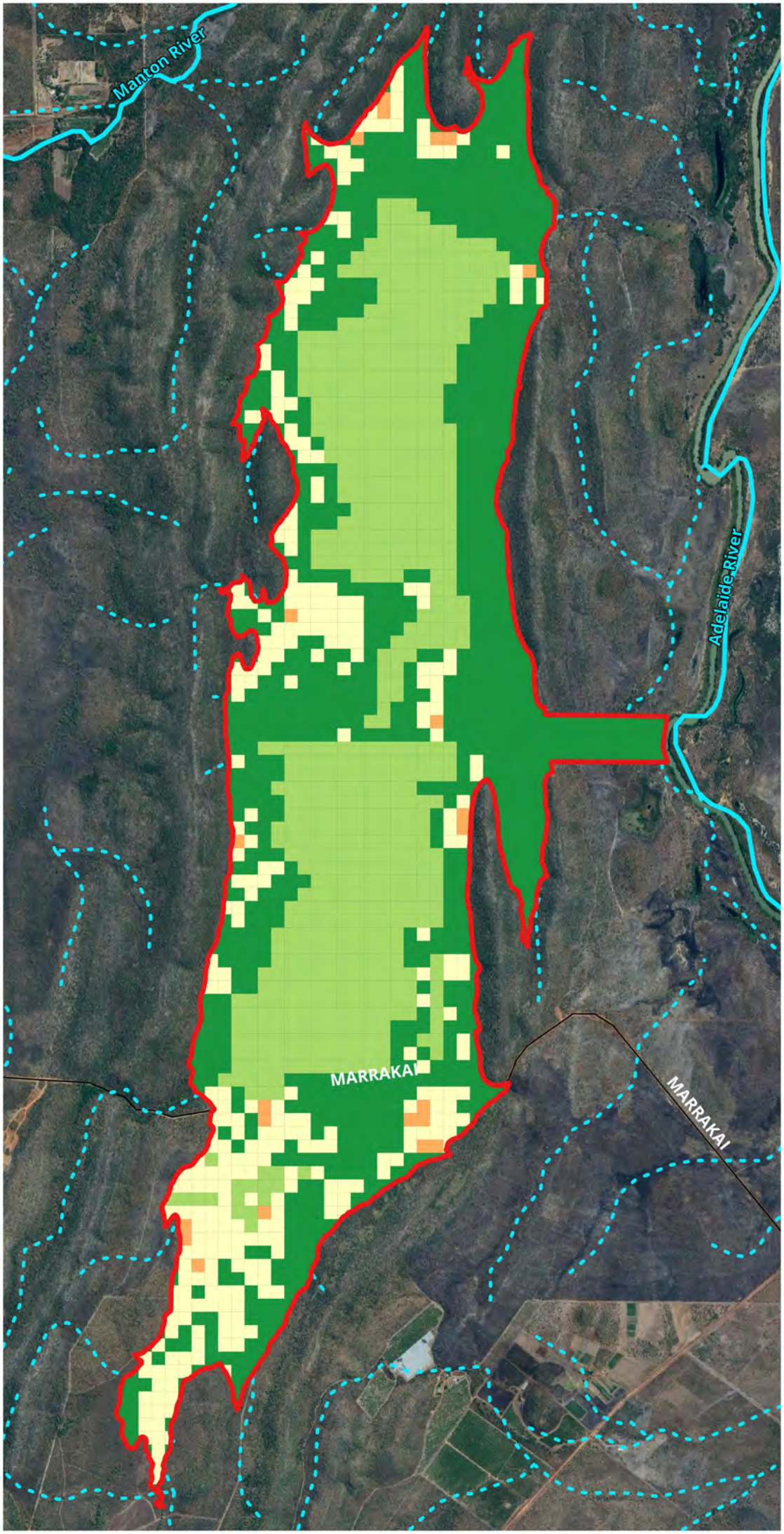

Figure 2 - Darwin Cycad densities within the AROWS basin and intake corridor

Key

Cycas armstrongii hectare density grid

- None
- None/Low (predicted)
- Low
- Moderate
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

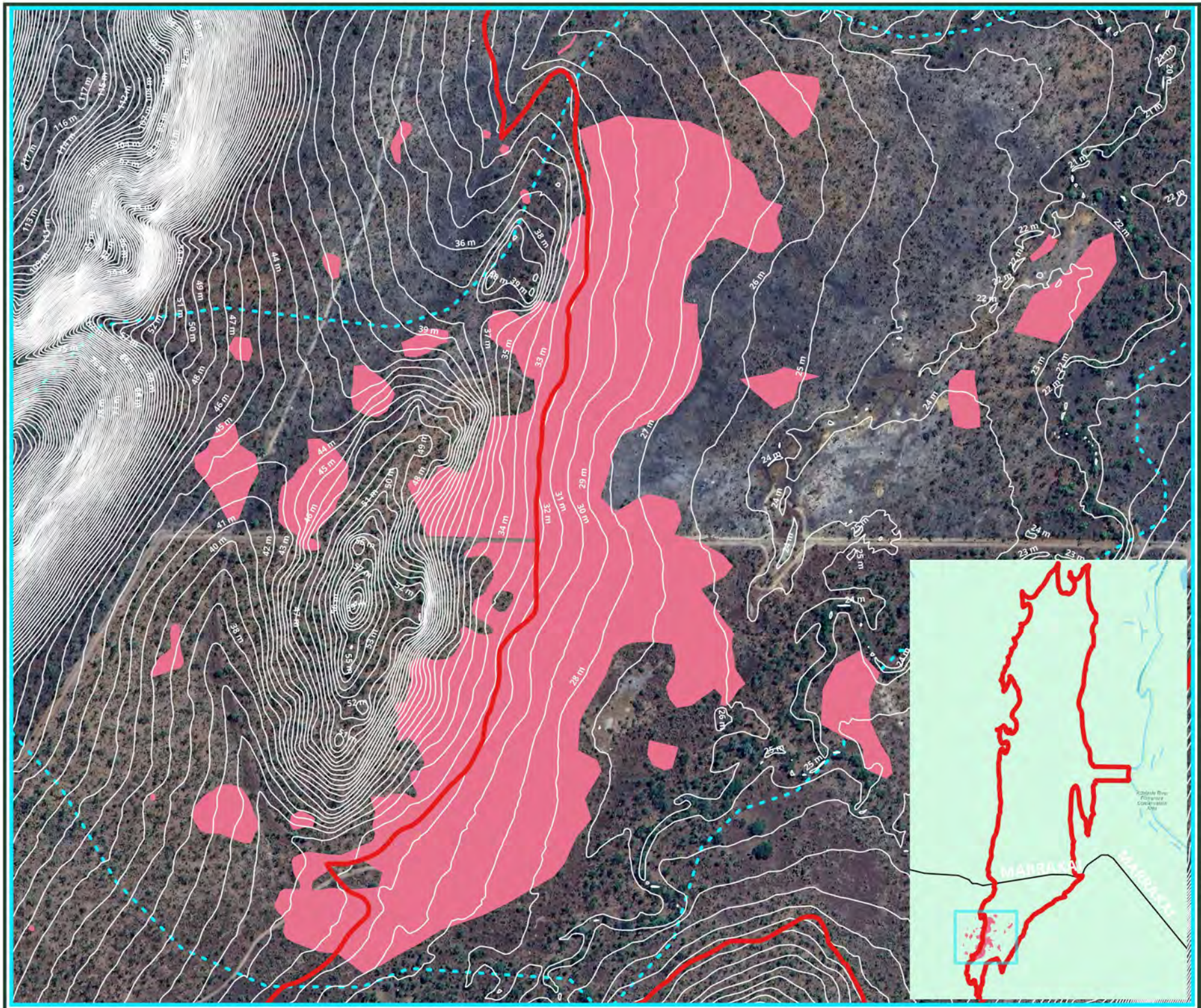

FIGURE 3 - Helicteres macrothrix distribution in the AROWS basin

Key

- Helicteres macrothrix distribution
- 32 m inundation boundary
- Streams

Background - Google Satellite

0 50 100 150 200 m

1:6,500

Project: AROWS
Client: GHD
Author M. Proos
21 February 2024

CONNECT environmental

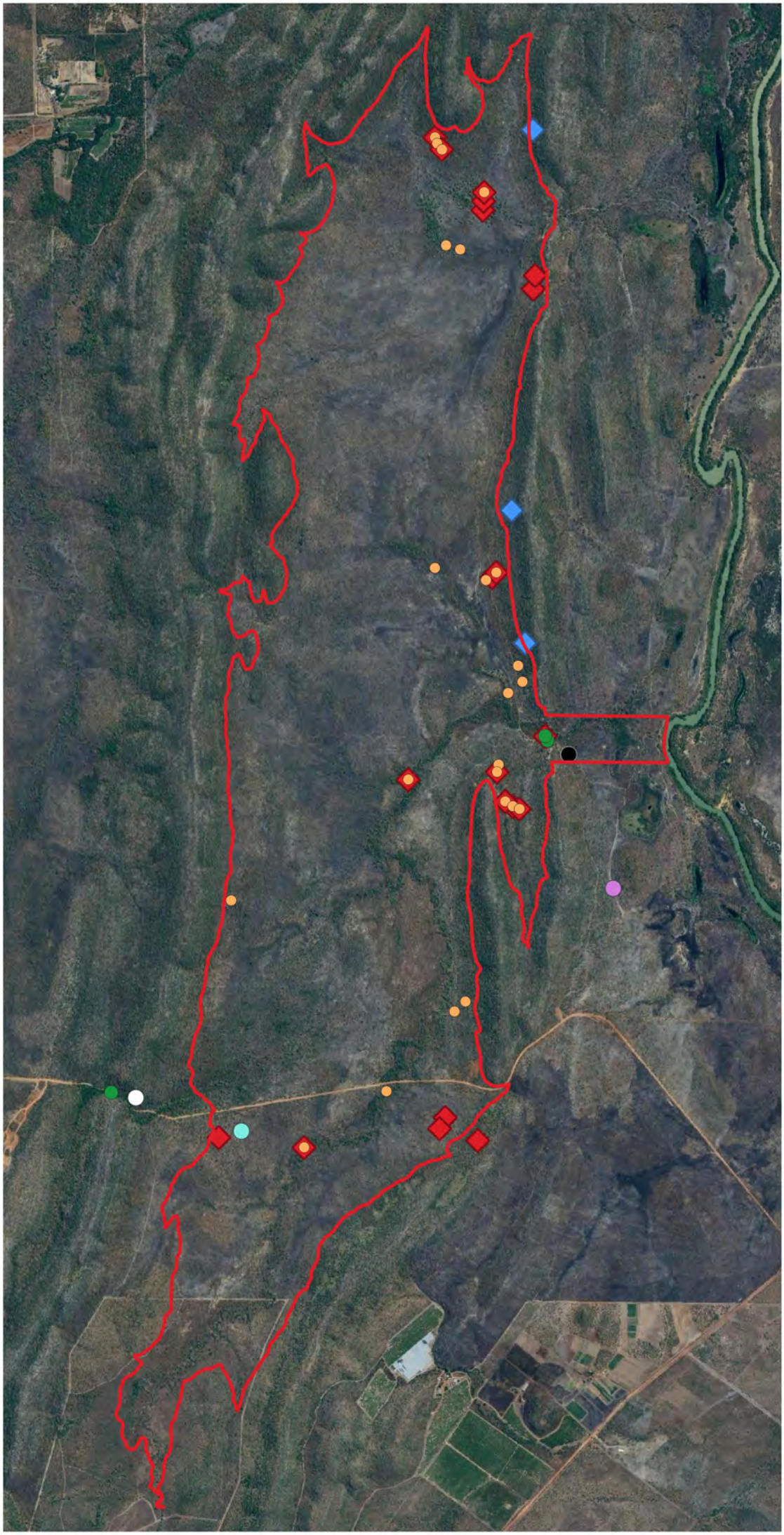

Figure 4 - Locations of detected threatened fauna in the vicinity of the AROWS basin

Key

- AROWS basin (32 m inundation line) and intake corridor
- Black-footed Tree-rat
- Gouldian Finch
- Mertens Water Monitor
- Northern Quoll
- Tyto calls
- Northern Brushtail Possum

Partridge Pigeon

- Not confirmed
- Confirmed

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
16 August 2023

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2.3 Limitations to the Surveys

In 2019, the limitations to the surveys and subsequent conclusions were:

- The agreed / allowable survey period was from mid-May to October 2019. In this regard, the late 'build-up' period and wet season were not able to be sampled. The potential detection of several species may benefit from conducting additional surveys during those periods.
- Cameras were not deployed on private properties in the far southern part of the AROWS basin (south of Koolpinyah Station) because the length and timing of permissible access (5 and 6 August – two days only) made it impractical. One potential target species requiring cameras to be deployed in that area (Pale Field-rat) was best surveyed prior to June and would require much longer than two days of camera deployment. Nevertheless, cameras targeting the Pale Field-rat were deployed in adjacent habitats to the north of those properties. In addition, it was noted that the target areas within those properties did not contain suitable habitat – they were largely devoid of dense vegetation along the drainage lines.
- The drier-than-normal 2018-19 wet season may have resulted in subtle (or not-so-subtle) changes to habitats and food availability, which in turn may have adversely affected flora and fauna distributions and abundances, and therefore the survey results. For example, seasonally saturated areas are likely to have dried out earlier than normal, and creeks probably ceased flows sooner. Flora that exists in such areas may have flowered earlier than normal, or not at all. This may have resulted in 'false absences' (i.e., when a species is present but was not detected for whatever reason). The flow on effect to target flora and fauna for this project was described as best as possible throughout the relevant sections of that report.
- Floristic diversity is best documented during the wet season in the top end. Given these surveys were conducted in August and September, some plants may either not have been present or were not readily identifiable.

In 2020, the limitations to the surveys and subsequent conclusions included:

- Permission was not granted to access the private properties in the far southern part of the project area (south of Koolpinyah Station). Therefore, no surveys were conducted on those properties.
- The 2019-20 wet season received less rainfall than the average and therefore may have caused subtle (or not-so-subtle) changes to habitats and food availability, which in turn may have adversely affected flora and fauna distributions and abundances, and therefore the survey results.
- Given that surveys were conducted during the wet season (and early dry season), accessibility around the basin was limited.
- Covid-19 affected the scheduling of the surveys at about the peak of the ideal survey period (March-April 2020). As a result, there were some delays and logistical challenges.

In 2022, the limitations to the surveys and subsequent conclusions included:

- The surveys were limited by the project timeframes (late March to early June) and budgeting. Consequently, information gaps remain and recommendations for further surveys were made (refer to **Section 2.4**).
- For *Typhonium praetermissum*, the ideal survey period is approximately January and February, though it could be extended to March if individuals are being detected elsewhere and still appear healthy. However, this is somewhat subjective and if the species is not detected during March, it may be difficult to conclude whether the result is a true absence of the species, or whether the aerial parts of the plant have already died. As such, further surveys during January or February should be conducted.
- For Masked Owl (*Tyto novaeholladiae*), the ideal survey period is the lead up to the breeding season (possibly March to October (DEWHA, 2010)). However, the survey was conducted in June and, consequently, their detectability may be lower (Ward, 2010).

General limitations when conducting fauna surveys with cameras include:

- A species may occupy a chosen site; however, the species may not be photographed. This is called a false negative and was alleviated as much as possible through the sampling design.
- A species might only occasionally occur at a site and therefore the period of camera deployment might coincide with it not being present. However, this limitation was minimised as much as possible by extending the period of camera deployment to four weeks, which is likely to be enough time between the visits to the site of the species.
- The results of the survey are just a 'snapshot' in time. Over time, habitat conditions, population abundances and distributions, and threats to species change. Consequently, the presence or potential absence of species within the AROWS basin may change.
- Flora and fauna records (obtained through NR Maps) are not necessarily an accurate representation of the abundance and distribution of a species in any given area. Survey effort in that area must also be recognized as a factor.

2.4 Recommendations

The following recommendations were made in relation to further survey effort within the AROWS basin and intake corridor:

- In 2019:
  - *Helicteres macrothrix* surveys should be extended to determine the full extent and size of the population intersected by the AROWS 32 m inundation line. The portion of the population of *H. macrothrix* located outside of the 32 m inundation line should be surveyed using the same methodology as outlined in the TSSP, but with a significant increase in the number of 25 m^2 quadrats conducted.
  - *Utricularia singeriana* surveys should commence as early in the flowering season as possible, in accordance with the methodology outlined in the TSSP.
  - Masked Owl surveys should be conducted during the wet season in accordance with DENR's guidelines.
  - Northern Quoll surveys should be conducted in additional areas of potentially suitable habitat observed.
  - Fawn Antechinus surveys should be conducted in additional areas of potentially suitable habitat observed.
  - Pale Field-rat surveys may be required in unsurveyed areas.
  - Merten's and Mitchell's Water Monitor surveys may be required in the wet season to better understand the abundance and distribution of the species within the AROWS basin.
- In 2020:
  - *Helicteres macrothrix* surveys should be conducted in the area on the outside of the 32 m inundation line that adjoins the detected sub-population inside the 32 m inundation line within the private property to the south of Koolpinyah Station.
- In 2022:
  - Spider Flower (*Cleome insolata*) and *Typhonium praetermissum* surveys should be conducted in all suitable within the basin.

3 Likelihood of Occurrence Assessment

A review and update of the previous (2018) likelihood of occurrence assessment has been completed here because of the five-year period since then, the subsequent potential changes to threatened and migratory species conservation status listings, species information and the substantial survey effort has occurred since then. The assessment includes the species listed in the Protected Matters Search Tool (PMST) report and those that have been detected within 20 km of the AROWS basin as shown in the NT Flora and Fauna Atlases.

The assessment also includes a preliminary risk assessment for potentially occurring species to inform the need for additional targeted surveys. In addition, further consultation with relevant government agencies is recommended for several species to confirm the appropriate impact assessment approach. These are listed in **Section 5**.

The updated assessment was completed in October 2023, though was repeated in February 2024 because of changes to the conservation status of some fauna species in December 2023 and January 2024. The latest assessment includes the Sharp-tailed Sandpiper (*Calidris acuminata*), Common Greenshank (*Tringa nebularia*) and Northern Blue-tongue Skink (*Tiliqua scincoides intermedia*).

3.1 Procedure

The assessment of the likelihood of occurrence of threatened and migratory species for the AROWS basin and intake corridor was conducted by:

1. Interrogating relevant information sources to obtain a list of potentially occurring threatened and migratory species for the area (including an appropriate geographic buffer), including:
    a. The NT Government's Flora and Fauna Atlases
    b. The Australian Government's EPBC Act 'Protected Matters Search Tool'
2. Describing each species' conservation status, habitat preferences and number of records within an appropriate distance of the target site.
3. Analysing each species' habitat preferences and number of local records (as an indicator of the species' historic presence) against the land unit mapping and aerial imagery to determine each species' likelihood of occurrence.
4. Categorising each species into the following likelihood of occurrence classes:
    a. **Unlikely**: species or ecological community is not expected to occur within the survey area based on the apparent lack of suitable habitat and/or local records
    b. **Possible**: species or ecological community may occur within the survey area based on the occasional or potential presence of suitable habitat, however there is no obvious indication of this
    c. **Likely**: species or ecological community is expected to occur within the survey area based on the apparent presence of suitable habitat and number / proximity of local records.
    d. **Known**: species or ecological has been confirmed to occur within the survey area.

3.2 Attributes Assessed and Limitations

All threatened flora and threatened and migratory fauna recorded within 20 km of the AROWS basin (in the NT Flora and Fauna Atlases) and contained within the EPBC Act Protected Matters Search Tool report (**Appendix D**) have been included in this assessment. A buffer of 20 km was considered appropriate for this project because it satisfactorily characterised local and regional abundance and distributions of threatened species and adequately captured the potential for these species to exist in the survey area.

There are several inherent limitations to all likelihood of occurrence assessments of this nature, including:

- Records from the NT Flora and Fauna Atlases are used to inform the analysis of patterns of distribution and abundance of species, though survey effort is recognized as a limitation.
- Conclusions made in this assessment are based partly on publicly available information at the time of the preparation of the report. It may be possible that some information relating to threatened species records is not publicly available and therefore the conclusions made herein may require review. Consultation with DEPWS is recommended to determine whether the conclusions made in this report are sound.

This assessment is based on previous survey results and the author's experience with the AROWS basin. The following caveats are applied to this assessment:

- Threatened marine animals (including sharks and turtles) are excluded from this assessment, even though records of them may exist within 20 km. No suitable habitat exists within the AROWS basin.
- All migratory species listed in the Protected Matters Search Tool report (**Appendix C**) are included.
- Survey effort has been recognised as a factor in the consideration of the number of 'local' records.
- 'Local' records are defined as those within 20 km of the AROWS basin.
- The assessment does not include data deficient or near threatened species unless that species is listed in a higher category under other legislation.
- This assessment is restricted to the habitats within the AROWS basin and intake corridor. It does not consider areas or actions outside of the basin or intake corridor (such as proposed water extraction from the Adelaide River).

3.3 Relevant Background Information

Some additional information was collated to inform the assessment, as described in the following sections.

3.3.1 Fire History

Fire history from the NAFI database is comprised here of:

- Fire frequency – the number of years in which an area (polygon) has burned between 2000 and 2021.
- Late fire frequency – the number of years in which an area (polygon) has burned after 31 July between 2000 and 2021.
- Time since last burnt – the number of years since an area (polygon) has burned.

These are mapped for the AROWS basin (32 m inundation line) in **Figure 5**.

3.3.2 Fire Frequency

The long-term fire frequency (2000-2021) of the AROWS basin is shown in **Figure 5** (NAFI, 2022). The area and percentage of the AROWS basin burnt in relation to each fire frequency category is shown in **Table 5**. The number in each polygon is the number of times that cell has burned between 2000 and 2021, irrespective of time of year. No area has burned in ≤11 years during that time. Nearly 80% of the AROWS basin has burned in 19 (86%) of the last 22 years.

Table 5 Frequency, area (ha) and percentage of the AROWS basin burnt from 2000 to 2021

Number of years burnt from 2000 to 2021	Area (ha)	Percentage of AROWS basin (32 m line)
12	0.15	0.01
13	7.57	0.41
14	11.58	0.63

Number of years burnt from 2000 to 2021	Area (ha)	Percentage of AROWS basin (32 m line)
15	30.12	1.65
16	53.61	2.93
17	130.52	7.13
18	137.19	7.50
19	269.82	14.74
20	284.51	15.55
21	673.87	36.82
22	231.19	12.63
TOTAL	**1830.14 ha**	**100%**

3.3.3 Late Fire Frequency

The long-term late fire frequency (2000-2021) of the AROWS basin is shown in **Figure 5** (NAFI, 2022). The area and percentage of the AROWS basin burnt in relation to each late fire frequency category is shown in **Table 6**. The number in each polygon is the number of years that cell has burned after 31 July between 2000 and 2021. Approximately 80% of the basin has either not burned or burned only once after 31 July in any year between 2000 and 2021.

Table 6 Frequency, area (ha) and percentage of the AROWS basin burnt after 31 July from 2000 to 2021

Number of years burnt after 31 July from 2000 to 2021	Area (ha)	Percentage of AROWS basin (32 m line)
0	825.85	45.13
1	644.12	35.20
2	113.92	6.23
3	113.42	6.20
4	119.63	6.54
5	7.82	0.43
6	5.38	0.30
TOTAL	**1,830.14 ha**	**100%**

3.3.4 Weeds

Weeds observed during flora and fauna surveys conducted in 2019 included Gamba Grass (*Andropogon gayanus*; scattered along tracks), Hyptis (*Hyptis suaveolens*; throughout project area), Snake Weed (*Stachytarpheta* spp.; mainly in the south), Rat's Tail grass (*Sporobolus* sp.; along a creek in the south), annual Mission Grass (*Cenchrus pedicellatus*; similar distribution pattern to Gamba Grass) and Mimosa (*Mimosa pigra*; several drainage lines and intake corridor).

3.3.5 Feral Animals

Six feral animal species have been detected in the AROWS basin during surveys conducted in 2019, 2020 and 2022 – Cats, Donkeys, Wild Dogs, Pigs, Cane Toads and Buffaloes. The following observations were made in 2019:

- Cane Toads were observed in high number along the Bamboo Creek in September 2019, at a time when there was apparently no water elsewhere within the basin. This site also attracted Pigs, Cats, Donkeys and Wild Dogs.
- All drainage areas show evidence of Pigs, whether through uprooting and trampling of vegetation, wallows or tracks. Pigs need to drink daily in hot weather and will often be found within 2 km of water (DSEWPaC, 2011b).
- A herd of Donkeys was observed near to the Mimosa dominated vegetation in the intake corridor and a single Donkey was seen on numerous occasions in the mid-north of the basin (possibly the same animal each time).

Figure 5
-
Fire history

Fire frequency 2000-2021

Late fire frequency 2000-2021

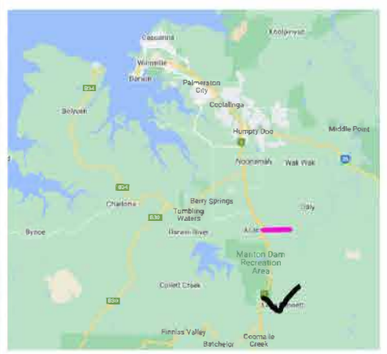
Time since last burnt 2000-2021

Key

- 32 m line
- Potential offtake route - Byers Rd
- Potential offtake route - spillway to Manton Gap
- Marrakat Tk diversion survey area

Background - Google Satellite / Google Maps

0 0.5 1 1.5 2 km



Project Name: AROWS 2022 Threatened Species Surveys
Client: Power and Water Corporation
Date: 8 August 2022
Datum: GD94 z52

CONNECT environmental

3.4 Results

3.4.1 Threatened Species

A total of ten threatened flora and 31 threatened fauna species were assessed for their likelihood of occurrence within the AROWS basin and intake corridor. Of these, two threatened flora and three threatened fauna species have been detected within the basin. A further four threatened flora and 11 threatened fauna species were determined to potentially occur (i.e., 'possible' or 'likely'). Refer to **Appendix B** for the full assessment. A summary is provided in **Table 7**.

Table 7 Threatened species likelihood of occurrence within the AROWS basin and intake corridor

Scientific Name	Common Name	Threatened status[28]		Likelihood of occurrence[29]
		TPWC Act	EPBC Act	
Threatened Plants				
Atalaya brevialata	Atalaya	CE	CE	Unlikely
Cleome insolata	Spider Flower	V	-	Possible
Cycas armstrongii	Darwin Cycad	V	-	Known
Goodenia quadrifida	-	DD	V	Unlikely
Helicteres macrothrix	-	E	E	Known
Stylidium ensatium	-	E	E	Unlikely
Typhonium praetermissum	-	V	-	Possible
Typhonium taylori	Typhonium	E	E	Unlikely
Utricularia dunstaniae	Bladderwort	V	-	Possible
Utricularia singeriana	Bladderwort	V	-	Possible
Threatened Birds				
Calidris acuminata	Sharp-tailed Sandpiper	-	V	Possible
Calidris ferruginea	Curlew Sandpiper	CE	CE	Possible
Charadrius leschenaultii	Greater Sand Plover	V	V	Unlikely
Charadrius mongolus	Lesser Sand Plover	E	E	Unlikely
Epthianura crocea tunneyi	Alligator Rivers Yellow Chat	E	E	Unlikely
Erythrotriorchis radiatus	Red Goshawk	V	E	Possible
Erythrura gouldiae	Gouldian Finch	V	E	Known
Falco hypoleucos	Grey Falcon	V	V	Unlikely
Geophaps smithii smithii	Partridge Pigeon (eastern)	V	V	Likely[30]
Limosa lapponica baueri	Nunivak Bar-tailed Godwit	V	E	Unlikely
Numenius madagascariensis	Eastern Curlew	CE	CE	Unlikely
Rostralata australis	Australian Painted Snipe	E	E	Possible
Tringa nebularia	Common Greenshank	LC	E	Possible

[28] Conservation status under either the Environment Protection and Biodiversity Conservation Act 1999 ('Nat.') or Territory Parks and Wildlife Conservation Act ('NT'): CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, NT = near threatened, '-' = not listed, DD = data deficient, LC = Least Concern.

[29] At time of surveys.

[30] Detected immediately east of the basin and there was an unconfirmed report of an individual within the basin.

Scientific Name	Common Name	Threatened status[28]		Likelihood of occurrence[29]
		TPWC Act	EPBC Act	
Tyto novaehollandiae kimberli	Masked Owl (northern)	V	V	Unlikely
Threatened Mammals				
Antechinus bellus	Fawn Antechinus	E	V	Unlikely
Conilurus penicillatus	Brush-tailed Rabbit-rat	E	V	Unlikely
Dasyurus hallucatus	Northern Quoll	CE	E	Possible[31]
Macroderma gigas	Ghost Bat	NT	V	Unlikely
Mesembriomys gouldii gouldii	Black-footed Tree-rat (Kimberley and mainland NT)	E	E	Known
Petrogale concinna canescens	Nabarlek	E	E	Unlikely
Phascogale pirata	Northern Brush-tailed Phascogale	E	V	Unlikely
Rattus tunneyi	Pale Field-rat	V	-	Unlikely
Saccolaimus saccolaimus	Bare-rumped Sheath-tailed Bat	NT	V	Possible
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum	NT	V	Known
Xeromys myoides	Water Mouse	DD	V	Unlikely
Threatened Frogs				
Uperoleia daviesae	Howard River Toadlet	V	V	Unlikely
Threatened Reptiles				
Acanthopsis hawkei	Plains Death Adder	V	V	Possible
Tiliqua scincoides intermedia	Northern Blue-tongue Skink	LC	CE	Possible
Varanus mertensi	Merten's Water Monitor	V	E	Known
Varanus mitchelli	Mitchell's Water Monitor	V	CE	Possible
Varanus panoptes[32]	Yellow-spotted Monitor	V	-	Unlikely

3.4.2 Migratory Species

Seventeen migratory marine species, six migratory terrestrial species and 10 migratory wetland species were assessed for their likelihood of occurrence within the AROWS basin and intake corridor. Of these, two migratory marine, six migratory terrestrial and nine migratory wetland species were determined to potentially occur. Refer to **Appendix C** for the full assessment. A summary is provided in **Table 8**.

Table 8 Migratory species likelihood of occurrence within the AROWS basin and intake corridor

Species	Common name	Likelihood of occurrence
Migratory marine species		
Apus pacificus	Fork-tailed Swift	Possible
Calonectris leucomelas	Streaked Shearwater	Unlikely
Phaethon lepturus	White-tailed Tropicbird	Unlikely

[31] *Detected immediately west of the basin in the escarpment near Bamboo Springs along the Marrakai Track.*

[32] *It is noted that the Yellow-spotted Monitor, while not apparent within the basin at present and only rarely recorded within 20 km of the basin over the last 20 years, may re-occupy the basin in the future.*

Species	Common name	Likelihood of occurrence
Anoxypristis cuspidata	Narrow Sawfish	Unlikely
Caretta caretta	Loggerhead Turtle	Unlikely
Chelonia mydas	Green Turtle	Unlikely
Crocodylus porosus	Saltwater Crocodile	Possible
Dermochelys coriacea	Leatherback Turtle	Unlikely
Eretmochelys imbricata	Hawksbill Turtle	Unlikely
Lepidochelys olivacea	Olive Ridley Turtle	Unlikely
Manta alfredi	Reef Manta Ray	Unlikely
Manta birostris	Giant Manta Ray	Unlikely
Natator depressus	Flatback Turtle	Unlikely
Pristis pristis	Freshwater Sawfish	Unlikely
Pristis zijsron	Green Sawfish	Unlikely
Sousa sahulensis as Sousa chinensis	Australian Humpback Dolphin	Unlikely
Tursiops aduncus	Spotted Bottlenose Dolphin	Unlikely
Migratory terrestrial species		
Cecropis daurica	Red-rumped Swallow	Possible
Cuculus optatus	Oriental Cuckoo	Possible
Hirundo rustica	Barn Swallow	Possible
Motacilla cinerea	Grey Wagtail	Possible
Motacilla flava	Yellow Wagtail	Possible
Rhipidura rufifrons	Rufous Fantail	Possible
Migratory wetland species		
Acrocephalus orientalis	Oriental Reed-warbler	Unlikely
Actitis hypoleucos	Common Sandpiper	Possible
Calidris acuminata	Sharp-tailed Sandpiper	Possible
Calidris ferruginea	Curlew Sandpiper	Possible
Calidris melanotos	Pectoral Sandpiper	Possible
Charadrius leschenaultii	Greater Sand Plover	Possible
Charadrius veredus	Oriental Plover	Possible
Glareola maldivarum	Oriental Pratincole	Possible
Pandion haliaetus	Osprey	Unlikely
Tringa nebularia	Common Greenshank	Possible

4 Significant Impact Assessment

4.1 Approach

The assessment of impacts has been separated into two groups:

- Those species that were detected within or immediately adjacent to the basin.
- Those that potentially occur within the basin though were not detected.

Each group is further separated into species that are listed under the EPBC Act and those that are listed under the TPWC Act only for ease of review.

4.2 Summary

A summary of the assessments is provided in **Table 9** for EPBC Act-listed species and **Table 10** for TWPC Act-only listed species. Detected species include those detected both within or immediately adjacent to the basin or intake corridor.

Table 9 Summary of the impact assessment for species listed under the EPBC Act

Species	Common Name	Detected	Significant impact assessment outcome
Threatened Plants			
Helicteres macrothrix	-	Yes	**Likely** – The loss of 25,000 plants within the 32 m inundation line will reduce the size of a sub-population, apparently reduce the current estimated area of occupancy, and possibly affect habitat critical to the survival of the species.
Threatened Birds			
Calidris acuminata	Sharp-tailed Sandpiper	No	**Unlikely** – Marginal habitat exists within the basin and the species is unlikely to utilise the basin frequently.
Calidris ferruginea	Curlew Sandpiper	No	
Tringa nebularia	Common Greenshank	No	
Erythrotriorchis radiatus	Red Goshawk	No	**Unlikely** – A reduction in population size is not expected and a positive effect on habitat for the species, at least to some extent, is expected. However, it is unclear if there will be a residual loss of habitat critical to the species survival. Either way, this is anticipated to be minimal.
Erythrura gouldiae	Gouldian Finch	Yes	**Unlikely** – No habitat critical to the survival of the species, the species has a wide distribution of the species and there is a lack of important breeding habitat in the basin.
Geophaps smithii smithii	Partridge Pigeon	Yes	**Unlikely** – The AROWS basin is unlikely to contain an important population of the species nor contain habitat critical to the survival of the species.
Rostralata australis	Australian Painted Snipe	No	**Unlikely** – Marginal habitat exists within the basin and the AROWS development may benefit the species by the creation of wetlands and waterbodies with suitable riparian vegetation.

Species	Common Name	Detected	Significant impact assessment outcome
Threatened Mammals			
Dasyurus hallucatus	Northern Quoll	Yes	**Unlikely** – No quolls were detected within the basin and habitat within the basin may not be critical to the species survival. However, further surveys are recommended along the adjacent escarpment. This conclusion should be reviewed upon completion of the surveys.
Mesembriomys gouldii gouldii	Black-footed Tree-rat	Yes	**Possible** – While there is unlikely to be habitat critical to the survival of the species, the loss of 495 ha of suitable and a further 980 ha of potential habitat may reduce the size of the local population and reduce the species area of occupancy.
Saccolaimus saccolaimus	Bare-rumped Sheath-tailed Bat	No	**Possible** – Survey recommended within the basin.
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum	Yes	**Unlikely** – The individuals detected within the basin do not appear to be part of an important population, the habitats do not appear to be critical to the species survival and the AROWS basin development does not appear likely to significantly impact the species.
Threatened Reptiles			
Acanthopsis hawkei	Plains Death Adder	No	**Unlikely** – Given there are no records of the species within 20 km and the basin habitats do not appear to fit the description of a 'floodplain' habitat as defined in the *Adelaide River coastal floodplain* Site of Conservation Significance (SOCS) factsheet (McGuire *et al*., 2009), it is not expected that the basin is of conservation importance to the species. Further, given its reported key threats are Cane Toads and habitat modification due to over-grazing by cattle and inappropriate fire regimes, the inundation of the basin is not expected to significantly impact the species.
Tiliqua scincoides intermedia	Northern Blue-tongue Skink	No	**Unlikely** - While there will be a loss of some potential refuge habitat, key threats to the species already occur within the basin and will continue to occur regardless of if the AROWS project proceeds. In addition, inundation is listed as a threat of minor consequence to the species. The species has also not been detected within the basin, probably related to the presence of key threats.
Varanus mertensi	Merten's Water Monitor	No	**Unlikely** – Merten's Water Monitor was detected in only one location within the basin. Mitchell's Water Monitor was not detected. In addition, there are no areas of permanent surface water in the AROWS basin (32 m inundation line). All are ephemeral. With the creation of large areas of lacustrine habitats in the basin from the AROWs project, it is expected that, eventually, more suitable habitat will be available for these species than is currently present.
Varanus mitchelli	Mitchell's Water Monitor	No	

Table 10 Summary of the impact assessment for species listed under the TPWC Act

Species	Common Name	Detected	Impact assessment outcome
Threatened Plants			
Cycas armstrongii	Darwin Cycad	Yes	**Unlikely** – The individuals within the do not appear to form an important sub-population because of their relatively low numbers there and the relatively small areas of high suitability habitat within the basin (of which it was concluded that none is likely to be critical to the survival of the species). It appears unlikely that the species will be significantly impacted by the AROWS basin development.
Cleome insolata	Spider Flower	No	**Possible** – Survey recommended within the basin prior to further impact assessment.
Typhonium praetermissum	-	No	
Utricularia dunstaniae	Bladderwort	No	
Utricularia singeriana	Bladderwort	No	

4.3 Detected Species

The species assessed here include those that were detected within or adjacent to the AROWS basin, as described in **Section 2**. Generally, all other surveyed species that were not detected are assumed to not occur there, at least at that time. Any exceptions to this are indicated where appropriate. The detected species are:

- EPBC Act-listed species:
  - *Helicteres macrothrix*
  - Gouldian Finch (*Erythrura gouldiae*)
  - Partridge Pigeon (*Geophaps smithii*)
  - Northern Quoll (*Dasyurus hallucatus*)
  - Black-footed Tree-rat (*Mesembriomys gouldi*)
  - Northern Brushtail Possum (*Trichosurus vulpecula*)
  - Merten's Water Monitor (*Varanus mertensi*).
- TPWC Act only listed species:
  - Darwin Cycad (Cycas armstrongii)

As stated in the *Darwin Region Water Supply Infrastructure: Environmental Constraints, Information Gaps and Approvals* (EcOz, 2021b), a detailed study relating to water quality is recommended given that once the basin is inundated, there will be a period required for the subsequent aquatic ecosystem to mature and the reservoir's nutrient concentrations to reach an equilibrium. Initial severe deoxygenation of water is expected. This process is not considered in detail for each species in this impact assessment however it is recommended that this impact assessment is reviewed once issues relating to water ecosystem equilibrium and quality are better understood.

*The impact assessment should also be reviewed once the full suite of surveys has been conducted, as described in **Section 4.3.2.7** (Information Gaps and Recommendations).*

4.3.1 Assessment Approach

For each species, a summary of the survey results is presented along with the species' conservation status at NT-level, national level and from the IUCN Red List, with the latter being included for context. As the default, the status at the national level (i.e., under the EPBC Act) is used for the impact assessment using the relevant criteria from the EPBC Act *Significant Impact Guidelines* (DoE, 2013). Where a species is not listed under the EPBC Act, the status at the NT-level (i.e., under the TPWC Act) is used. In this case, the EPBC Act guidelines are used in the absence of NT-specific criteria.

Following that, an analysis of the significance of the individuals detected is conducted to determine how important they are. For vulnerable species, the assessment focusses on the criteria for an 'important' population from the *Significant Impact Guidelines* (DoE, 2013). For endangered or critically endangered species, the assessment uses other information relating to the species apparent distribution and abundance in the local area, region and across the NT, where appropriate.

Habitats within the project area are then assessed on how critical they are to the survival of each species. Criteria are drawn from the EPBC Act *Significant Impact Guidelines* (DoE, 2013).

Lastly, an assessment of the impact significance against the criteria in the EPBC Act *Significant Impact Guidelines* (DoE, 2013) is conducted.

4.3.2 Threatened Species Listed Under the EPBC Act

4.3.2.1 Helicteres macrothrix

Survey Results

Approximately 14,000 individuals of the species were detected outside of the 32 m inundation boundary (within the basin) and 25,000 plants within the 32 m inundation boundary (Connect Environmental, 2020 and 2022). The survey method focussed on an absolute count of all individuals to achieve the highest possible accuracy, however it is highly likely that some plants were not detected given that three ecologists were involved with the counts and surveys occurred on three occasions with varying stages of grass growth. The total counts are most likely an underestimate.

Once uploaded to GIS, the species distribution was mapped by drawing a polygon around plants with group separation of minimum 20 m (i.e., plants less than 20 m apart were included in the same patch).

The total mapped area of the species, as shown in **Figure 6**, was approximately 34 ha of which 24 ha is within the 32 m inundation boundary.

Conservation Status

The conservation status of *Helicteres macrothrix* is listed as:

- Endangered under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999*.

It is not on the IUCN Red List of Threatened Species.

Significance of the Individuals

As of 2006, three populations of the species were known to occur with a combined population size in the 100,000's (TSSC, 2006 and 2008). A review of the NT Flora Atlas for this assessment indicates that no other populations have been identified since, though there are new records within the vicinity of the existing populations, with the most recent record being from 2016. The 39,000 plants detected in the AROWS basin for this project appear to be part of the Lake Bennett population, given their proximity (~2.2 km apart directly).

The extent of occurrence (EoO) and area of occupancy (AoO) of the species, as calculated by DLRM in 2016, are shown in **Table 11**, along with an estimate of the changes to these values with the inclusion of the results

of these AROWS surveys. Consultation with DEPWS is recommended to determine the veracity of the AoO conclusions made in this report as there is some discrepancy to the values reported by DLRM (2016).

The species was listed under the EPBC Act because its geographic distribution is restricted and is precarious for the survival of the species (TSSC, 2006). The individuals detected within the AROWS basin do not appear to increase the number of populations, however there appears to be an increase in extent of occurrence, area of occupancy and total number of known plants.

Table 11 The extent of occurrence and area of occupancy of Helicteres macrothrix in 2016 (DLRM, 2016) and 2022 (estimated)

Criteria	Area (DLRM, 2016)	Estimated area including the individuals identified in the AROWS basin for this project
Extent of occurrence	503 km^2	530 km^2
Conservatively estimated potential habitat within currently known extent	127 km^2	Not calculated
Potential habitat with highest likelihood of occurrence within the currently known extent	80 km^2	Not calculated
Area of occupancy[33]	12	An additional two[34]

Significance of the Habitat

Suitable habitat for *Helicteres macrothrix* within the AROWS basin is possibly habitat critical to the survival of the species, as assessed in **Table 12**.

Table 12 Assessment of habitat critical to the survival of Helicteres macrothrix

Criteria	Assessment
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:	
for activities such as foraging, breeding, roosting, or dispersal	**Possible (though unclear)** The three existing known localities of the species are vulnerable to potential clearing for either subdivision, maintenance of railway easement, road maintenance, ongoing development of access roads and processing areas associated with quarry activities, weeds, and changes in fire regimes, soil hydrology and nitrogen availability (DEPWS, 2021). At present, the individuals detected within the AROWS basin are likely to be vulnerable to weeds (and associated changes in fire regimes, soil hydrology and nitrogen availability), though also (to some extent) fire break maintenance (individuals were observed along maintained fire breaks) and grazing. In the absence of an evaluation of the severity of each threat at each existing locality, given that the detected individuals within the AROWS basin comprise a substantial portion of the total known population and that there is some difference in the type and level of threat to those individuals detected, it is possible that the habitat within the AROWS basin is necessary for the species survival.
for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)	
to maintain genetic diversity and long-term evolutionary development, or	

[33] *Number of 2 km^2 cells within which mapped records occur.*

[34] *The area of occupancy of the species to 2016 was calculated by M. Proos of Connect Environmental as 9 (not 12) 2 x 2 km cells with an increase of two when the results of the AROWS surveys are included. As such, the total area of occupancy would now be 11 cells. Records not publicly available may have been included that are not included here. Consultation with DEPWS is recommended to determine the veracity of the AoO conclusions made in this report.*

Criteria	Assessment
for the reintroduction of populations or recovery of the species or ecological community	On the contrary, given that there is an estimated 80 km^2 of potential habitat with highest likelihood of occurrence within the species' current known extent of occurrence (DLRM, 2016), the area of occupation within the AROWS basin is a very small component of that. However, based on the current reported total population size and described threats at each of the three localities (DEPWS, 2021), it is concluded that the habitat with the AROWS basin could be critical to the survival of the species.

Potential Impacts

Potential impacts to *Helicteres macrothrix* from the AROWS project include:

- The loss of at least approximately 25,000 plants within the AROWS basin (32 m inundation boundary) from inundation (a reduction in 64% of the AROWS basin sub-population).
- A reduction in the area that the plants occupy from approximately 34 ha to 10 ha, if only the inundated plants (i.e., within the 32 m inundation boundary) will die.
- It is also possible that a transition zone (i.e., riparian community) will form around the reservoir, though the extent and vegetation composition of it is dependent on the effects of inundation patterns and the surrounding topography including slope and drainage channels on the water table. Consequently, additional plants outside the 32 m inundation boundary may be impacted.

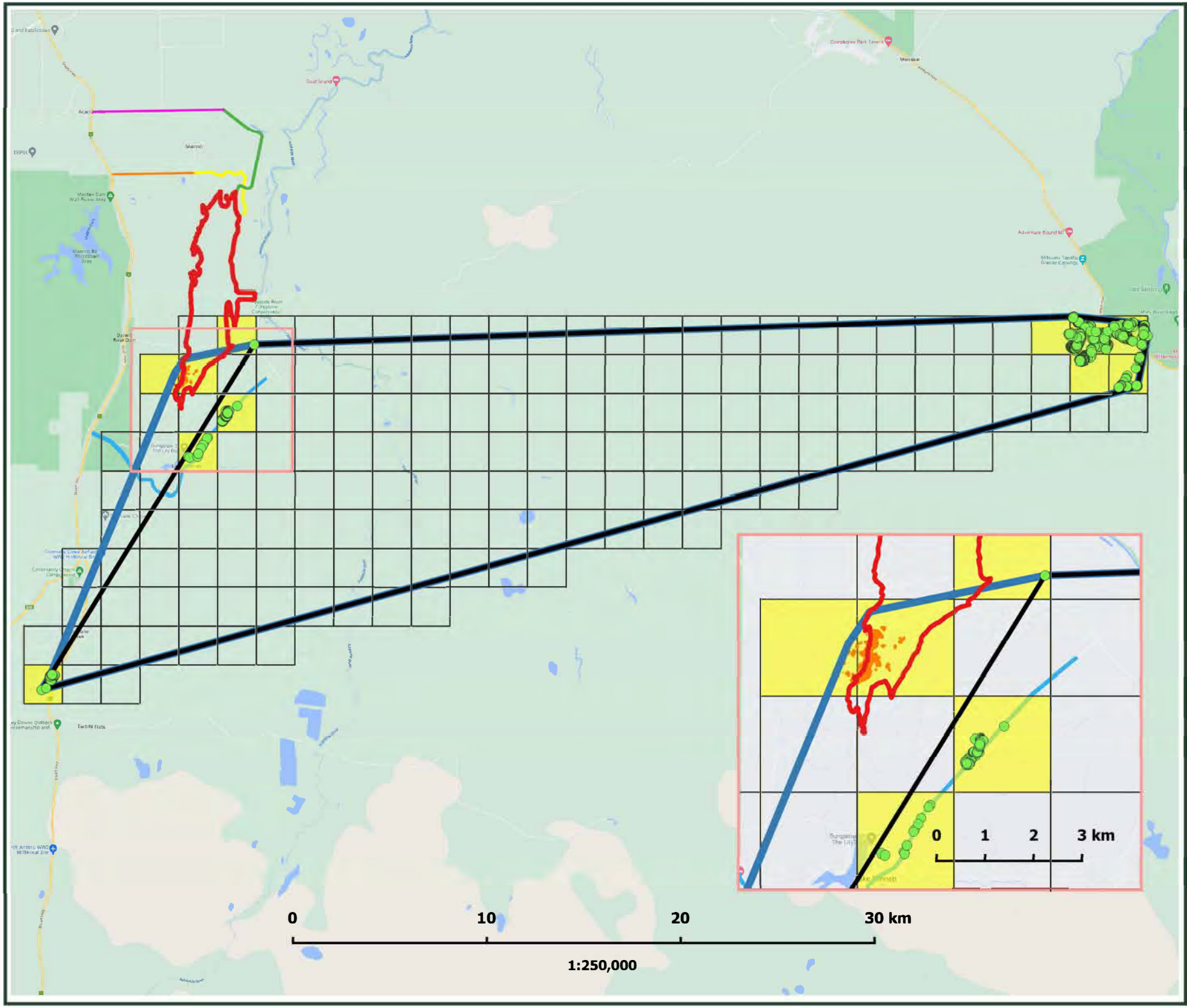


Figure 6 - Helicteres macrothrix records (NT Flora Atlas (as of September 2022), EoO, AoO and distribution in the AROWS basin

Key

- Helicteres macrothrix (NT Flora Atlas as of Sept 22)
- Helicteres macrothrix distribution in AROWS basin
- Helicteres macrothrix EoO (without AROWS plants)
- Helicteres macrothrix EoO (with AROWS plants)
- 2 x 2 km grid
- Helicteres macrothrix occupied grid cells
- 32 m line
- Acacia Gap Road
- Byers Road
- Proposed Marrakai Track diversion
- Potential offtake route - Byers Rd
- Potential offtake route - spillway to Manton

Background - Google Maps

Project: 2022 AROWS Significant Impact Assessment
Client: Power and Water Corporation
Author: M. Proos
Date: 27 September 2022

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Significance of Potential Impacts

To assist in determining the significance of anticipated impacts to *Helicteres macrothrix* within the AROWS basin, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 13**. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Based on this assessment, there appears to be high potential for a significant impact to this species from the proposed AROWS project.

Table 13 Significant impact assessment for Helicteres macrothrix

Significant Impact Criteria for endangered species	Assessment of likelihood
Lead to a long-term decrease in the size of a population	**Likely** – The loss of at least 25,000 plants within the 32 m inundation line will decrease the size of the Lake Bennett population.
Reduce the area of occupancy of the species	**Likely** – The loss of 25,000 plants within the 32 m inundation line will apparently reduce the current estimated area of occupancy by one or two 2 km^2 cells.
Fragment an existing population into two or more populations	**Unlikely** - The population of the species within the AROWS basin is confined to one general location. The inundation to the 32 m line will not fragment it distribution, but rather just reduce its extent of occurrence in that sub-population.
Disrupt the breeding cycle of a population	**Unlikely** – The breeding cycle of the remaining plants should largely remain unaffected.
Adversely affect habitat critical to the survival of a species	**Possible** – As assessed in **Table 12**, it is possible that the habitat occupied by the species within the AROWS basin is critical to the survival of the species given the described threats to the species in other populations. However, more detailed assessment of its distribution, habitat requirements, population size, the factors limiting distribution and/or threats to its survival is required (DEPWS, 2021c). However, given that there is an estimated 80 km^2 of potential habitat with highest likelihood of occurrence within the species' current known extent of occurrence (DLRM, 2016), the area of occupation within the AROWS basin is a very small component of that. Nevertheless, based on the current reported total population size and described threats at each of the three localities (DEPWS, 2021), it is concluded that the habitat with the AROWS basin could be critical to the survival of the species and, if so, the AROWS project will adversely affect it.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Possible** – The species is currently reported to be in decline and if threats to the species persist, the cumulative effect of these threats and the AROWS project could see further decline. However, DEPWS (2021c) list the conservation objectives for the species as including further research on its distribution, habitat requirements and population size as well as an assessment of the factors limiting distribution, and/or threats to its survival. In this regard, it is uncertain.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely** – It is understood that the species is not known to be vulnerable to any disease.
Interfere substantially with the recovery of the species	**Unlikely / possible** – It is unclear if the AROWS basin contains habitat critical to its survival. Depending on the severity of the threat to the other known populations of the species, the loss of at least 25,000 plants may interfere substantially with the recovery of the species.

4.3.2.2 Gouldian Finch (Erythrura gouldiae)

Survey Results

Two Gouldian Finches were detected in the intake corridor in June 2019. The individuals were foraging on track side grasses. No other individuals of the species were detected despite ecologists spending significant time within the basin. However, the species was not targeted during the surveys, as per the existing *Threatened Species Survey Plan* (EcOz, 2018) because there was expected to be no suitable breeding habitat within the AROWS basin.

Conservation Status

The conservation status of the Gouldian Finch is listed as:

- Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999* (last assessed: 2016).
- Least Concern on the IUCN Red List of Threatened Species (last assessed: 2 December 2021).

Significance of the Individuals

The detection of two individuals is not unexpected given that Gouldian Finches are found throughout northern NT including coastal areas (refer to **Figure 7**). Considerable time was spent in the basin by the survey ecologists in 2019, 2020 and 2022. Given that no other individuals were observed during this time (noting that targeted surveys were not conducted), it is concluded that the species was unlikely to have occurred in high numbers in the basin during those years. However, the species' range can change substantially between years (S. Pryke in litt., 2012, cited in Birdlife International, 2022), birds can disperse widely (>200 km in a few weeks; Legge *et al.*, 2021), the entire population is not considered to be structured / fragmented (Esparza-Salas 2008; Bolton et al., 2015, cited in TSSC, 2016b) and there may be extreme fluctuations in the number of mature individuals (TSSC, 2016b).

Despite the species being a threatened species under both the TPWC and EPBC Acts, the IUCN lists the species as Least Concern (last assessed 2 December 2021; Birdlife International, 2022). *The Action Plan for Australian Birds 2020* (Legge *et al*., 2021) also reports that the population of the species appears stable and is well over 1,000 mature birds.

Significance of the Habitat

Habitat critical to the survival of the species is not described or mapped in the *National Recovery Plan for the Gouldian Finch (Erythrura gouldiae)* (O'Malley, 2006) because of insufficient information relating to the species' distribution and habitat suitability patterns. However, O'Malley lists key areas with significant populations of Gouldian Finches which are likely to persist if threats to the species in those locations are minimized. Within the NT, these locations are:

- Yinberrie Hills and surrounds
- Limmen National Park
- Kakadu National Park and surrounds
- Bradshaw Field Training Area.

The closest of these is Kakadu National Park, approximately 80 km east.

However, in lieu of a formal definition or mapping of habitat critical to the survival of the species, the significance of habitats within the AROWS basin for the Gouldian Finch is discussed in **Table 14**.

Table 14 Assessment of habitat critical to the survival of the Gouldian Finch

Criteria	Assessment
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:	
for activities such as foraging, breeding, roosting, or dispersal For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) to maintain genetic diversity and long-term evolutionary development, or	**Unlikely** Gouldian Finches are mostly known to breed between January and October (with a peak from April to July, coinciding with the seeding of Sorghum spp. (Dostine et al., 2001)) in wooded hills with Snappy Gums (Eucalyptus brevifolia and E. leucophloia) or Salmon Gums (E. tintinnans) (O'Malley, 2005; TSSC, 2016b; DEPWS, 2021b). These species generally grow on slopes and low rocky hills (WAH, 1998-; NTH, 2013) with little overlap in distribution (refer to **Figure 11**). When not breeding, generally from about November to February, Gouldian Finches disperse into the wider landscape to forage (TSSC, 2016b). Several studies also suggest that other tree species are used for nesting including: ▪ Weier et al. (2016), in a study in the east Kimberley region (Wyndham), indicates that preferred nest-hollow tree species include C. dichromophloia and E. miniata, where these species dominate. ▪ O'Malley (2005) reference studies that suggest nesting trees could include *C. dichromophloia* (Tidemann et al., 1992 cited in O'Malley, 2005) and Darwin Woollybutt (*E. miniata*; McNee and Collins, 1992 cited in O'Malley, 2005). In addition, habitats away from hills are also reported to be used for breeding following consecutive productive years (Eussen, 2009, cited in MRM, 2018), though such breeding occasions are speculated as being negligible to the long-term success of the species. Such information may require further investigation.
for the reintroduction of populations or recovery of the species or ecological community	Based on the above, it was concluded that no significant breeding habitat exists within the AROWS basin and was the basis for the species not being included as a target species in the initial survey design (EcOz, 2018). Further, the local is area is not typically known to be an important breeding area nor does it contain tree species typically associated with breeding (e.g., E. tintinnans; according to the greater Darwin and Coomalie land unit mapping (Fogarty et al, 1984; Robinson et al, 1972) or the Supplementary Vegetation Survey Report (Astrebla, 2019)). Consequently, the habitats are not expected to be critical to the survival of the species.

Potential Impacts

Potential adverse impacts to the Gouldian Finch include a loss of up to approximately 1,800 ha of foraging habitat, which the species is expected to use occasionally. No significant breeding habitat is expected to occur within the basin. The presence of the dam will also provide additional drinking spots for the species, both temporally (i.e., throughout the year) and spatially.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Gouldian Finches detected, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 15**. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Based on this analysis, it appears unlikely that the AROWS project will significantly impact the Gouldian Finch.

Table 15 Significant impact assessment for the Gouldian Finch

Significant Impact Criteria for endangered species	Assessment of likelihood
Lead to a long-term decrease in the size of a population	**Unlikely** – The AROWS basin is not typically considered to be in an area of importance for the species breeding (refer to **Table 14**). The loss of habitats used for wet season foraging and possibly occasionally for breeding is not expected to be significant to the species. A long-term decrease in the size of a population from the AROWS project is not expected.
Reduce the area of occupancy of the species	**Unlikely** – The species area of occupancy is not expected to be reduced from the AROWS project, or if it is, the reduction is likely to be negligible given the species' wide distribution, the availability of foraging habitat and the lack of important breeding habitat within the basin.
Fragment an existing population into two or more populations	**No –** Foraging habitat within the inundation area will be lost (permanently), however fragmentation of the population is not expected given the species is reported to be one large unstructured population and ample habitat exists to the north and south of the basin.
Disrupt the breeding cycle of a population	**Unlikely –** The AROWS basin is generally not understood to be an important breeding area. Further, the species is mostly known to breed in *E. tintinnans* (in this area) which is understood not to occur in or around the AROWS basin. As such, any impacts to the species breeding cycle are expected to be negligible.
Adversely affect habitat critical to the survival of a species	**Unlikely** – The AROWS basin has been assessed as being unlikely to contain habitat critical to the survival of the species (refer to **Table 14**).
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – Based on the wide distribution of the species and apparent lack of important breeding habitat in the basin, it is unlikely that the species is likely to decline from the AROWS project.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely**
Interfere substantially with the recovery of the species	**Unlikely** – Based on the wide distribution of the species and apparent lack of important breeding habitat in the basin, it is unlikely that the AROWS project will interfere substantially with the recovery of the species.

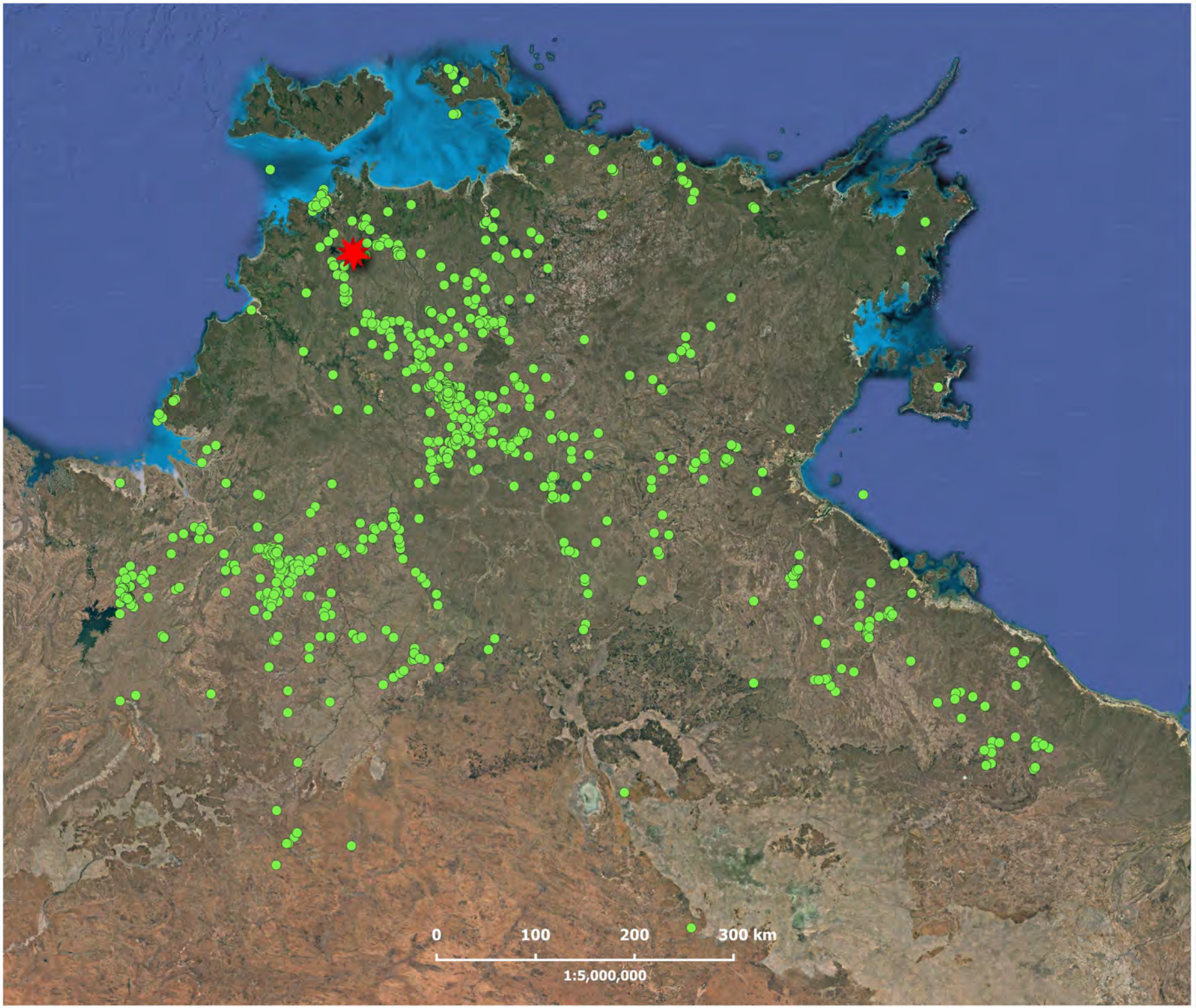

Figure 7
-
All NT Gouldian Finch records (NT Fauna Atlas; as of 27 September 2022)

Key

AROWS project location

Gouldian Finch record

Background - Google Satellite

Project: 2022 AROWS Significant Impact Assessment
Client: Power and Water Corporation
Author: M. Proos
Date: 27 September 2022

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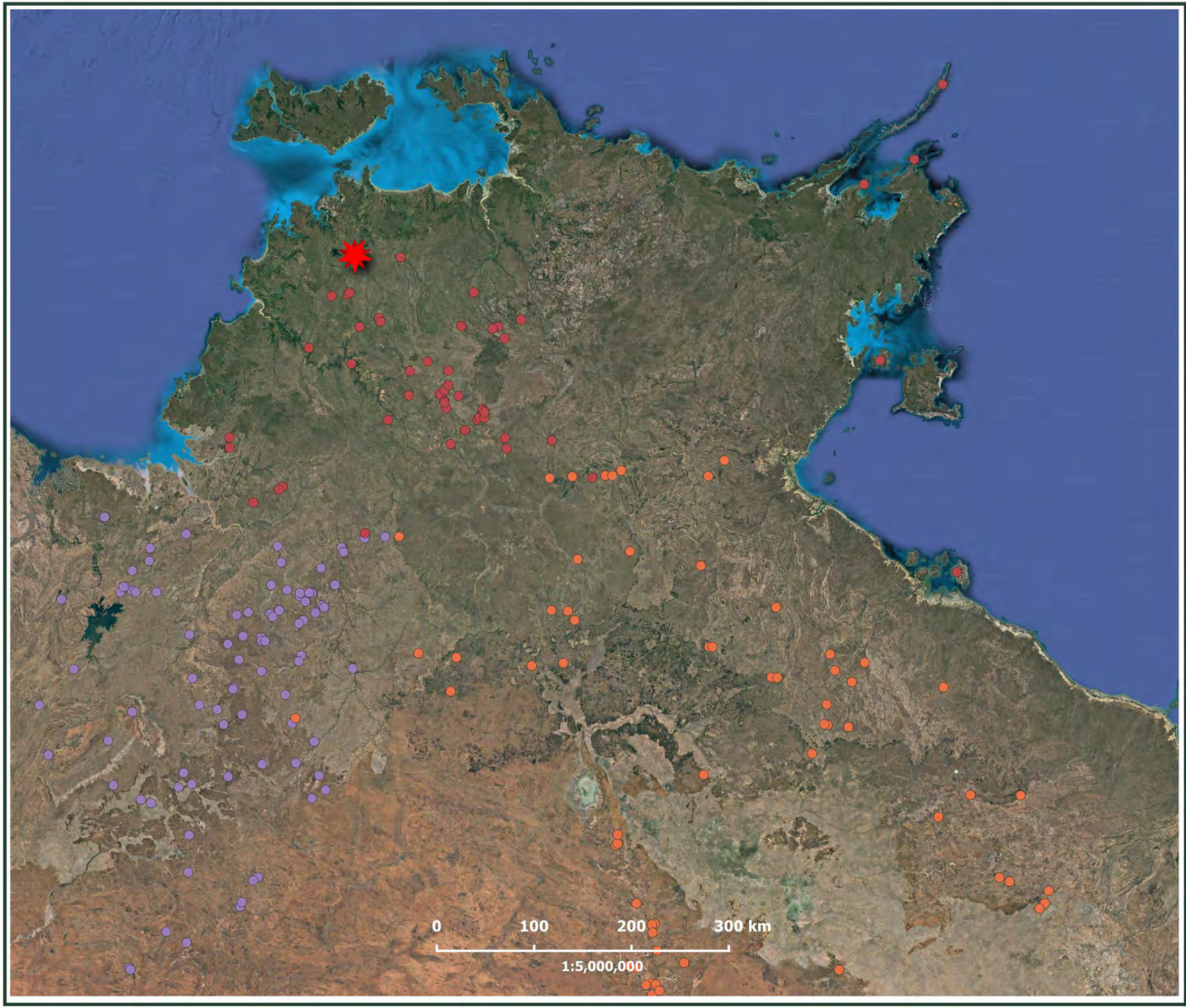

Figure 8 - All records of Eucalyptus tintinnans, E. leucophloia and E. brevifolia in the NT FLora Atlas (as of 27 September 2022)

Key

- AROWS project location
- E. brevifolia
- E. leucophloia
- E. tintinnans

Background - Google Satellite

Project: 2022 AROWS Significant Impact Assessment
Client: Power and Water Corporation
Author: M. Proos
Date: 27 September 2022

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4.3.2.3 Partridge Pigeon (Geophaps smithii smithii)

Survey Results

Partridge Pigeons were not detected within the AROWS basin, however suitable habitat appeared to exist in the form of well-drained eucalypt woodlands. Two Partridge Pigeons were detected immediately to the east (outside) of the basin. This detection, and the similarity of habitats in the basin, suggests that the species is likely to exist in the basin, albeit in a low density.

Conservation Status

The conservation status of the Partridge Pigeon is listed as:

- Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Vulnerable under the national *Environment Protection and Biodiversity Conservation Act 1999* (last assessed: 1 October 2015).
- Least Concern on the IUCN Red List of Threatened Species (last assessed: 6 December 2021).

Significance of the Individuals

Given the highest conservation status of the species is vulnerable, an assessment of the 'importance' of the population within the AROWS basin is shown in **Table 16**. It is based on the criteria in the EPBC Act *Significant Impact Guidelines* (DoE, 2013). The population within the AROWS basin is not expected to be an important population.

Nearly 80% of the AROWS basin has burned in 19 (86%) of the last 22 years (refer to **Section 3.3.1**). While the distribution of invasive weeds such as Gamba Grass and Perennial Mission Grass has not been mapped within the basin, they both exist and have likely affected the intensity of fires over time.

'Intense' fires can also occur as late dry season fires. Only approximately 7% of the AROWS basin has burned after 31 July at or greater than about 1 in 5 years on average in the last 22 years (2000-2021; refer to **Section 3.3.1**). Approximately 20% of the basin has burned after 31 July twice or more in the last 22 years.

Table 16 'Important' population assessment for the Partridge Pigeon

Criteria	Response
Populations identified in recovery plans	No
Key source populations either for breeding or dispersal	It is probably unlikely that the individuals in the vicinity of the AROWS basin are included in a key source population or necessary for maintaining genetic diversity because: ▪ Only two individuals were identified despite extensive searches and these were adjacent to, not in, the basin. ▪ In the last 22 years, approximately 86% of the AROWS basin has burned nearly every year (refer to **Section 3.3.1**) and areas of invasive grasses including Gamba Grass and Perennial Mission Grass exist within the basin, indicating that intense fires could occur more frequently over time. ▪ The long-term outlook for the AROWS basin population may not be favourable for the species given the recent fire history, and the presence of invasive grasses and cats. ▪ The AROWS basin is not a conservation reserve.
Populations that are necessary for maintaining genetic diversity	
Populations that are near the limit of the species range	No – The AROWS basin is not near the limit of the species range.

Significance of the Habitat

Habitat suitability was assessed and delineated following the fauna surveys in 2019 (refer to **Table 17**; Connect Environmental, 2019). However, at present, these habitats are unlikely to constitute habitat critical to the survival of the species, as assessed in **Table 18**.

Table 17 The area of Partridge Pigeon habitat in the AROWS basin (Connect Environmental, 2019)

Revised suitable habitat	Area (ha)
High suitability – well-drained eucalypt communities (E1, E2 and E3)	455
Low to moderate suitability – *Corymbia grandifolia* dominated community (E4) (imperfectly drained landscape position)	589

Table 18 Assessment of habitat critical to the survival of the Partridge Pigeon

Criteria	Assessment
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:	
for activities such as foraging, breeding, roosting, or dispersal	**Unlikely** The AROWS basin is unlikely to contain an important population of the species, as described in **Table 16**, and consequently is unlikely to be necessary for the species survival. No individuals were detected within the basin, despite extensive searches. The AROWS basin currently experiences a high fire frequency and contains invasive grasses that are unlikely to be favourable to the species presence in that area, and may be implicated in any recent decline in numbers in that area.
For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)	
to maintain genetic diversity and long-term evolutionary development, or	
for the reintroduction of populations or recovery of the species or ecological community	

Potential Impacts

Key potential impacts to the Partridge Pigeon from the AROWS development are:

- The loss of 455 ha of suitable habitat and 589 ha of low-moderate suitability habitat.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Partridge Pigeon, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 19**. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Based on this analysis, it appears unlikely that the AROWS project will significantly impact the Partridge Pigeon.

Table 19 Significant impact assessment for the Partridge Pigeon

Significant Impact Criteria for 'vulnerable' species	Assessment of likelihood
Lead to a long-term decrease in the size of an important population of a species	**Unlikely** – The population within the project is unlikely to be an important population as assessed in **Table 16**.
Reduce the area of occupancy of an important population	

Significant Impact Criteria for 'vulnerable' species	Assessment of likelihood
Fragment an existing important population into two or more populations	
Disrupt the breeding cycle of an important population	
Adversely affect habitat critical to the survival of a species	**Unlikely** – The AROWS basin is unlikely to constitute habitat that is critical to the species survival, as described in **Table 18**.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – The AROWS basin is unlikely to constitute important populations of the species nor contain habitat critical to the survival of the species, as described in **Table 16 and Table 18**, respectively.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely** – No diseases are listed as a threat to the species.
Interfere substantially with the recovery of the species	**Unlikely** – The AROWS basin does not appear to contain an important population of the species or habitat critical to its survival. In that regard, the AROWS development appears unlikely to interfere substantially with the recovery of the species.

4.3.2.4 Northern Quoll (Dasyurus hallucatus)

The following assessment should be reviewed following consultation with relevant government agencies as to the need for further survey of the species on the escarpments adjacent to the basin, as recommended in ***Section 5.1.1****. This assessment is based on the premise that the species does not occur, or only very infrequently occurs, within the AROWS basin. Further surveys may be required along the escarpment to determine the abundance and distribution of the species there.*

Survey Results

In 2019, the Northern Quoll was not detected within the AROWS basin despite the deployment of 18 cameras spread across the target habitat identified in the TSSP (about 189 ha; EcOz, 2018) and about nine hours of vehicle-based spotlighting along tracks (Connect Environmental, 2019). Further surveys were recommended to include other areas of eucalypt woodland within the basin (that weren't surveyed in 2019) as well as a sample of the escarpments bordering the basin.

In 2020, during additional surveys, one Northern Quoll was detected on a camera on the escarpment to the immediate west of the AROWS basin (Connect Environmental, 2020). No other individuals were detected. It is unclear whether this individual is part of a population in that area. Advice was sought from DEPWS as to whether further surveys are recommended to determine whether other individuals occupy the adjacent escarpment areas. DEPWS was satisfied with the sampling method and effort for Northern Quolls within the basin.

Conservation Status

The conservation status of the Northern Quoll is listed as:

- Critically endangered under the NT *Territory Parks and Wildlife Conservation Act 1976*
- Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999*

- Endangered on the IUCN Red List of Threatened Species (last assessed: 15 June 2015).

Significance of the Individual

While no Northern Quolls were detected within the basin during the surveys, one was detected on a camera trap on the escarpment near Bamboo Springs, immediately west of the basin. Only one individual was triggered, on one camera, on one occasion (i.e., on only one burst of three images).

To determine the significance of the survey results, DoE (2016) classifies an 'important' population as:

- A high-density quoll population which occurs in refuge-rich habitat critical to the survival of the species, including where Cane Toads are present.
- One occurring in habitat that is free of Cane Toads and unlikely to support Cane Toads upon arrival i.e., granite habitats in WA, populations surrounded by desert and without permanent water.
- One that is subject to ongoing conservation or research actions i.e., populations being monitored by government agencies or universities or subject to reintroductions or translocation.

The characterization of populations by DoE (2016) is:

- High-density population – numerous camera triggers of multiple individuals across multiple cameras and or traps on the site.
- Low-density population – 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.

Based on this, the survey results indicate that, at most, a low-density population may exist. As such, it is unlikely that the individual detected is part of an 'important' population.

Significance of the Habitat

Northern Quolls are found in a broad range of habitats include rocky areas, eucalypt forest and woodlands, dry rainforests and vine thickets, sandy lowlands and beaches, shrublands, grasslands and deserts (DoE, 2016). Breeding and refuge habitats are generally confined to rocky areas or structurally diverse woodlands (most commonly open forests dominated by eucalypts (Woinarski & Hill, 2012)) and the surrounding habitats are used for foraging and dispersal. In Kakadu, the species has been detected in (amongst other habitats not found in the project area) open forest and woodlands dominated by *E. tetrodonta*, *E. miniata* and *E. tectifica* and riparian areas dominated by *Melaleuca viridiflora* and *Pandanus spiralis* (Oakwood, 2000).

Whilst little appears to be known of the characteristics of foraging or dispersal habitat, DoE (2016) indicates that such habitats comprise native vegetation within 1 km of, or connected to, shelter habitat or any quoll records or land comprising predominately native vegetation that is connected to shelter habitat within the range of the species.

Using this definition, in 2019, potential breeding and refuge habitats in the AROWS basin were defined and mapped by Connect Environmental (Connect Environmental, 2019) as all areas of *E. miniata*, *E. tetrodonta* and *E. tectifica* woodland given that these areas contained varying degrees of structurally diverse vegetation (including hollow-bearing trees). The total area was 419 ha.

In addition, potentially suitable foraging and dispersal habitat was mapped by placing a 1 km buffer on all potential breeding and refuge habitat, as per the DoE (2016) definition. This area was 1,472 ha.

Habitat critical to the survival of the species provides shelter for breeding, refuge from fire / or predation and potential poisoning from cane toads (DoE, 2016) and includes:

- Offshore islands where the northern quoll is known to exist.
- 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.

Based on all data collected to date, it is concluded that no areas of habitat within the basin are critical to the survival of the species given that no quolls were detected despite extensive surveys, there has been a high frequency of fires over the last 20 or so years (which may worsen because of the spread of invasive grasses) and Cats and Cane Toads are present.

However, the area immediately west of the basin (Bamboo Springs) could be habitat critical to the survival of the species because:

- One quoll was detected there in 2020.
- The habitat is characterized by a structurally diverse woodland on a rocky escarpment and is dissected by a creek that is the only apparent permanent surface water in the basin.

In relation to the significance of dispersal and foraging habitat, DoE (2016) state that such habitat is critical to the survival of the species if it is associated with or connecting *populations important for the long-term survival* of the Northern Quoll. Given that there does not appear to be a population important for the long-term survival of the Northern Quoll, the adjoining habitats are unlikely to be critical to the survival of the species.

Potential Impacts

Potential impacts to the Northern Quoll from the proposed AROWS project include:

- The loss of approximately 419 ha of potential breeding and refuge habitat and 1,472 ha of potential foraging and dispersal habitat. However, it is noted that quolls were not detected in any of these habitats, likely because of significant threatening processes present (including Cane Toads, frequent fires and invasive grasses).

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Northern Quoll, an assessment against the significant impact criteria contained within the Australian Government's *EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus* (DoE, 2016) was undertaken, as shown in **Table 20**. Based on this analysis, it appears unlikely that the AROWS project will have a significant impact on the Northern Quoll.

Table 20 Assessment of the significance of potential impacts to the Northern Quoll from the proposed AROWS project using the DoE (2016) criteria

Criteria	Assessment of likelihood
Result in the loss of habitat critical to the survival of the Northern Quoll	**Unlikely** – The only area of habitat considered to possibly be habitat critical to the survival of the species is located on the escarpment to the immediate west of the basin near (and including) 'Bamboo Springs'. This area will not be inundated.
Decrease the size of a population important for the long-term survival of the Northern Quoll and therefore interfere with the recovery of the species	**Unlikely** – Based on the detection of only one individual on one camera trap on one occasion, it is concluded that it is not part of a population important for the long-term survival of the species.
Introduce inappropriate fire regimes or grazing activities (i.e., increasing the risk of late dry season high intensity fires to the area) that substantially degrade habitat critical to the survival of the Northern Quoll or decrease the size of a population important for the long term survival of the species	**Unlikely** – In the last 22 years, approximately 86% of the AROWS basin has burned nearly every year (refer to **Section 3.3.1**) and areas of invasive grasses including Gamba Grass and Perennial Mission Grass exist within the basin, indicating that intense fires could occur more frequently over time.

Criteria	Assessment of likelihood
Fragment a population important for the long-term survival into two or more populations	**Unlikely** – Based on the detection of only one individual on one camera trap on one occasion, it is concluded that it does not form a population important for the long-term survival of the species.
Result in invasive species or increases of them that are harmful to the northern quoll becoming established in its habitat, namely Cane Toads, Feral Cats, Red Foxes or exotic grasses which increase fire risk. This includes actions which have inadequate quarantine measures in place for movements between the mainland and offshore islands where Northern Quolls occur.	**Unlikely** – A range of invasive species are already present within the basin including Cane Toads, Cats and invasive grasses (such as Gamba Grass and Perennial Mission Grass).

4.3.2.5 Black-footed Tree-rat (Mesembriomys gouldii gouldii)

Survey Results

The Black-footed Tree-rat was detected on 23 cameras during surveys conducted in 2019 and 2020 (Connect Environmental, 2020). As such, the species was concluded as being relatively common within suitable habitats in the AROWS basin. They were detected in six vegetation communities. Approximately 495 ha of suitable (known) habitat was estimated to exist within the 32 m inundation line of the AROWS basin area in 2019 (Connect Environmental, 2019). In addition, it appeared plausible that the species could utilize habitats temporarily during times of refuge or food scarcity, across an additional 980 ha of habitat within the basin (Connect Environmental, 2019).

Conservation Status

The conservation status of the Black-footed Tree-rat is listed as:

- Endangered under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999*.
- Vulnerable on the IUCN Red List of Threatened Species (last assessed: 19 July 2015).

Significance of the Individuals

A total of 6,604 records of the species exists in the NT Fauna Atlas, of which 5,742 records are from 2010 onwards. Records since 2010 are distributed across the western top end as well as far eastern Arnhem Land.

Whilst there is an apparent high number of records in the last decade, the TSSC has concluded that, as of 2015, the species has "undergone a very severe reduction in numbers over three generation lengths (10 years for this assessment), equivalent to at least 50 percent and the reduction has not ceased, the cause has not ceased and is not understood". Without robust information to support another view, the detection of the individuals in the AROWS basin should be considered important.

Significance of the Habitat

Suitable habitat for the Black-footed Tree-rat within the AROWS basin appears unlikely to be habitat critical to the survival of the species, as assessed in **Table 21**.

Table 21 Assessment of habitat critical to the survival of the Black-footed Tree-rat

Criteria	Assessment
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:	
for activities such as foraging, breeding, roosting, or dispersal	**Unlikely** – The habitats within the AROWS basin are unlikely to be critical to the survival of the species because: ▪ A total of 6,604 records of the species exists in the NT Fauna Atlas, of which 5,742 records are from 2010 onwards. Records since 2010 are distributed across the western top end as well as far eastern Arnhem Land. ▪ In the last 22 years, approximately 86% of the AROWS basin has burned nearly every year (refer to **Section 3.3.1**) and areas of invasive grasses including Gamba Grass and Perennial Mission Grass exist within the basin, indicating that intense fires could occur more frequently over time. ▪ The long-term outlook for the AROWS basin population may not be favourable for the species given the recent fire history and presence of invasive grasses. ▪ The AROWS basin is not a conservation reserve.
For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)	
to maintain genetic diversity and long-term evolutionary development, or	
for the reintroduction of populations or recovery of the species or ecological community	

Potential Impacts

Potential impacts to the Black-footed Tree-rat from the AROWS project include:

- The loss of at least approximately 495 ha of suitable habitat within the 32 m inundation line.
- The loss or displacement of numerous individuals, which is likely to affect resource competition in adjacent areas.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Black-footed Tree-rat, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 22**. Based on this analysis, it is possible that the AROWS project will significantly impact the Black-footed Tree-rat.

Table 22 Significant impact assessment for the Black-footed Tree-rat

Significant Impact Criteria for endangered species	Assessment of likelihood
Lead to a long-term decrease in the size of a population	**Possible** – The loss of 495 ha of suitable habitat and a further 980 ha of potential habitat will reduce the available area of habitat for the species in the local area (and region). Consequently, a decrease in the local and perhaps regional population of the species is possible. This is probably exacerbated by ongoing and possible increasing threats to the species including inappropriate fire regimes, urban development in the region, cats, feral herbivores and invasive grasses.
Reduce the area of occupancy of the species	**Possible** – Woinarski *et al*., (2014) estimated the species' area of occupancy to be 604 km^2, however this is expected to be a significant under-estimate due to limited survey effort across its range. As such, geographic distribution is not considered to be limited. Nevertheless, given that the 32 m inundation area is approximately 18 km^2 (noting that not all is occupied by the species), the area of occupancy of the species may decrease.

Significant Impact Criteria for endangered species	Assessment of likelihood
Fragment an existing population into two or more populations	**Unlikely** – While the population of the species within the AROWS basin will be fragmented by an 11 km long inundated area, apparently suitable habitat to the north and south of this area exists. As such, the population will, in theory, remain connected, noting that surveys to the immediate north and south have not been conducted.
Disrupt the breeding cycle of a population	**Possible** – The breeding cycle of the individuals within and immediately adjacent to the basin is expected to be disrupted through a loss of habitats in the wet season (as water is pumped into the basin) and increased pressure on adjacent resources to support the displaced individuals in addition to those already occupying the adjacent areas.
Adversely affect habitat critical to the survival of a species	**Unlikely** – The AROWS basin has been assessed as being unlikely to contain habitat critical to the survival of the species (refer to **Table 21**).
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – Based on the wide-ranging distribution of the species, and the high number of records in the last ten years, is appears unlikely that the species is likely to decline as a result of the AROWS project.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely** – Diseases resulting from the AROWS project appear unlikely.
Interfere substantially with the recovery of the species	**Unlikely** – Based on the wide-ranging distribution of the species (AoO of >604 km^2), and the high number of records in the last ten years in the NT Fauna Atlas (5,724), is appears unlikely that the AROWS project will interfere substantially with the recovery of the species.

4.3.2.6 Northern Brushtail Possum (Trichosurus vulpecula arnhemensis)

Survey Results

Northern Brushtail Possums were detected by 16 (out of 56) cameras in 2019 and four (out of 24) in 2020. The species was the sixth most common mammal captured on camera in 2019. During the surveys in 2019 and 2020, the species was not listed as a threatened species under either NT or national legislation.

Conservation Status

The conservation status of the Northern Brushtail Possum is listed as:

- Near Threatened under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Vulnerable under the national *Environment Protection and Biodiversity Conservation Act 1999* (last assessed: 11 May 2021)
- Least Concern (at species level – *Trichosurus vulpecula*) on the IUCN Red List of Threatened Species (last assessed: 15 June 2015).

Significance of the Individuals

Given that the highest conservation status of the species is vulnerable, an assessment of the 'importance' of the individuals detected within the AROWS basin is shown in **Table 23**. Based on this, the population within the AROWS basin is not expected to be important.

Nearly 80% of the AROWS basin has burned in 19 (86%) of the last 22 years (refer to **Section 3.3.1**). While the distribution of invasive weeds such as Gamba Grass and Perennial Mission Grass has not been mapped within the basin, they both exist and have likely affected the intensity of fires over time.

'Intense' fires can also occur as late dry season fires. Only approximately 7% of the AROWS basin has burned after 31 July at or greater than about 1 in 5 years on average in the last 22 years (2000-2021; refer to **Section 3.3.1**). Approximately 20% of the basin has burned after 31 July twice or more in the last 22 years.

Table 23 'Important' population assessment for the Northern Brushtail Possum

Criteria	Response
Populations identified in recovery plans	No
Key source populations either for breeding or dispersal	It is probably unlikely that the individuals in the AROWS basin are included in a key source population or necessary for maintaining genetic diversity because: ▪ A total of 14,745 records of the species exists in the NT Fauna Atlas, of which 11,924 records are from 2010 onwards. Records since 2010 are distributed across the western top end, southern Arnhem Land and Groote Eylandt. ▪ In the last 22 years, approximately 86% of the AROWS basin has burned nearly every year (refer to **Section 3.3.1**) and areas of invasive grasses including Gamba Grass and Perennial Mission Grass exist within the basin, indicating that intense fires could occur more frequently over time. ▪ The long-term outlook for the AROWS basin individuals may not be favourable for the species given the recent fire history and presence of invasive grasses. ▪ The AROWS basin is not a conservation reserve.
Populations that are necessary for maintaining genetic diversity	
Populations that are near the limit of the species range	No – The AROWS basin is not near the limit of the species range.

Significance of the Habitat

Suitable habitat for the Northern Brushtail Possum within the AROWS basin is unlikely to be critical to the survival of the species, as assessed in **Table 24**.

Table 24 Assessment of habitat critical to the survival of the Northern Brushtail Possum

Criteria	Assessment
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:	
for activities such as foraging, breeding, roosting, or dispersal	**Unlikely** – The habitats within the AROWS basin are unlikely to be critical to the survival of the species because: ▪ A total of 14,745 records of the species exists in the NT Fauna Atlas, of which 11,924 records are from 2010 onwards. Records since 2010 are distributed across the western top end, southern Arnhem Land and Groote Eylandt. ▪ In the last 22 years, approximately 86% of the AROWS basin has burned nearly every year (refer to **Section 3.3.1**) and areas of invasive grasses including Gamba Grass and Perennial Mission Grass exist within the basin, indicating that intense fires could occur more frequently over time.
For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)	
to maintain genetic diversity and long-term evolutionary development, or	

Criteria	Assessment
for the reintroduction of populations or recovery of the species or ecological community	▪ The long-term outlook for the AROWS basin individuals may not be favourable for the species given the recent fire history and presence of invasive grasses. ▪ The AROWS basin is not a conservation reserve.

Potential Impacts

Potential impacts to the Northern Brushtail Possum because from the AROWS project include:

- The loss of approximately 495 ha of suitable habitat within the 32 m inundation line. Whilst this has not been assessed in detail, the same area of habitat as the Black-footed Tree-rat has been estimated given the similarity in suitable habitat characteristics.
- The loss or displacement of numerous individuals.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Northern Brushtail Possum, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 25**. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Based on this analysis, it appears unlikely that the AROWS project will significantly impact the Northern Brushtail Possum.

Table 25 Significant impact assessment for the Northern Brushtail Possum

Significant Impact Criteria for vulnerable species	Assessment of likelihood
Lead to a long-term decrease in the size of an important population of a species	**Unlikely** – The population within the project is unlikely to be an important population as assessed in **Table 23**.
Reduce the area of occupancy of an important population	
Fragment an existing important population into two or more populations	
Disrupt the breeding cycle of an important population	
Adversely affect habitat critical to the survival of a species	**Unlikely** – The AROWS basin has been assessed as being unlikely to contain habitat critical to the survival of the species (refer to **Table 24**).
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – Based on the wide-ranging distribution of the species, and the high number of records in the last ten years, is appears unlikely that the species is likely to decline from the AROWS project.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely –** Diseases resulting from the AROWS project appear unlikely.

Significant Impact Criteria for vulnerable species	Assessment of likelihood
Interfere substantially with the recovery of the species	**Unlikely** – Based on the wide-ranging distribution of the species (the EoO is estimated to be 571 694 km^2 and the AoO estimated to be 1,392 km^2), and the high number of records in the last ten years in the NT Fauna Atlas (11,924), it appears unlikely that the AROWS project will interfere substantially with the recovery of the species.

4.3.2.7 Mertens' Water Monitor (Varanus mertensi)

Survey Results

Within the 32 m inundation line, the Mertens' Water Monitor was detected at one location – in a billabong in the intake corridor in 2019. It was not detected elsewhere despite the presence of apparently suitable habitat. It was also observed on one occasion on the Marrakai Track in Bamboo Springs (i.e., the permanent creek that crosses the Marrakai Track at the western side entry to the AROWS basin).

Conservation Status

The conservation status of Mertens' Water Monitor is listed as:

- Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999* (last assessed: 21 December 2023).
- Endangered on the IUCN Red List of Threatened Species (last assessed: 20 February 2017).

It is not listed under the national *Environment Protection and Biodiversity Conservation Act 1999*.

Significance of the Individuals

A total of 797 records of the species exists in the NT Fauna Atlas, of which 413 records are from 2010 onwards. Records since 2010 are distributed across the top end.

Whilst there are numerous records in the last decade, DCCEEW (2023c) has concluded that, in the last three generations, the species has undergone a "severe and sustained population reduction". Without robust information to support another view, the detection of the individual in the AROWS basin should be considered important. It is noted that, anecdotally, the species is recorded relatively frequently.

Significance of the Habitat

Given that DCCEEW indicate that all areas where the species persists following the establishment of Cane Toads is habitat critical to the survival of the species, it would appear that the small billabong located in the intake corridor is such habitat, as assessed in **Table 26**. It seems reasonable to suggest that most or all of the remainder of riparian habitats within the basin are not critical to the survival of the species. The assessment has been made against the description used in the species Conservation Advice (DCCEEW, 2023c).

Table 26 Assessment of habitat critical to the survival of Merten's Water Monitor

Criteria	Assessment
All areas where this species persists following the establishment of cane toads.	**Likely** – While the individual or population within the intake corridor has not been monitored, the species appears to be persisting in that area.

Criteria	Assessment
Areas within its recorded distribution that provide connectivity among remnant subpopulations. Specifically, natural and artificial water bodies that connect remnant subpopulations and have open water, food resources, basking sites, and shelter opportunities.	**Unlikely** because: ▪ Merten's Water Monitor was detected at only one location, despite extensive active searches and camera deployment across the drainage lines within the basin. ▪ There are no areas of permanent surface water in the AROWS basin (32 m inundation line). All are ephemeral. ▪ Cane Toads, being a key threat to the species (DEPWS, 2021d), are also present throughout the basin. ▪ The AROWS basin is not a conservation reserve.

Potential Impacts

Potential impacts to Merten's Water Monitors from the AROWS project include:

- The loss of riparian habitat, primarily the billabong located in the intake corridor.

The inundation of the basin may also result in reduced water quality from deoxygenation and substantial nutrient release from decomposing vegetation (EcOz, 2021b). Consequently, there may be a period where water is unsuitable for the species until the aquatic ecosystem is matured. Further studies are recommended to determine the severity of this (EcOz, 2021b).

However, with the creation of large areas of lacustrine habitats in the basin, it is expected that, eventually, more suitable habitat will be available than currently present.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Merten's Water Monitor, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 27**. Based on this analysis, it appears unlikely that the AROWS project will significantly impact the Merten's Water Monitors.

Table 27 Significant impact assessment for the Merten's Water Monitors

Significant Impact Criteria for endangered species	Assessment of likelihood
Lead to a long-term decrease in the size of a population	**Unlikely** – The species was detected in only one location within the basin. In addition, there are no areas of permanent surface water in the AROWS basin (32 m inundation line). All are ephemeral. With the creation of large areas of lacustrine habitats in the basin from the AROWs project, it is expected that, eventually, more suitable habitat will be available for the species than is currently present.
Reduce the area of occupancy of the species	
Fragment an existing population into two or more populations	
Disrupt the breeding cycle of a population	
Adversely affect habitat critical to the survival of a species	**Unlikely** – With the creation of large areas of lacustrine habitats in the basin from the AROWs project, it is expected that, eventually, more suitable habitat will be available for the species than is currently present.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – The area of habitat for the species is expected to increase.

Significant Impact Criteria for endangered species	Assessment of likelihood
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**Unlikely** – Invasive species that threaten the Merten's Water Monitor are already within basin. Cane Toads now encompass the entire distribution of Merten's Water Monitor in the NT (DEPWS, 2021).
Introduce disease that may cause the species to decline	**Unlikely** – Diseases resulting from the AROWS project appear unlikely.
Interfere substantially with the recovery of the species	**Unlikely** – There is no reason to suggest that the AROWS project will interfere substantially with the recovery of the species.

4.3.3 Threatened Species Listed Under the TPWC Act Only

4.3.3.1 Darwin Cycad (Cycas armstrongii)

Survey Results

The following terms for density are used in accordance with definitions adopted by the NT Herbarium (Nicholas Cuff, pers. comm. 12/9/2019):

- None – cycads are absent.
- Low – less than 130 adults per hectare (an adult is defined as a plant with an above-ground stem of at least 50 cm height).
- Moderate – 131-400 adults per hectare.
- High – 401-700 adults per hectare.
- Very high – greater than 700 adults per hectare.

The *Threatened Species Survey Report, Adelaide River Off-stream Water Storage (AROWS) Project* (Connect Environmental, 2019) describes the abundance and distribution of Darwin Cycads in the AROWS basin in 2019 as follows:

- A total of 11,880 adult Darwin Cycads were recorded within the 32 m inundation line.
- The survey targeted areas within which Darwin Cycads were observed to be present and was not intended to cover the basin comprehensively. It is considered likely that this figure represents approximately 80-90% of the total population present within the AROWS basin. Therefore, it is possible that up to 14,250 Darwin cycads may occupy the area of the AROWS basin within the 32 m inundation line.
- A total of 7,077 individual adult Darwin cycads were recorded within the 24 m inundation line. This comprises 60% of the population found within the 32 m inundation line. Given that this may underrepresent the actual population by up to 20%, it is considered possible that up to 8,500 adult Darwin Cycads may be located within the 24 m inundation line.

The AROWS basin population of Darwin Cycads had the following density characteristics (**Figure 2**):

- Very high or high density: no sub-populations with densities of very high or high were observed.
- Moderate densities:
  - 32 m inundation area: 14 moderately dense sub-populations occupying 21.92 ha, comprising 4,370 cycads (**Figure 2**).
  - 24 m inundation area: nine moderately dense sub-populations occupying 14.86 ha, comprising 3,111 cycads.
- Low densities:

- 32 m inundation area: low densities within 322 quadrats over 310 ha, comprising 7,461 cycads.
- 24 m inundation area: low densities within 189 quadrats over 187 ha, comprising 3,966 cycads.

- Not present or present in low density (estimated):
  - 32 m inundation area: either absent or present at low densities within 650 quadrats over 642 ha.
  - 24 m inundation area: either absent or present at low densities within 629 quadrats over 629 ha.
- Not present:
  - 32 m inundation area: absent from 1012 quadrats over 829 ha.
  - 24 m inundation area: absent from 722 quadrats over 696 ha.

No Darwin Cycads were present within the intake corridor.

In **Figure 2**, the following interpretations apply:

- 'None/Low (predicted)': Those areas that weren't surveyed though are unlikely to contain cycads, or relatively few per hectare.
- 'None': Those areas that were surveyed and cycads were noted as being absent; and
- 'None/Low': The offtake corridors where cycads may be present, though individual counts were not conducted.

Conservation Status

The conservation status of the Darwin Cycad is listed as:

- Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Vulnerable in the IUCN Red List of Threatened Species (last assessed: 22 October 2020).

It is not listed under the national *Environment Protection and Biodiversity Conservation Act 1999*.

Significance of the Individuals

The Darwin Cycad is locally abundant however less than 1% of the total population exists within a conservation reserve (Liddle, 2009). It occurs from the Darwin area east to the Wildman River catchment, south to Hayes Creek and west to within 50 km of the coast (NTH, 2013). It is also common on the Tiwi Islands and has been recorded from Cobourg Peninsula (NTH, 2013).

It is understood that high density patches of cycads are of relatively high conservation significance (compared to lower density patches) (N. Cuff, pers. comm., 2019), probably because they have not been substantially affected by key threats and therefore are 'source' populations. Liddle (2004) indicates that over 1,200 adult plants per ha can occur. It could be inferred that any sub-populations containing high or very high densities could be 'important' populations, and necessary for maintaining genetic diversity.

No patches of high or very density cycads were recorded within the AROWS basin. The species' key threats include the expansion of rural residential areas, horticulture, agriculture and forestry (Kerrigan *et al*. 2006). Where land isn't subjected to land clearing, the species is threatened by Gamba Grass and other introduced grasses due to competition and altered fire regimes (Kerrigan *et al*. 2006). Intense fires at a frequency more than around 1 in 5 years are thought to result in a long-term population decline (DEPWS, 2021), though it is probable that an intense fire more frequent than 1 in 10 years would result in decline (Liddle, 2004). 'Intense' fires are defined by Liddle (2004) as fires with fuel loads of ≥20 t/ha because of introduced grasses, whereas 'ambient' fires are fuel loads comprising native grasses. The invasive grasses Gamba Grass (*Andropogon gayanus*) and Perennial Mission Grass (*Pennisetum polystachion*) are specifically mentioned by Liddle. Both species are present in the AROWS basin and are likely to have increased the intensity of fires.

Based on this information, an assessment of the 'importance' of the population within the AROWS basin is shown in **Table 28**. It uses the criteria in the EPBC Act *Significant Impact Guidelines* (DoE, 2013).

Table 28 'Important' population assessment for Cycas armstongii

Criteria	Response
Populations identified in recovery plans	No
Key source populations either for breeding or dispersal	It is probably unlikely that the population of cycads within the AROWS basin is a key source population or necessary for maintaining genetic diversity because: ▪ No high or very high-density patches were identified. ▪ In the last 22 years, approximately 86% of the AROWS basin has burned nearly every year (refer to **Section 3.3.1**) and areas of invasive grasses including Gamba Grass and Perennial Mission Grass exist within the basin, indicating that intense fires could occur more frequently over time. ▪ The long-term outlook for the AROWS basin population may not be favourable for the species given the recent fire history and presence of invasive grasses. ▪ The AROWS basin is not a conservation reserve. ▪ Only minor areas of habitats thought to contain large populations of the species exist within the AROWS basin (i.e., land unit 1 is mapped as occurring in approximately 8% of the northern half of the basin; no areas of land units 3a or 3b are mapped).
Populations that are necessary for maintaining genetic diversity	
Populations that are near the limit of the species range	No – The population is not known to be near the limit of the species range.

Significance of the Habitat

Suitable habitat for Darwin Cycads within the AROWS basin is unlikely to constitute habitat critical to the survival of the species, as assessed in **Table 29**. Criteria are from the EPBC Act *Significant Impact Guidelines* (DoE, 2013).

Table 29 Assessment of habitat critical to the survival of the Darwin Cycad

Criteria	Assessment
'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:	
for activities such as foraging, breeding, roosting, or dispersal	**Unlikely** The AROWS basin is unlikely to contain an important population of the species, as described in **Table 28**, and consequently is unlikely to be necessary for the species survival. Further, Liddle (2004) describes large populations of the species occurring in land units 3a, 3b and 1 (from the greater Darwin land unit mapping (Fogarty *et al*., 1984). Based on this mapping, which only covers about the northern half of the AROWS basin (880 ha), only about 70 ha (8%) is mapped as any of these land units. Lastly, the AROWS basin currently experiences high fire frequencies and contains invasive grasses that will probably result in a long-term decline of that population.
For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)	
to maintain genetic diversity and long-term evolutionary development, or	
for the reintroduction of populations or recovery of the species or ecological community	

Potential Impacts

Potential impacts to the Darwin Cycad because of the AROWS project are:

- The loss of at least approximately 11,880 cycads within the AROWS basin (32 m inundation boundary) because of inundation.

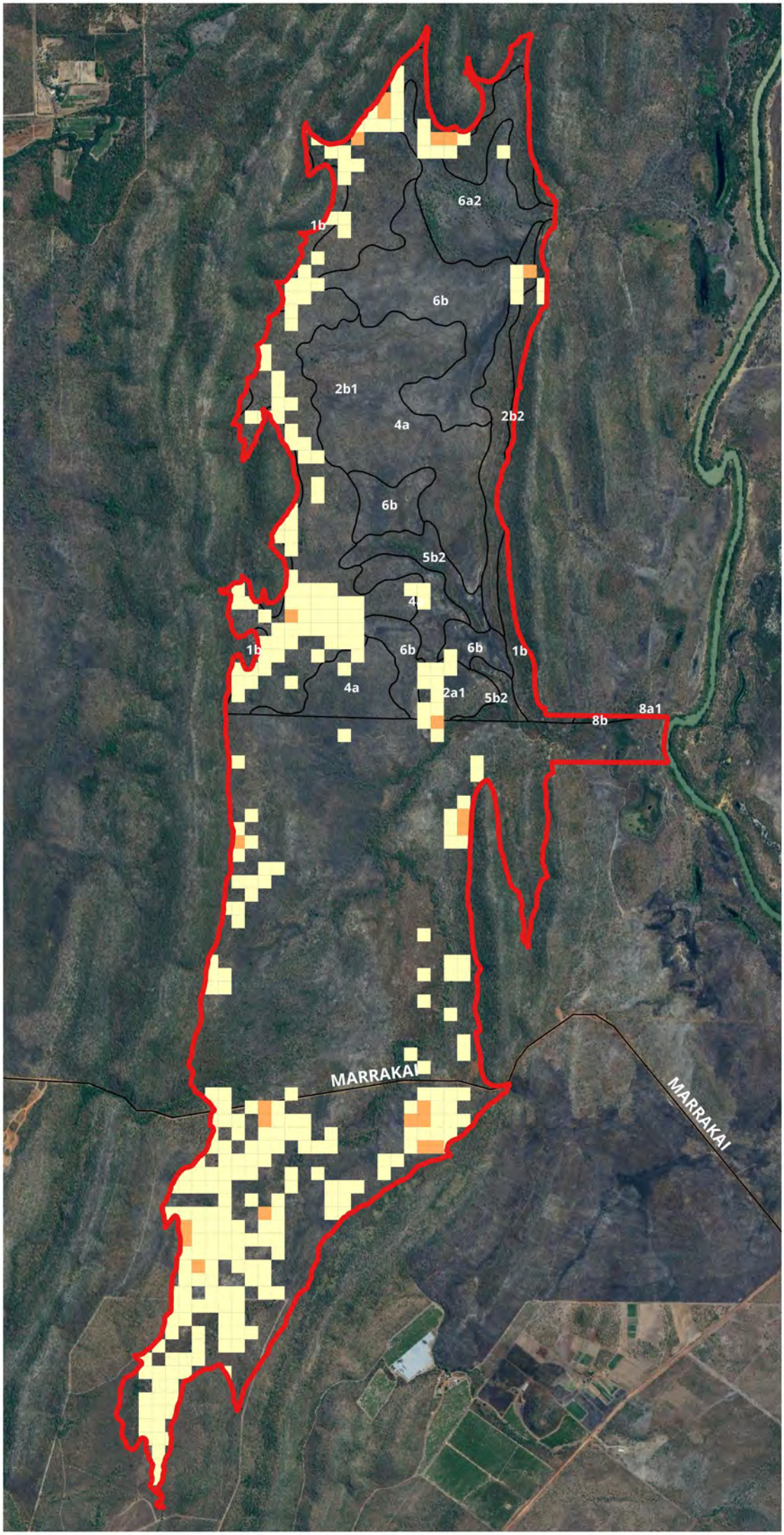

Figure 9 - Darwin Cycad density within the AROWS basin and Greater Darwin land units (Fogarty et al, 1984)

Key

Cycas armstrongii hectare density grid

- Low
- Moderate
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

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Significance of Potential Impacts

To assist in determining the significance of anticipated impacts to the Darwin Cycad, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 30**. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Based on this analysis, there appears to be low potential for a significant impact to this species from the proposed project.

Table 30 Significant impact assessment for the Darwin Cycad

Significant Impact Criteria for 'vulnerable' species	Assessment of likelihood
Lead to a long-term decrease in the size of an important population of a species	**Unlikely** – The population within the project is unlikely to be an important population as assessed in **Table 28**.
Reduce the area of occupancy of an important population	
Fragment an existing important population into two or more populations	
Disrupt the breeding cycle of an important population	
Adversely affect habitat critical to the survival of a species	**Unlikely** – The AROWS basin is unlikely to constitute habitat that is critical to the species survival, as described in **Table 29**.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – The AROWS basin is unlikely to constitute important populations of the species nor contain habitat critical to the survival of the species, as described in **Table 28 and Table 29**, respectively.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely** – It is understood that the species is not known to be vulnerable to any disease.
Interfere substantially with the recovery of the species	**Unlikely** – The AROWS basin does not appear to contain an important population of the species or habitat critical to its survival. In that regard, the AROWS development appears unlikely to interfere substantially with the recovery of the species.

4.4 Undetected Species

4.4.1 Preliminary Risk Assessment

A preliminary assessment of inherent risks to species that potentially occur within the basin though were not detected, as assessed in **Section 3**, is conducted here. The preliminary assessment helps to inform the need for further assessment and any recommendations for further species-specific surveys. The assessment is based on criteria in the *Significant Impact Guidelines* (DoE, 2013) though has used the definitions for the consequences of impacts in the Species Expert Assessment Plan (SEAP) Manual (TSSC, 2015), as shown in **Table 31**. It considers *inherent* risks only (i.e., pre-mitigation) although specific potential impacts are not listed here. The assessment is based generally on the premise that the AROWS basin, which is an area of

approximately 1,800 ha, will be transformed into series of mostly lacustrine habitats, depending on the level at which the water sits and the patterns of inundation.

Four threatened flora and seven threatened fauna species are included. The results are shown in **Table 32** for species listed under the EPBC Act and **Table 33** for species listed under the TPWC Act only. In general, species with ratings of 'insignificant' (and no greater) are unlikely to require on-ground surveys to determine their presence and/or distribution. Such potential impacts are considered acceptable and covered by current legislation and management. Where potential impacts are determined to be 'minor' or greater, further analysis is warranted, potentially including surveys. The assessed risk may change following any on-site surveys once the true abundance of relevant species and potentially suitable habitat is better understood.

The assessment is also separated into the species that are listed under the EPBC Act and those that are listed under the NT TPWC only.

Table 31 Impact consequence definitions for threatened species (TSSC, 2015)

Consequence	Insignificant	Minor	Moderate	Major	Critical
Impact on population[3]	Minimal impact on local population numbers; area affected negligible compared to total population; minimal or acceptable impact on population size	Minor impact on local population numbers. Population in other locations not impacted	Moderate impact on local population numbers. Some impacts on populations in other locations; moderate and/or short-term effects	Major population reduction or loss of local population; recovery measure in years to decades; serious and significant impact on species	Population reduction which may results in species extinction; recovery period is greater than decades; very significant and serious impact on high value species
Fragmentation of habitat / loss of habitat connectivity / reduce the areas of occupancy[4]	Minimal losses of local habitat only, recovery likely in a relatively short period of time; threats are covered by current management or legislation	Minor losses of local habitat requiring recovery over short term	Moderate loss of local habitat requiring recovery over a short to medium term and resulting in loss of connectivity between habitats at a local scale	Loss of local habitat with no potential for recovery, or partial loss of habitat across large areas and/or with limited potential for recovery in the medium to long term. Results in a net reduction in connectivity over a large area	Complete loss of local habitat with no potential for recovery and loss of habitat in other locations with limited potential for recovery in the long term resulting in a significant impact on habitat connectivity over a large area
Impact on the habitat critical to the survival of the species[5]	Minimal modification, destruction, removal or decrease of local habitat only, recovery likely in a relatively short period of time; insignificant impact to habitat or threat activity only occurs in a very small area of habitat; limited damage to minimal area of low significance; minor effects on physical environment	Minor modification, destruction, removal or decrease of local habitat requiring recovery over short term	Moderate modification, destruction, removal or decrease of local habitat requiring recovery over a short to medium term and resulting in loss of connectivity between habitats at a local scale	Modification, destruction, removal or loss of local habitat with no potential for recovery, or partial loss of habitat across large areas and/or with limited potential for recovery in the medium to long term. Results in a net reduction in connectivity over a large area; habitat is affected which may endanger the species and habitat long term survival – 70-90% habitat affected or removed; 30% fragile habitat affected or removed; 10-20% critical habitat affected or removed;	Significant impact resulting in the removal, destruction, fragmentation and degradation of habitat; the entire habitat is in danger of being affected or removed, that >90% habitat, >50% fragile habitat, and >30% critical habitat
Disruption to breeding cycle[6]	Minimal impact on any aspect of the breeding cycle;	Minor disruption to the breeding cycle	Moderate disruption to breeding cycle resulting in modification of behaviour both within the direct impact zone and at nearby locations; long term recruitment and/or population dynamics are not adversely impacted	Direct impacts on breeding cycle resulting in a net decline in size of the population; there is limited information to judge the impact	Complete disruption of breeding cycles over several seasons with significant population decline and possible extinction
Impact of invasive species and/or disease[7]	Minimal impact on local population numbers or habitat quality	Minor impact on local population numbers or habitat quality. Population in other locations not impacted	Moderate impact on local population numbers or habitat quality. Some impacts on populations in other locations	Major population reduction or loss of local population or loss of habitat quality	Population reduction which may results in species extinction loss of critical habitat extent or quality
Interaction with species migration	Minimal impact on species migratory patterns	Results in minor behavioural modification on a local scale or impacts to physical conditions of animal interfering with migration for the short term only. Unlikely to negatively impact on the overall success of migration	Results in modification of behaviour or animal conditions such that there is potential for medium term impacts, with some possibility of individuals failing to complete migration	Results in modification of behaviour or animal condition such that there is potential for medium to long term impacts, both locally and in nearby locations, with some individuals failing to complete migration	Significant impact resulting in either complete failure, or failure of majority of individuals, to complete migration in that cycle

[3] Refers to the proportional changes to the numbers of individuals; change in the size of the population

[4] Refers to the physical destruction of the species habitat and/or chemical or physical barriers

[5]Refers to species habitat resource includes modify, destroy, isolate or decrease the availability or quality of habitat

[6]Breeding cycle including activities associated with breeding (mating, gestation, nesting). Assessment assumes that the species is present in the affected area during the breeding cycle

[7]Refers to the invasive species that is harmful to the species becoming established in the species habitat and introduced disease that may cause the species to decline

Table 32 Preliminary assessment of the inherent risk level for potentially occurring threatened species listed under the EPBC Act

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[35]	Survey recommendation	Justification
Threatened Birds					
Calidris acuminata	Sharp-tailed Sandpiper	NT: Least Concern; Nat.: Vulnerable	Insignificant	No	A significant impact is probably unlikely because only marginal habitat is apparent, and the species possibly very infrequently visits the site. There are some small ephemeral wetlands within the basin and intake corridor, though these are not expected to be important given their small extent, the proximity of the basin to coastal areas and, in the case of the small wetland in the intake corridor, degradation as a result of dense Mimosa (a 'weed of national significance'). Further, given the low number of local records and the understanding that the species is only infrequently recorded inland, it is unlikely that any of the relevant criteria listed in the *Significant Impact Guidelines* (DoE, 2013) would be met. This conclusion is also consistent with the assessment in **Section 4.5.1** for migratory shorebirds using the criteria in the *EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE, 2017). No further assessments are deemed necessary for this species.
Calidris ferruginea	Curlew Sandpiper	NT: Critically Endangered; Nat.: Critically Endangered	Insignificant	No	
Tringa nebularia	Common Greenshank	NT: Least Concern; Nat.: Endangered.	Insignificant	No	
Erythrotriorchis radiatus	Red Goshawk	NT: Vulnerable; Nat.: Endangered	Minor	No	A reduction in population size is not expected and a positive effect on habitat for the species, at least to some extent, is expected. However, it is unclear if there will be a residual loss of habitat critical to the species survival. Either way, this is anticipated to be minimal. A detailed impact assessment for the species is provided in **Section 4.4.2.1.**

[35] *That is, if individuals or a population of the species occurs on the site, what is the maximum anticipated level of impact to the aspects listed in **Table 9**?*

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[35]	Survey recommendation	Justification
Rostralata australis	Australian Painted Snipe	NT: Endangered; Nat.: Endangered	Insignificant	No	The AROWS basin and intake corridor may contain marginal habitat for the species in the form of shallow wetlands and waterlogged grasslands. However, it is noted that little is known of its specific habitat requirements (DCCEEW, 2022). It is considered that the development of the AROWS project may benefit the species by the creation of wetlands and waterbodies with suitable riparian vegetation. No further assessments are deemed necessary for this species.
Threatened Mammals					
Saccolaimus saccolaimus	Bare-rumped Sheath-tailed Bat	NT: Near threatened; Nat.: Vulnerable	Minor	Yes	A survey for the Bare-rumped Sheath-tail Bat within the AROWS basin has not occurred to date. Suitable habitat appears to exist within the basin. If the species is present, the transformation of the AROWS basin will result in the loss of suitable habitat. Given that no bat surveys were conducted within the basin, it is recommended that a bat survey targeting the Bare-rumped Sheath-tail Bat is considered.
Threatened Reptiles					
Acanthophis hawkei	Plains Death Adder	NT: Vulnerable; Nat.: Vulnerable	Insignificant	No	The AROWS basin contains some areas that contain cracking soils and are seasonally saturated or inundated (Connect Environmental, 2019). However, given there are no records of the species within 20 km, only the north-western section of the basin falls within the 'Adelaide River coastal floodplains' and the basin habitats do not appear to fit the description of a 'floodplain' habitat as defined in the *Adelaide River coastal floodplain* Site of Conservation Significance (SOCS) factsheet (McGuire *et al*., 2009), it is not expected that the basin is of conservation importance to the species. Further, given its reported key threats are Cane Toads and habitat modification due to over-grazing by cattle and inappropriate fire regimes, the inundation of the basin is not expected to significantly impact the species.

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[35]	Survey recommendation	Justification
Tiliqua scincoides intermedia	Northern Blue-tongue Skink	NT: Least Concern; Nat.: Critically Endangered	Minor	No	Preliminary potential habitat mapping for the species, based on the habitat description in the species' Conservation Advice, suggests that there are areas of potential habitat for the species. These occur primarily along relatively well-vegetated creeks which may provide some pockets of shelter and refuge from adjacent hotter and drier habitats. However, frequent fires occur across the basin and the riparian vegetation in the basin is not immune to these fires. Creeks are ephemeral and riparian vegetation is relatively narrow. Very few areas within the basin would be described as providing 'cool and moist conditions' during the dry season. A good example of a 'cool and moist' creek line is at Bamboo Springs, approximately 700 m west of the western boundary of the 32 m inundation line along the Marrakai Track. In addition, of the 55 cameras deployed in 2019 and 24 in 2020, 29 and 11, respectively, were in or adjacent to areas of potential refuge habitat for the species (noting that this species was not targeted during surveys). The species was not detected, including at cameras placed in the vicinity of Bamboo Springs. Of note, Cane Toads were recorded at most of these riparian camera sites during 2019. Cane Toads are reported to be the greatest threat to the species (DCCEEW, 2023b). Cats and Pigs were also recorded on 10 and 17 cameras, respectively, during 2019, primarily along creek lines. It is noted that baited remote cameras are an effective survey method, amongst others (DCCEEW, 2023b). In general, it appears as though there is a low likelihood of the species occurring within the basin based on the analysis of habitats, fire frequency, survey results and records elsewhere in the species range where Cane toads also occur. Further, given the current and persistent threats to the species within the basin, apparently marginal habitat, and its lack of detection during 2019 and 2020, it is not expected that a significant impact to the species is likely. A detailed impact assessment for the species is in **Section 4.4.2.2**.

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[35]	Survey recommendation	Justification
Varanus mitchelli	Mitchell's Water Monitor	NT: Vulnerable; Nat.: Critically Endangered	Insignificant	No	The species may occur infrequently in the AROWS basin, however, given it was not detected by ecologists or cameras in 2019 and 2020, it is not expected to be present in high densities. Merten's Water Monitor is assessed in further detail in **Section 4.3.2.7** and it is expected that an assessment for Mitchell's Water Monitor would result in a similar conclusion given their similar habitat preferences and co-occurrence in freshwater habitats (de Laive *et al*., 2021). It may be plausible to suggest that a positive impact on the species will result from the inundation of the basin due to the creation of more suitable habitats.

Table 33 Preliminary assessment of inherent risk level for potentially occurring threatened species listed under the TPWC Act only

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[36]	Survey recommendation	Justification
Threatened Plants					
Cleome insolata	Spider Flower	NT: Vulnerable; Nat.: Not listed	Minor	Yes	A significant impact is possible if a sub-population is present. Further survey is recommended, noting that only small areas of potential habitat exist.
Typhonium praetermissum	-	NT: Vulnerable; Nat.: Not listed	Moderate	Yes	A significant impact is possible if a sub-population is present. Further survey is recommended, noting the survey is dependent on updated habitat distribution modelling provided by the NT Government.
Utricularia dunstaniae	Bladderwort	NT: Vulnerable; Nat.: Not listed	Minor - Moderate	Yes	A significant impact is possible if a sub-population is present. Further survey is recommended, noting that only small areas of potential habitat exist.

[36] *That is, if individuals or a population of the species occurs on the site, what is the maximum anticipated level of impact to the aspects listed in **Table 9**?*

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[36]	Survey recommendation	Justification
Utricularia singeriana	Bladderwort	NT: Vulnerable; Nat.: Not listed	Minor – Moderate	Yes	A significant impact is possible if a sub-population is present. Further survey is recommended, noting that only small areas of potential habitat exist.

4.4.2 Detailed Impact Assessment

Following on from the preliminary risk assessment in **Section 4.4.1**, a more detailed risk assessment has been conducted for species that were concluded as potentially being impacted at a 'minor' or greater level, except those species where further survey was recommended due to gaps in survey data (i.e. there is uncertainty in relation to the species presence or absence in the basin). The detailed risk assessment of impacts is conducted against the criteria contained within the EPBC Act *Significant Impact Guidelines* (DoE, 2013). It includes only the Red Goshawk. Species that were recommended to be further surveyed to better understand the level of potential impact are:

- *Typhonium praetermissum*
- Spider Flower (*Cleome insolata*)
- *Utricularia dunstaniae*
- *Utricularia singeriana*
- Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus*)

Following these surveys (if they proceed), the assessment of impacts against the criteria contained within the EPBC Act *Significant Impact Guidelines* (DoE, 2013) can be conducted.

4.4.2.1 Red Goshawk

The following assessment has been conducted on the assumption that the species may occur in the area. The species was not targeted, nor detected, during the surveys from 2019 to 2022. However, given it is known to occur across the top end of the NT and has been recorded within 20 km of the basin, it has been assessed here. It is noted that ecologists generally watched for all fauna during the surveys, including raptors. Species such as Whistling, Black and Square-tailed Kites, Black-breasted Buzzards, Brown Goshawks, Brown Falcons and Swamp Harriers were recorded between 2019 and 2022. No Red Goshawks were detected, providing some indication of their potential absence or low density across that area.

Survey Results

The species was not detected within the basin, noting that it was not a target species given it was originally concluded that only marginally suitable foraging (not nesting) habitat was present within the basin (EcOz, 2018).

Conservation Status

The conservation status of the Red Goshawk is listed as:

- Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976*.
- Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999* (last assessed: 2023).
- Endangered on the IUCN Red List of Threatened Species (last assessed: 19 November 2021).

Local and NT-wide Records

As of August 2023, a total of 488 records of the species exists in the NT Fauna Atlas, of which eight are within 20 km of the AROWS basin. The species occurs across much of northern Australia.

Significance of the Habitat

Red Goshawks mostly occur in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers, and the edges of rainforests (Marchant & Higgins 1993, cited in DCCEEW, 2023a). Red Goshawks are reported to typically nest in tall trees (>20 m) in proximity to, or along, a watercourse or wetland (DCCEEW, 2023a). They have large home ranges with reports of individuals flying up to 10 km from a nest with breeding home ranges of up to 200 km^2 (DCCEEW, 2023a). DCCEEW (2023a) reports a study by MacColl and others (2021) that tracked Red Goshawks travelling over 1,500 km and over 1 km high.

The EPBC Act Conservation Advice for the species (DEECCW, 2023) defines habitat critical to the survival of the species. These definitions, and an assessment of habitats within the basin against these definitions, are shown in **Table 34**. Based on these definitions, it is suggested that the entire basin could be defined as foraging habitat and up to approximately 554 ha of breeding habitat. Breeding habitat has been calculated using the following vegetation communities that occur within 2.5 km of the Adelaide River (which all have tree height descriptions of 'mid'):

- E1 - *Eucalyptus miniata, Erythrophleum chlorostachys, Corymbia confertifolia* mid woodland; *Livistona humilis, Terminalia ferdinandiana, Planchonia careya* mid sparse shrubland; *Heteropogon triticeus, Sorghum intrans, Mnesithea rottboellioides* tall open tussock.
- E3 - *Eucalyptus tectifica, Corymbia grandifolia, Erythrophleum chlorostachys* mid open woodland; *Livistona humilis, Terminalia ferdinandiana, Cycas armstrongii* mid sparse shrubland; *Heteropogon triticeus, Sorghum intrans* tall open tussock grassland.
- E4 - *Corymbia grandifolia, Erythrophleum chlorostachys, Corymbia confertifolia* mid open woodland; *Terminalia grandifolia, Livistona humilis* mid sparse shrubland; *Sorghum plumosum, Sorghum intrans, Heteropogon triticeus* tall open tussock grassland.
- W1a - *Melaleuca cajuputi, Corymbia bella, Terminalia platyphylla* mid open forest; *Terminalia platyphylla, Melaleuca cajuputi, Planchonia careya* sparse shrubland; *Mnesithea rottboellioides, Germainia grandiflora* tall closed tussock grassland.
- W1b - *Melaleuca leucadendra, Acacia auriculiformis, Corymbia polycarpa* mid open forest; *Corymbia bella, Terminalia platyphylla* mid sparse shrubland; *Stachytarpheta* spp., *Flacourtia territorialis, Mnesithea rottboellioides* low sparse shrubland.
- W1c - *Lophostemon grandiflorus, Acacia auriculiformis, Erythrophleum chlorostachys* mid open forest; *Pandanus spiralis, Planchonia careya, Livistona humilis* tall open shrubland; *Sarga* spp. (annual), *Heteropogon triticeus, Chrysopogon latifolius* tall tusssock grassland.
- W2b - *Lophostemon grandiflorus, Corymbia bella, Melaleuca viridiflora* mid open woodland; *Pandanus spiralis, Planchonia careya, Hakea arborescens* sparse shrubland; *Arundinella nepalensis, Germainia grandiflora* tall closed tussock grassland.
- W4 - *Corymbia bella, Erythrophleum chlorostachys, Corymbia polycarpa* mid open woodland; *Planchonia careya, Terminalia grandiflora, Livistona humilis* sparse shrubland; *Sorghum plumosum, Chrysopogon fallax* tall open tussock grassland.

The limitations to this include:

- The NVIS classification system structural information classes define 'mid' level trees as being 10-30 m tall. Therefore, it is unclear where congregations of trees greater than 14 m (or 20 m) are present within the basin (as defined as being suitable for nesting in the species' EPBC Act Conservation Advice (DCCEEW, 2023a).
- The 2.5 km distance from a watercourse used in the *Conservation Advice* is assumed to be an estimate and therefore the calculations used for the AROWS basin vegetation communities within that distance should also be seen as an estimate.
- An escarpment occurs between the AROWS basin and the Adelaide River, which may affect the choice of nest placement by Red Goshawks.
- There are other water courses within the basin, though none are permanent (hence the Adelaide River has been used as the focus water course).

It should also be noted that a key threat to the species is habitat degradation through the draining of wetlands (DCCEEW, 2023a). While the impact of the extraction of water from the Adelaide River on the Adelaide River floodplains is not considered here, the creation of lacustrine habitats within the basin is likely to create suitable habitat that will be utilised by potential prey species of the Red Goshawk.

Table 34 Assessment of habitat critical to the survival of the Red Goshawk using the definitions provided in the species EPBC Act Conservation Advice (DCCEEW, 2023a)

Criteria	Assessment
Foraging habitat	
Coastal and subcoastal tall open forests and woodlands	**Likely** – the AROWS basin contains coastal and subcoastal tall open forest and woodlands and tropical savannas traversed by wooded or forested creeks, and some small and marginal areas of freshwater wetlands.
Tropical savannas traversed by wooded or forested creeks and rivers	
Freshwater wetlands and their margins	
Edges of rainforest	
Breeding habitat	
Areas with large, tall trees (>14 m) within proximity to a watercourse (within 2.5 km), that occur within foraging habitat.	**Likely** – Analysis of vegetation mapping indicates that various *Eucalyptus*, *Malaleuca* and *Corymbia* woodlands and open woodlands of heights from 10 to 30 m exist within 2.5 km of the Adelaide River. Watercourses exist within the AROWS basin, though Adelaide River has been used here given it has permanent water.
Particularly important breeding habitat includes: - Riparian vegetation supporting tall stands of remnant paperbark trees (*Melaleuca* sp.) with horizontal limbs along watercourses.	**Possible** – riparian vegetation along the eastern creek lines of the basin, especially in or near the intake corridor, may contain tall (>14 m) stands of remnant paperbark trees.
- Tall dry woodlands in proximity to watercourses with Darwin stringybark (Eucalyptus tetrodonta) dominated woodlands the primary breeding habitat across northern Australia.	**Possible** – while no specific areas of *E. tetrodonta* dominated woodland are mapped within 2.5 km of the Adelaide River within the basin, there is a small patch of *E. tetrodonta* woodland approximately 3 km from the Adelaide River (just south of the Marrakai Track).
These breeding habitats are often found in areas of topographic ruggedness such as plateaus or gorges where breeding can occur on elevated country in dry woodlands or on lower creek systems.	**Possible** – the AROWS basin is surrounded by escarpment.

Potential Impacts

Potential adverse impacts to the Red Goshawk include a loss of up to approximately 1,800 ha of foraging habitat, which the species may use occasionally, and possibly up to approximately 550 ha of breeding habitat (using the definitions in **Table 34** and noting the limitations in the previous section).

However, potential breeding habitat described here may not contain many 'tall' trees. Further, the 'new' habitats created by the basin are expected to constitute foraging and breeding habitat also (refer to the '**Significance of the Habitat**' section above). Therefore, these figures are likely to be less.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Red Goshawk, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 15**. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Based on this analysis, it appears unlikely that the AROWS project will significantly impact the Red Goshawk.

Table 35 Significant impact assessment for the Red Goshawk

Significant Impact Criteria for endangered species	Assessment of likelihood
Lead to a long-term decrease in the size of a population	**Unlikely** – While there will be a loss of some foraging and breeding habitat, new foraging and breeding habitat will be created. Given the species is wide-ranging, individuals have large home ranges (and foraging distances), and there is expected to be some transition of habitats to habitats that the species can utilise, it is not expected that the population will decline because of the AROWS project. It is noted that the EPBC Act *Conservation Advice* (DCCEEW, 2023) indicate that all individuals of the species exist in one large subpopulation spread over an extremely large area.
Reduce the area of occupancy of the species	**Unlikely** - The current area of occupancy is estimated to be 134,000 km^2 (MacColl *et al*., 2021, cited in DCCEEW, 2023). While an estimated 18 km^2 of foraging habitat and 5.5 km^2 of breeding habitat exists within the AROWS basin, the perimeter of the basin will transition to a riparian zone that will also contain foraging and breeding habitat. Importantly, it would be expected that the species can still use the area and, as such, its area of occupancy is not expected to reduce.
Fragment an existing population into two or more populations	**Unlikely** – It is stated within the EPBC Act *Conservation Advice* (DCCEEW, 2023) that all individuals of the species exist in one sub-population spread over an extremely large area.
Disrupt the breeding cycle of a population	**Unlikely** – The species breeding season is reported to be May to October in northern Australia (DEECCW, 2023). While construction activities may disturb locally nesting individuals, the population as a whole will not be disrupted.
Adversely affect habitat critical to the survival of a species	**Unlikely but uncertain** – It is unclear whether there will be an overall residual loss of habitat critical to the survival of the species given the transition of some of the basin to habitats that are likely to, at least in the long term, constitute suitable foraging and breeding for the species. The positive impact from the creation of lacustrine habitats may, to some extent, be favourable for the species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – It is unlikely that the species is likely to decline as a result of the loss or modification of habitats because: - There are very few records of the species within 20 km. - There is likely to be a transition of some habitats to suitable foraging and breeding habitat given that the basin will contain a new permanent water source for the species.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**Unlikely** – Several invasive grasses are already present in the basin. Earth moving or other activities may exacerbate the spread of invasive grasses in localized areas within the basin. Consequently, a slight increase in risks to the local population or habitat quality is possible though this is not likely to be substantial.
Introduce disease that may cause the species to decline	**Unlikely**
Interfere substantially with the recovery of the species	**Unlikely** – Based on the wide distribution of the species and the transition of habitats (rather than a complete loss), it appears unlikely that the AROWS project will interfere substantially with the recovery of the species.

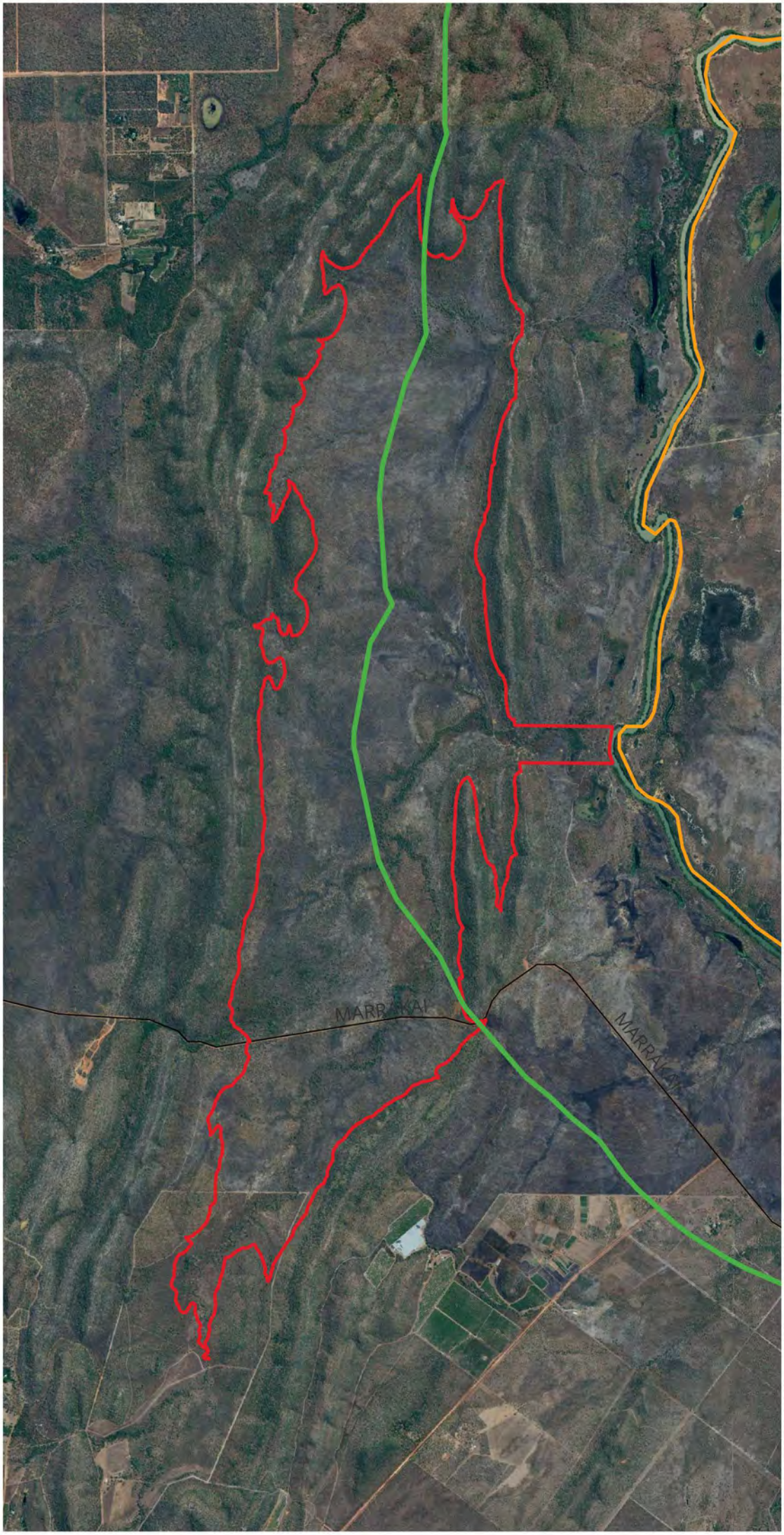

Figure 10
-
2.5 km buffer of the Adelaide River

Key

- 2.5 km buffer of Adelaide River
- Adelaide River
- NT government roads
- AROWS basin (32 m inundation line) and intake corridor

Background - Google Satellite

N

0 0.5 1 1.5 2 km

1:50,000

Client: GHD Pty Ltd
Author: M. Proos
Geodatum: GDA94 / Z52
25 October 2023

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4.4.2.2 Northern Blue-tongue Skink

The following assessment has been conducted on the assumption that the species may occur in the area, albeit at a low density. The species was not targeted, nor detected, during the surveys from 2019 to 2022. Given that the species is known to occur across the top end of the NT and has been recorded within 20 km of the basin, it has been assessed in further detail here.

Survey Results

The species was not detected within the basin, noting that it was not a target species given it was only listed under the EPBC Act in December 2023. However, cameras placed within potential refuge habitat for the species may have detected individuals if they occurred there.

Conservation Status

The conservation status of the Northern Blue-tongue Skink is:

- Critically Endangered under the national *Environment Protection and Biodiversity Conservation Act 1999* (last assessed: 2023).
- Least Concern on the IUCN Red List of Threatened Species (last assessed: 20 February 2017), noting that it is reported in the species profile that T. s. intermedia may be experiencing population declines (Shea, 2017).

It is not listed as a threatened species under the NT *Territory Parks and Wildlife Conservation Act*.

Local and NT-wide Records

As of August 2023, a total of 517 records of the species exists in the NT Fauna Atlas, of which eight are within 20 km of the AROWS basin. The species occurs across northern WA and NT.

Significance of the Habitat

While the species is known to occur in a wide variety of ecosystems, it is typically recorded in dense vegetation near seasonal or permanent water (Shea 1992; AWC unpublished data; DAC unpublished data; WAC unpublished data; cited in DCCEEW, 2023b). Habitat critical to the survival of the species is described in the EPBC Act Conservation Advice (DCCEEW, 2023b) as areas of dense vegetation that provide cool and moist conditions within otherwise hot, dry, and flammable landscapes that are within the historical distribution of the species. Examples include rainforests and vine thickets, riparian forests, well-vegetated creeks, gorges, and drainage lines, well-vegetated swamps, soaks, and springs, dense thickets within floodplains, grasslands, shrublands, savannas and woodlands, shady thickets in rocky ranges and gorges, well-watered and well-vegetated gardens. An assessment of habitats within the basin against the definition in the Conservation Advice is shown in **Table 36**.

Based on this definition, it is suggested that the habitats along creek lines and some other small pockets within the basin could comprise potential refuge habitat for the species. A total of 160 ha of this habitat occurs using the following vegetation communities:

- U2 – *Canarium australianum*, *Erythrophleum chlorostachys*, *Corymbia bella* mid closed forest; *Syzygium suborbiculare*, *Planchonia careya*, *Clerodendrum floribundum* mid sparse shrubland; *Hyptis suaveolens*, *Flacourtia territorialis* low sparse shrubland.
- U3 – *Bambusa arnhemica* low closed forest.
- W1a – *Melaleuca cajuputi, Corymbia bella, Terminalia platyphylla* mid open forest; *Terminalia platyphylla, Melaleuca cajuputi, Planchonia careya* sparse shrubland; *Mnesithea rottboellioides, Germainia grandiflora* tall closed tussock grassland.
- W1b – *Melaleuca leucadendra, Acacia auriculiformis, Corymbia polycarpa* mid open forest; *Corymbia bella, Terminalia platyphylla* mid sparse shrubland; *Stachytarpheta* spp., *Flacourtia territorialis, Mnesithea rottboellioides* low sparse shrubland.

- W1c – *Lophostemon grandiflorus, Acacia auriculiformis, Erythrophleum chlorostachys* mid open forest; *Pandanus spiralis, Planchonia careya, Livistona humilis* tall open shrubland; *Sarga* spp. (annual), *Heteropogon triticeus, Chrysopogon latifolius* tall tusssock grassland.
- W2b – *Lophostemon grandiflorus, Corymbia bella, Melaleuca viridiflora* mid open woodland; *Pandanus spiralis, Planchonia careya, Hakea arborescens* sparse shrubland; *Arundinella nepalensis, Germainia grandiflora* tall closed tussock grassland.

Table 36 Assessment of habitat critical to the survival of the Northern Blue-tongue Skink using the definition provided in the species EPBC Act Conservation Advice (DCCEEW, 2023b)

Examples of habitat	Assessment
Areas of dense vegetation that provide cool and moist conditions within otherwise hot, dry, and flammable landscapes that are within the historical distribution of the Northern Blue-tongue Skink, such as:	
Rainforests and vine thickets	**Possible** – No rainforest or vine thickets occur within the 32 m inundation boundary, however one small area of closed forest (vegetation unit U2) occurs in the far north-western section of the basin bordering the 32 m inundation boundary. This is not ordinarily considered a rainforest (or vine thicket), though would still provide extended shade and somewhat cooler conditions for animals.
Riparian forests	**Possible** – Riparian vegetation along the eastern creek lines of the basin, including in the intake corridor, contain some patches of dense vegetation. These are mapped as 'open forests' (vegetation units W1a and W1b) though are relatively narrow and not immune from frequent fires, indicating their relatively simple composition and limited extent.
Well-vegetated creeks, gorges, and drainage lines	**Likely** – Some creek lines, mostly in the eastern part of the basin, are relatively densely vegetated (vegetation units W1a and W1b). However, all are ephemeral and bordered by relatively narrow riparian vegetation which is not immune to frequent fires. Relatively few, if any, would be characterized as 'cool and moist' in comparison to the adjacent Bamboo Springs (which occurs outside the 32 m inundation boundary). No gorges occur within the 32 m inundation line though a small area at the base of the escarpment incline occurs in the far north-west part of the basin. This area contains a closed forest (vegetation community U2), providing relatively good shading for animals.
Well-vegetated swamps, soaks, and springs	**Unlikely** – None are known to occur within the 32 m inundation line. The creek line downstream of Bamboo Springs is seasonally saturated and contains dense grassy areas though little mid-storey species.
Dense thickets within floodplains, grasslands, shrublands, savannas and woodlands	**Possible** – While some relatively dense vegetation thickets may occur within the basin, these are isolated, small, not immune from frequent fire and not associated with significant rocky outcrops to provide alternative refuge from fire. Some are dominated by Gamba Grass and Pandanus.
Shady thickets in rocky ranges and gorges	**Possible –** One small area potentially meeting this definition is a patch of *Canarium australianum*, *Erythrophleum chlorostachys* and *Corymbia bella* closed forest surrounded by boulders at the base of the escarpment in the far north-west of the basin (refer to vegetation unit U2). Like much of the basin, this area has a mostly open understorey.
Well-watered and well-vegetated gardens	**Unlikely –** No well-watered and well-vegetated gardens are known to occur within the 32 m inundation boundary.
Non-vegetated areas that provide shelter from thermal extremes, fire, and predators are also habitat critical to the survival of the northern blue-tongue skink, such as:	
Areas with deep rocky crevices and underground burrows	**Unlikely** – No significant rocky outcrops are known to occur within the 32 m inundation boundary.

Potential Impacts

As described in the species' Conservation Advice (DCCEEW, 2023b), threats to the Northern Blue-tongue Skink are Cane Toads, Cattle, Pigs, Cats, frequent severe fires, mining, water drawdown, inundation, illegal collection and traditional hunting. Of these, exotic invasive species and frequent fires, at least, are present within the basin and are likely to have had a moderate to major impact on any population that does occur or may have occurred there.

Therefore, potential adverse impacts to the species as a direct result of the AROWS project include a loss of up to approximately 160 ha of potential refuge habitat, noting that the species has not been detected within the basin. Associated impacts may include fragmentation of habitats.

Significance of Potential Impacts

To assist in determining the significance of potential impacts to the Northern Blue-tongue Skink, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken, as shown in **Table 15**. Based on this analysis, it appears unlikely that the AROWS project will significantly impact the Northern Blue-tongue Skink.

Table 37 Significant impact assessment for the Northern Blue-tongue Skink

Significant Impact Criteria for critically endangered species	Assessment of likelihood
Lead to a long-term decrease in the size of a population	**Unlikely** – While there will be a loss of some marginal refuge habitat, some key threats to the species already occur within the basin and will continue to occur irrespective of whether the AROWS project proceeds. In addition, inundation is listed as a threat of minor consequence to the species. The species has also not been detected within the basin, probably related to the presence of the species' key threats. Based on this, it is not expected that the population will decline because of the AROWS project if one occurs there.
Reduce the area of occupancy of the species	**Unlikely** – The species has not been detected within the basin and it may be reasonable to suggest it does not occur there based on the presence of key threats including invasive species and frequent fires. While an estimated 160 ha of potential refuge habitat exists within the AROWS basin, the perimeter of the basin will transition to a riparian zone that may also contain potential refuge habitat. As such, its area of occupancy is not expected to reduce.
Fragment an existing population into two or more populations	**Unlikely** – Potentially suitable habitat surrounds the basin and, apart from a loss of some potential habitat, it is not expected that a population will be fragmented. In addition, no individuals have been detected within the basin.
Disrupt the breeding cycle of a population	**Possible** – Mating is suggested to be August to September, followed by a 3–4 month gestation period (DCCEEW, 2023b). If individuals are present, some disruption to their breeding cycle may occur. The inundation cycle of the basin is not known however given the condition of habitats within the basin, and lack of individuals detected, it may be reasonable to suggest that very few, if any, individuals would be affected in this manner.
Adversely affect habitat critical to the survival of a species	**Unlikely but uncertain** – It is unclear whether there will be an overall residual loss of habitat critical to the survival of the species given the transition of some of the basin to habitats that may, at least in the long term, constitute potential sheltering habitat for the species. The positive impact from the creation of lacustrine habitats may, to some extent, be favourable for the species. In addition, it is unclear if habitats within the basin are critical to the species survival given their condition, vegetation composition and extent and apparent effect from current known threats.

Significant Impact Criteria for critically endangered species	Assessment of likelihood
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – It is unlikely that the species is likely to decline as a result of the loss or modification of habitats because it is not clear if critical habitat exists within the basin and potential refuge habitat may be created from the inundation of the basin.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	**Unlikely** – Several invasive species are already prevalent in the basin including Cane Toads, Pigs and Cats.
Introduce disease that may cause the species to decline	**Unlikely**
Interfere substantially with the recovery of the species	**Unlikely** – Based on the wide distribution of the species and the transition of habitats (rather than a complete loss), it appears unlikely that the AROWS project will interfere substantially with the recovery of the species. Inundation of habitats from projects such as the AROWS project is thought to be of minor consequence to the species (DCCEEW, 2023b).

4.5 Migratory Species

To inform a decision on whether each potentially occurring migratory species should be surveyed within the basin or intake corridor, a preliminary assessment of the inherent risk to each species has been undertaken here. It provides useful information in relation to the quality or importance of habitats as well as whether a significant impact is possible.

There are 16 migratory species with the potential to occur within AROWS basin and intake corridor, as assessed in **Section 3**. As per the *EPBC Act Significant Impact Guidelines* (DoE, 2013), an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

4.5.1 Migratory Shorebirds (Migratory Wetland Species)

Using the criteria in the *EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE, 2017), the AROWS basin and intake corridor are unlikely to constitute 'important habitat' for migratory shorebirds, as described in Table 38. In addition, based on the criteria for assessing the significance of a potential impact, no migratory shorebirds are expected to be significantly impacted by the loss or modification of habitats within the AROWS basin or intake corridor, as assessed in **Table 40**.

Table 38 Assessment of 'important habitat' for migratory shorebirds

Criteria	Response
Does the shorebird area support:	
a) at least 0.1 per cent of the flyway population of a single migratory shorebird species, or	**Unlikely –** Based on the small number of records of migratory shorebirds within 20 km of the AROWS basin (probably partly reflecting the limited areas of suitable habitats), the nature and small area of potential habitat within the AROWS basin and the abundance of higher quality habitat in the region (e.g., beaches, coastal mudflats, wetlands and floodplains), it is unlikely that 0.1% of the flyway population of any shorebird species would utilise the AROWS basin. The 0.1% population estimates are provided in **Table 39**. A small ephemeral wetland (<2.0 ha) is present within the intake corridor however approximately half is overrun by Mimosa (*Mimosa pigra*) (Astrebla, 2019), a Weed of National Significance and the other half is comprised of a *Melaleuca cajaputi* open forest (Astrebla, 2019). Several larger areas containing hydrosol soils that are seasonally saturated or inundated occur in the basin, primarily in the northern half, though these are grasslands and would provide limited habitat for foraging migratory shorebirds.
b) at least 2000 migratory shorebirds, or	**Unlikely –** Based on the small number of records of migratory shorebirds within 20 km of the AROWS basin, the nature and small area of potential habitat and the likely abundance of higher quality habitat in the region (e.g., coastal wetlands and floodplains), it is unlikely that 2,000 migratory shorebirds would utilise the AROWS basin at any given time.
c) at least 15 migratory shorebird species	**Unlikely –** It is unlikely that 15 or more migratory bird species would utilise the AROWS basin at any given time given the nature and small area of the habitats within the basin and their proximity to other larger and more suitable wetlands in the region.

Table 39 Flyway, 1% and 0.1 % population estimates for migratory shorebirds that potentially occur in the AROWS basin and intake corridor (sourced from Hansen et al, 2016)

Species	Common name	Population estimate	1% flyway population	0.1% flyway population
Actitis hypoleucos	Common Sandpiper	190,000	1,900	190
Calidris acuminata	Sharp-tailed Sandpiper	85,000	850	85
Calidris ferruginea	Curlew Sandpiper	90,000	900	90
Calidris melanotos	Pectoral Sandpiper	1,220,000 (min)	12,200	1,220
Charadrius leschenaultii	Greater Sand Plover	200,000-300,000	2,000	200
Charadrius veredus	Oriental Plover	230,000	2,300	230
Glareola maldivarum	Oriental Pratincole	2,880,000	28,800	2,880
Tringa nebularia	Common Greenshank	110,000	1,100	110

Table 40 Assessment of significant impacts to migratory shorebirds

Criteria	Response
Is there a real chance or possibility that the proposed activity will:	

Criteria	Response
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Unlikely –** The AROWS basin is not considered to constitute important habitat for migratory shorebirds (as assessed in **Table 38**).
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Unlikely –** The site is not considered to constitute important habitat for migratory shorebirds (as assessed in **Table 38**). There are already Cane Toads and numerous exotic flora species in and around the basin (Connect Environmental, 2019).
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Unlikely** – The AROWS basin is not expected to support an ecologically significant proportion of the species within the AROWS basin (refer to **Table 39** for ecologically significant proportions).

4.5.2 Other Migratory Birds

For the other seven potentially occurring migratory bird species, the *Draft referral guideline for 14 migratory birds listed under the EPBC Act* (DoE, 2015) describes 'important habitat' for these species (also summarized in **Appendix B**) as well as 'ecological significant proportions' of populations (**Table 39**). Using these habitat descriptions, the AROWS basin may contain important habitat for each species. However, analysis of the potential for significant impact to each species using both habitat area and ecologically significant population thresholds (**Table 39**) indicates that no species is likely to be significantly impacted by the loss of habitats within the AROWS basin and intake corridor and subsequent transformation to a lacustrine habitat.

Table 41 Ecologically significant proportions, number of local records and potential for significant impact for the potentially occurring migratory non-shorebird species

Species	Common name	Ecologically significant proportion of a population threshold[37]		Habitat area thresholds (ha)		Records within 20 km of the AROWS basin (as of August 2023)	Potential for significant impact
		1% (internationally important)	0.1% (nationally important)	1% (upper threshold)	0.1% (lower threshold)		
Regular non-breeding migrants							
Apus pacificus	Fork-tailed Swift	1,000	100	*	*	43[38]	**Unlikely** – While it is possible that flocks of over 100 individuals are found within the vicinity of the AROWS basin (based on the analysis of historic records), it is probably unlikely that the transformation of habitats within the basin to a lacustrine (lake) habitat would substantially alter their abundance or distribution in the local area (i.e., **seriously** disrupt an ecologically significant proportion of the population). Across its range, it is considered that there is no evidence of declines or substantial threats (Birdlife International, 2019).
Cuculus optatus	Oriental Cuckoo	10,000	1,000	250,000	25,000	9	**Unlikely** – Habitat area threshold not met and ecologically significant proportion thresholds unlikely to be met given the paucity of local records.
Extremely uncommon migrants							
Cecropis daurica	Red-rumped Swallow	10,000	1,000	*	*	0	**Unlikely** – Numbers of individuals within the AROWS basin would be so small relative to their global populations that a significant impact is unlikely (DoE, 2015).
Hirundo rustica	Barn Swallow	10,000	1,000	*	*	1	

[37] *As per Table 5 of the Draft referral guideline for 14 migratory birds listed under the EPBC Act (DoE, 2015).*

[38] *Some of these records were of tens or hundreds of birds.*

Species	Common name	Ecologically significant proportion of a population threshold[37]		Habitat area thresholds (ha)		Records within 20 km of the AROWS basin (as of August 2023)	Potential for significant impact
		1% (internationally important)	0.1% (nationally important)	1% (upper threshold)	0.1% (lower threshold)		
Motacilla cinerea	Grey Wagtail	10,000	1,000	-	-	0	**Unlikely** – Numbers of individuals within the AROWS basin would be so small relative to their global populations that a significant impact is unlikely (DoE, 2015).
Motacilla flava	Yellow Wagtail	10,000	1,000	-	-	0	
Migratory flycatchers							
Rhipidura rufifrons	Rufous Fantail (Arafura)	2,200	219	4,500	450	81	**Unlikely** – Mapping of potentially suitable habitat within the AROWS basin and intake corridor indicates that, at most[39], 162 ha is present (refer to **Figure 11**). Therefore, the 0.1% area threshold is not met (noting that suitable habitat is also likely to be eventually created as a result of the AROWS basin inundation). DoE (2015) assumes a mean bird density of 0.18 birds/ha (range 0.02-2.66), therefore approximately 29 birds (0.18x162; range of 3-430 birds) may occur within the basin and intake corridor. This number is likely to be less given that the area of potentially suitable habitat is probably an overestimate (refer to footnote) and that there are likely to be additional habitats created as a result of the AROWS development.

[39] Mapped potentially suitable habitat uses riparian or wet forest vegetation communities as surrogates for suitable habitat as described in the Draft referral guideline for 14 migratory birds listed under the EPBC Act (DoE, 2015). However, based on the author's experience on site, it is unlikely that all these vegetation communities meet the reported structural features of suitable habitat (including a moderately dense canopy cover often with two lower strata: a 2-6 m high layer and a shrubby or heath understorey 1-2 m high (DoE, 2015 (in Appendix A of that document)) given the relatively high fire frequency and abundance of pigs along creeks within the basin. The area of actual suitable habitat is probably far less.

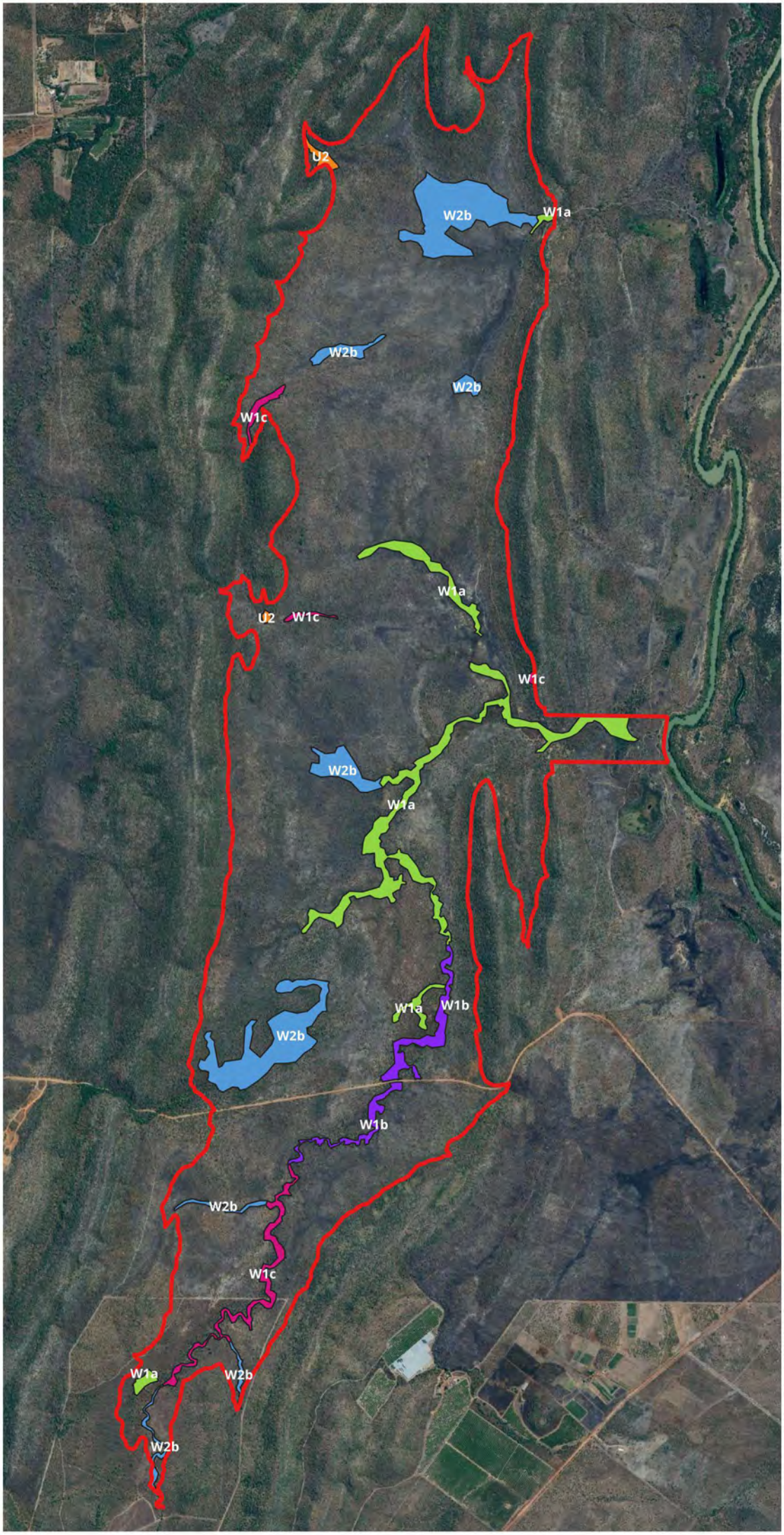

Figure 11

Potentially suitable habitat for the Arafura Fantail within the AROWS basin and intake corridor

Key

Arafura Fantail potential habitat

- U2 Canarium australianum, Erythrophleum chlorostachys, Corymbia bella closed forest
- W1a Melaleuca cajuputi, Corymbia bella, Terminalia platyphylla fringing open forest
- W1b Melaleuca leucadendra, Acacia auriculiformis, Corymbia polycarpa fringing open forest
- W1c Lophostemon grandiflorus, Acacia auriculiformis, Erythrophleum chlorostachys fringing open forest
- W2b Lophostemon grandiflorus, Corymbia bella, Melaleuca viridiflora open woodland
- AROWS inundation area (32 m AHD) and intake corridor

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
27 August 2023

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4.5.3 Migratory Marine Species

The only migratory marine species listed in the PMST report with the potential to occur within the basin or intake corridor, as assessed in **Section 3**, is the Salt-water Crocodile (*Crocodylus porosus*). It appears unlikely that habitats within the AROWS basin or intake corridor are 'important', as discussed in **Table 42**.

Table 42 Assessment of 'important' habitat within the AROWS basin and intake corridor for the Salt-water Crocodile

Criteria	Response
a. Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or	**Unlikely –** Without detailed analysis, it is unclear whether the region supports an ecologically significant proportion of a population of Salt-water Crocodiles. However, it may be plausible to suggest that, at least occasionally, Salt-water Crocodiles are present within the larger creeks or wetlands nearer to the Adelaide River, particularly the creek / billabong at the intersection of the intake corridor and basin proper, or the small ephemeral wetland (<2.0 ha) within the intake corridor. The ephemeral wetland within the offtake corridor is dominated by *Melaleuca cajaputi*, *Corymbia bella* and *Terminalia platyphylla* open forest or *Mimosa pigra* low open forest (Astrebla, 2019). The distances from the Adelaide River to the creek / billabong at the intersection between the intake corridor and basin and the ephemeral wetland in the intake corridor are approximately 850 m and 300 m respectively. Salt-water Crocodile nests are known to occur hundreds of metres from permanent water (Webb *et al*., 1977). A targeted crocodile survey within the AROWS basin or intake corridor was not conducted, although no crocodiles were incidentally observed by cameras or ecologists (Connect Environmental, 2019). The basin is not known to contain any permanent surface water, however Bamboo Springs on the western side of the basin is thought to flow year-round (Connect Environmental, 2019). Given that Salt-water Crocodiles are known to nest in freshwater communities including *Melaleuca* open forests (Fukuda & Cuff, 2013), further studies may be required to better assess the presence, or likelihood of occurrence, of the species within the basin or intake corridor. However, a preliminary assessment suggests that the habitats in these locations are not important given their limited extent, and the presence of pigs and Mimosa pigra, a weed of national significance.
b. Habitat that is of critical importance to the species at particular life-cycle stages, and/or	**Unlikely –** It is unlikely that habitats within the basin or intake corridor are of critical importance to the species at particular life-cycle stages because of the relatively small size and disturbed nature of these potentially suitable habitats.
c. Habitat utilised by a migratory species which is at the limit of the species range, and/or	**Unlikely –** The AROWS basin and intake corridor are not at the limit of the species range.
d. Habitat within an area where the species is declining.	**Unlikely** – The IUCN lists the population trend of the species as 'stable' with no severe fragmentations or decline of mature individuals (Webb *et al*, 2021).

Table 43 Assessment of significant impacts to the Salt-water Crocodile

Criteria	Response
Is there a real chance or possibility that the proposed activity will:	
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Unlikely** – The AROWS basin and intake corridor are unlikely to contain important habitat for the species (refer to **Table 42**).

Criteria	Response
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Unclear** – Key invasive species reported to threaten the species are Feral Pigs and Buffaloes and, potentially, Para Grass (*Urochloa mutica*) and Water Hyacinth (*Eichornia crassipe*) (Webb *et al*, 2021). Feral Pigs and Buffaloes are already present in the area.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Unlikely** – The loss of small areas of potential habitat within the AROWS basin and intake corridor are unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of the Salt-water Crocodiles.

5 Information Gaps and Recommendations

This section summarises the species for which further assessment is recommended to assess the potential more accurately for significant impact.

5.1 Species listed under the EPBC Act

5.1.1 Northern Quoll (Dasyurus hallucatus)

Species that potentially occupy the escarpment on either side of the basin may need to modify their movement patterns once the basin is inundated. For example, Northern Quolls that hunt in the basin will no longer have access to that woodland resource. However, the abundance and distribution of these species along the escarpment on either side of the basin is unclear. One Northern Quoll was detected on the escarpment above Bamboo Springs on the western side of the basin along the Marrakai Track in 2020, however none were detected within the basin despite extensive camera surveys. However, no substantial assessment of habitats has been conducted along the escarpment. It is recommended that, at least initially, further assessment of the habitat characteristics along the escarpment on at least the western side of the basin is conducted. The western side of basin appears to be more favourably positioned in relation to potential habitat for the species both locally (e.g., Bamboo Springs) and in the wider region (e.g., remnant vegetation and undulating topography surrounding Manton Dam). The assessment of impacts to the Northern Quoll in **Section 4.3.2.4** is focused on the AROWS basin only.

5.1.2 Bare-rumped Sheath-tail Bat (Saccolaimus saccolaimus)

The Bare-rumped Sheath-tail Bat (*Saccolaimus saccolaimus*) occurs across the monsoonal tropics of the NT (and Queensland and WA). It was not targeted during surveys from 2019 to 2022 in the AROWS basin. Given its potential presence there and apparent greater ability to detect the species using acoustic recordings in recent years, a survey may be warranted. Advice received by DEPWS (D. Milne, Pers. Comm., 29/11/2023) concurred.

5.2 Species listed under the TPWC Act only

Species considered to require further survey within the basin include (noting that partials surveys may have already been conducted):

- *Cleome insolata*
- *Typhonium praetermissum*
- *Utricularia dunstaniae*
- *Utricularia singeriana*.

5.3 Survey Planning

The results of this report (and the above consultation with relevant government agencies) will be used to prepare a revised survey plan for the basin. Other species which have already been recommended for further survey are described in the *Summary of Terrestrial Ecological Survey from 2019 to 2022, Adelaide River Off-stream Water Storage (AROWS) Project* (Connect Environmental, 2023, in prep.). Following the determination of the locations of the offtake and infrastructure corridors (expected to be late 2023 or early 2024), a subsequent analysis of the likelihood of occurrence of threatened and migratory species will be conducted for those areas and the results used to prepare a separate survey plan.

6 Conclusions and Recommendations

Noting the assessment limitations, the proposed AROWS project may significantly impact at least two threatened species – the endangered flora species *Helicteres macrothrix* and the endangered Black-footed Tree-rat. Both appear likely to experience substantial losses of individuals or suitable habitat which may lead to long-term population decreases, cause a reduction in their areas of occupancies, disrupt breeding cycles, adversely affect habitat critical to their survival or interfere with their recovery.

In addition, a third species – the endangered Red Goshawk – may experience a residual loss of habitat critical to its survival (as defined in the EPBC Act *Conservation Advice* for the species (DCCEEW, 2023a). However, it appears unlikely that the AROWS development will lead to a decline in the overall population of the species. Over the longer term, the creation of riparian habitats along the periphery of the lake may provide suitable breeding (and foraging) habitat for the species, and therefore the overall impact may not be significant (or may potentially be positive).

An assessment of unsurveyed or partially surveyed species (refer to **Section 5**) concluded that six additional species are recommended to be surveyed further to better define the significance of potential impacts to them. Following the completion of all surveys and the assessment of impacts, consideration of the necessity and acceptability of potential impacts will be required. This will require review of the project design and impact mitigation.

For *Helicteres macrothrix* and the Black-footed Tree-rat, consideration of the following is recommended:

- Investigate the viability of avoiding most of the basin population of *H. macrothrix*.
- For *H. macrothrix*, further research into the species distribution, habitat requirements, population size, factors limiting distribution, and/or threats to its survival (DEPWS, 2021c).
- Salvage seeds or plants of *H. macrothrix*.
- Conservation agreements to formally protect remaining populations of both species including monitoring and the management of threats.
- Investigate opportunities for ecological studies (e.g., with Charles Darwin University) on either species before, during and/or after impacts occur.
- Compensation (offsets) for the loss of individuals or suitable habitats.

Such recommendations should take into account the relevant conservation objectives in the EPBC Act Conservation Advices or NT threatened species factsheets found at https://nt.gov.au/environment/animals/threatened-animals and https://nt.gov.au/environment/native-plants/threatened-plants. Consultation with DEPWS and the Australian Government Department of the Environment is also recommended.

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8 Appendix A: DEPWS feedback on survey adequacy (dated June 2022)

The Flora and Fauna division has received a request from Power and Water Corporation to provide advice on the adequacy of survey methods used by ConnectEnviro to assess the presence of threatened flora and fauna within the project footprint of the Adelaide River Off-stream Waters Storage (AROWS) Project.

Flora

Six species of threatened flora are identified as potentially occurring within or nearby to the project footprint: *Cycas armstrongii*, *Goodenia quadrifida*, *Helicteres macrothrix*, *Stylidium ensatum*, *Typhonium praetermissum*, and *Utricularia singeriana*. This project has the potential to impact threatened species through habitat loss due to land clearing, inundation, and changes to hydrological regimes (water extraction).

Surveys for ***Cycas armstrongii*** (Vulnerable, TPWC Act) were conducted over 12 person-days (July, August 2019) along 215 km of walking meander transects through potentially suitable habitat (well-drained woodland on foothills and slopes) and in known areas of occurrence within the AROWS project area, Byers Rd potential offtake route, and spillway to Manton Gap potential route. Counts of individuals were taken during traverses, and used to estimate population densities within 1 ha grid-cells throughout the project area. No high or very high density stands of *Cycas armstrongii* were detected or predicted. The Division is of the opinion that the surveys were sufficient to infer that no impacts to high or very high density populations will occur as a result of inundation of the project area to 32 m AHD, or by development of the potential offtake routes. **The Division is satisfied with the survey methodology and effort for *Cycas armstrongii*.**

Surveys for ***Goodenia quadrifida*** (Vulnerable, EPBC Act) were conducted over 1 person-day (May 2019) along 7.7 km of random meander traverses walked within 12.8 ha of habitat identified as potentially suitable for this species (*Melaleuca nervosa* open woodland on estuarine floodplains). Flowering of a reference plant was confirmed in the week prior to survey. During 2019 surveys, an additional 18 ha of potentially suitable habitat was identified within the footprint of the potential offtake corridors; part of this area was searched on 14th May 2020, along 4 km of random meander traverses; potentially suitable habitat on the southern side of the Manton River was not accessible during the survey period. *Goodenia quadrifida* was not detected during surveys of potentially suitable habitat within the project area, during their period of flowering. The Division is of the opinion that the surveys were sufficient to infer that it is unlikely that *Goodenia quadrifida* occurs within project area. **The Division is satisfied with the survey methodology and effort for *Goodenia quadrifida*.**

Surveys for *Helicteres macrothrix* (Endangered, TWPC Act; Endangered EPBC Act) were conducted over 7 person days (May, August 2019) along 66.5 km of random meander traverses walked within 51.6 ha of suitable habitat (*Eucalyptus tectifica* woodland on Wildman Siltstone), and 100 ha of habitat identified as potentially suitable for this species, within the 32 m AHD inundation line in the project area. *Helicteres macrothrix* was detected within the project area, with an estimated area of occupancy of 24 ha. When *Helicteres macrothrix* plants were located, the extent of each patch was mapped and the number of

individuals (discreet stems) were counted (patches smaller than 8000 m^2). An estimate of plant density within the main patch (21 ha in area) was taken as the mean stem count from 60 quadrats randomly located within the patch. The population was estimated to contain between 28,466 and 143,653 individuals. In 2020, surveys were extended to areas outside of the 32 m AHD inundation zone adjoining the main 21 ha patch; a total of 40 km of transects were surveyed (June 2020) over nine person-days covering an area of 42 ha. Each individual plant was recorded and counted within the main population. Population estimates were revised using absolute count data and approximately 35,000 plants were estimated to occur within all of the patches surveyed, with 25,000 plants located within the 32 m AHD inundation line. **The Division is satisfied with the survey methodology for *Helicteres macrothrix*. The Division recommends that the survey area be extended to suitable habitat on the private property to the south of Koolpinyah Station, to provide density estimates within and outside of the 32 m AHD inundation zone to better contextualise the plants located within the basin.**

Surveys for ***Stylidium ensatum*** (Endangered, TPWC Act; Endangered EPBC Act) were conducted over 2 person days (July 2019) along random meander traverses walked within 53 ha of habitat identified as potentially suitable (*Melaleuca viridiflora* open woodland on margins of drainage areas in damp heavy clay or peaty soil) within the 32 m AHD inundation line in the project area. Flowering plants at a reference site was confirmed at the time of survey. *Stylidium ensatum* was not detected within the project area, and a visual comparison of habitat in the project area and habitat at the reference site was used to conclude that suitable habitat does not occur within the project area. **The Division is satisfied with the survey methodology and effort for *Stylidium ensatum*.**

Surveys for ***Typhonium praetermissum*** (Vulnerable, TWPC Act) and *Cleome insolata* (Vulnerable, TWPC Act) were not conducted within the project area. Revised modelling may indicate high likelihood of presence within the project area. **The Division will attempt to revise modelling at a later date but has no further recommendations at this stage.**

Surveys for ***Utricularia singeriana*** (Vulnerable, TPWC Act) were conducted over 4 person-days (May 2019) along 11 km of transects walked within habitat identified as potentially suitable (borders of seasonally inundated grassland and low open woodland). *Utricularia singeriana* was not detected within the project area in 2019, and a visual appraisal of habitat indicated that the timing of the survey was inappropriate for the detection of the species. Surveys were conducted within the project area in April and May 2020, and 55 km of transects were walked within areas identified as potentially suitable habitat within the project area. Two suspected individuals were observed at a reference site five days prior to the survey. *Utricularia singeriana* was not detected within the project area in 2020. **The Division is satisfied with the survey methodology for *Utricularia singeriana*. The private property to the south of Koolpinyah Station was not surveyed. The division recommends that surveys be undertaken within suitable habitat in parts of the project area to the south of Koolpinyah Station.**

Fauna

Masked owl: Surveys conducted in 2019 (June, October) and 2020 (March and May) across five sites and 37 call playback sessions across 10 nights.

Division is satisfied with the sampling method and effort for Masked Owl.

Mitchell's and Merten's Water Monitors: Cameras were set up to target Merten's and Mitchell's Water Monitors with a combined total of 1,217 camera trap nights (55 cameras) in 2019 and 2020. These consisted of cameras that had also been set up for Pale Field-rat, and along other water holes / courses and in lower branches of trees to target water monitors. Cameras were deployed as per TSSP and *Camera trapping SOP for the Top End Long-term Monitoring Program.*

Division is satisfied with the sampling method and effort for Mitchell's and Merten's Water Monitors.

Fawn Antechinus: A total of 2554 camera trap nights from 110 camera traps was used to target Fawn Antechinus and other mammals. Cameras were deployed as per TSSP and *Camera trapping SOP for the Top End Long-term Monitoring Program.*

Division is satisfied with the sampling method and effort for Fawn Antechinus.

Black-footed Tree-rat: A total of 2554 camera trap nights from 110 camera traps was used to target Black-footed Tree-rat and other mammals. Cameras were deployed as per TSSP and *Camera trapping SOP for the Top End Long-term Monitoring Program.*

Division is satisfied with the sampling method and effort for Black-footed Tree-rat.

Northern quoll: A total of 2554 camera trap nights from 110 camera traps was used to target Northern quoll and other mammals. Cameras were deployed as per TSSP and *Camera trapping SOP for the Top End Long-term Monitoring Program.*

Division is satisfied with the sampling method and effort for Northern quoll.

9 Appendix B: Threatened Species Likelihood of Occurrence Assessment

Note that this assessment is based on a desktop literature review (as per the information collated in **Section 4**), previous survey results and the author's experience with the AROWS basin. The following caveats are applied to this assessment:

- Threatened marine animals (including sharks and turtles) have been excluded from this assessment, even though records of them may exist within 20 km. No suitable habitat exists within the AROWS basin.
- Survey effort has been recognized as a factor in the consideration of the number of 'local' records.
- 'Local' records are defined as those within 20 km of the AROWS basin.
- The assessment does not include data deficient or near threatened species (unless that species is listed in a higher category under other legislation).

The assessment was conducted in August 2023 and updated in February 2024 to account for a revision in the conservation status of several species in late 2023.

Scientific Name	Common Name	Status[40]		Preferred habitat[41]	Records within 20 km[42]	Identified in		Preliminary assessment of likelihood of occurrence
		NT	Nat.			PMST report	2018 TSSP	
Threatened plants								
Atalaya brevialata	Atalaya	CE	CE	Foot slopes in open vegetation and on deeper, coarser sandy soils mostly along a specific, distinct geological boundary, often with surface gravel (DoE, 2013; Cowie, 2014). This includes in woodland with varying proportions of *Eucalyptus tectifica* and *Corymbia foelscheana* but also with *Xanthostemon paradoxus*, *Terminalia grandiflora* and *Acacia hemignosta* in the overstorey with open layer of perennial grasses such as *Eriachne avenacea* (Cowie, 2014). It has also been found in the adjoining mixed *Melaleuca viridiflora*, *Grevillea pteridifolia* and *Acacia leptocarpa* low woodland in more poorly drained situations but on slight rises (Cowie, 2014). Suitable habitat appears to often occur in a narrow band upslope of sandy, poorly drained flats dominated by the small tree *Grevillea pteridifolia* and *Dapsilanthus spathaceus* (Cowie, 2014).	0	✓	X	**Unlikely** The AROWS basin is outside the current known extent of occurrence as per the SPRAT database (DoE, 2023) and the habitat distribution model prepared by DLRM in 2016 (DLRM, 2016 – refer to **Figure 12** in **Appendix C**).
Cleome insolata	Spider Flower	V	-	Poorly drained sandsheet habitats, often on the margins of seasonally inundated drainage depressions.	12	X	X	**Possible** – suitable habitat may exist.
Cycas armstrongii	Darwin Cycad	V	-	Mainly in open grassy woodland on yellow and red earths, limited in the area by drainage.	161	X	✓	**Known** – species surveyed and mapped within the basin.
Goodenia quadrifida	-	DD	V	Grassland, the upper parts of estuarine floodplains and on poorly drained grey clays or silty soil (TSSC, 2008).	3	✓	✓	**Unlikely** – Surveys completed in 2019 and 2020 did not detect the species.
Helicteres macrothrix	-	E	E	Woodlands dominated by *Eucalyptus tectifica, E. tetrodonta* or *E. miniata*, on sandy loam on rocky siltstone slopes or granitic rocks, generally in mid to foot slope positions in the landscape.	140	✓	✓	**Known** – species was detected (and mapped) within the southern basin.
Stylidium ensatium	-	E	E	Wet margins of drainage flats in damp heavy clay or peaty soils (TSSC, 2016).	0	✓	✓	**Unlikely** – species not detected within the basin during surveys in 2019 and no suitable habitat identified.
Typhonium praetermissum	-	V	-	Land units of the upland lateritic plateaux and low hills typical of the Darwin region (DLRM, 2016).	150	X	✓	**Possible** – the species has been recorded nearby and potential habitat appears to exist. Several plants that appear to be the species were detected within the basin (though were not collected to confirm with genetic testing).
Typhonium taylori	Typhonium	E	E	Seasonally saturated sandy soil in nutrient poor grass / sedgeland with occasional *Melaleuca viridiflora*.	0	X	X	**Unlikely –** Restricted to the floodplains of the Howard River and its tributaries and a creek system on the nearby Shoal Bay Reserve.
Utricularia dunstaniae	Bladderwort	V	-	Wet sand, often in shallow water in *Melaleuca nervosa* woodland or *Verticordia* shrubland. It occurs frequently where water is percolating from the ground. Populations appear to be small and very localised.	0	X	✓	**Possible** – Surveys conducted for *Utricularia singeriana* within the AROWS basin did not detect *U. dunstaniae* (or *U. singeriana*). One small area of potential habitat for *U. singeriana* south of Koolpinyah Station remains unsurveyed. A survey for this species will be conducted at the same time given the broadly similar habitats.

[40] Conservation status under either the Environment Protection and Biodiversity Conservation Act 1999 ('Nat.') or Territory Parks and Wildlife Conservation Act ('NT'): CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, NT = near threatened, '-' = not listed, DD = data deficient.

[41] Habitat descriptions are from the NT threatened species factsheets at https://nt.gov.au/environment/native-plants/threatened-plants and https://nt.gov.au/environment/animals/threatened-animals, except where otherwise specified. In many instances, the descriptions listed in the associated TSSC or SPRAT profile are based on the NT descriptions.

[42] As per the NT Flora and Fauna Atlases (as of August 2023).

Scientific Name	Common Name	Status[40]		Preferred habitat[41]	Records within 20 km[42]	Identified in		Preliminary assessment of likelihood of occurrence
		NT	Nat.			PMST report	2018 TSSP	
Utricularia singeriana	Bladderwort	V	-	Sand plains subject to prolonged seepage or seasonal waterlogging (NTG, 2017).	0	X	✓	**Possible –** suitable habitat may exist.
Threatened birds								
Calidris acuminata	Sharp-tailed Sandpiper	LC	V	Fresh and hypersaline environments, feeding along the edge of water on mudflats, coastal and inland wetlands, and sewage ponds.	0	✓	X	**Possible** – marginal habitat occurs, and the species may infrequently visit the site.
Calidris ferruginea	Curlew Sandpiper	CE	CE	Intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. Also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand.	2	✓	✓	**Possible** – marginal habitat occurs, and the species may infrequently visit the site.
Charadrius leschenaultii	Greater Sand Plover	V	V	Sheltered sandy, shelly or muddy beaches, large intertidal mudflats and sandbanks, estuaries, tidal lagoons, rocky islands and coral reefs. Inland saline wetlands close to the coast are also used occasionally.	2	✓	✓	**Unlikely** – Suitable habitat does not exist within the basin or intake corridor.
Charadrius mongolus	Lesser Sand Plover	E	E	Almost strictly coastal, preferring sandy beaches, mudflats of coastal bays and estuaries, sand-flats and dunes near the coast and occasionally frequenting mangrove mudflats in Australia.	2	✓	✓	**Unlikely** – Suitable habitat does not exist within the basin or intake corridor.
Epthianura crocea tunneyi	Alligator Rivers Yellow Chat	E	E	Tall grasslands and samphire shrublands (on coastal saltpans). Most records of the Alligator Rivers subspecies are from floodplain depressions and channels, concentrating around wetter areas at the end of the dry season.	0	✓	✓	**Unlikely –** There are no local records, no apparent suitable habitat within the basin and no individuals were observed during surveys between 2019 and 2022 (though the species was not targeted).
Erythrotriorchis radiatus	Red Goshawk	V	E	Tall open eucalypt forest and riparian areas (including paperbark forest and gallery forests).	8	✓	✓	**Possible –** Local records exist (albeit in low numbers) and, given the proximity to Adelaide River (which may be more likely to contain important breeding habitat), the AROWS basin is probably used for foraging, if individuals occur in the area. A targeted survey is not expected to be required given that the species was not observed incidentally during extensive surveys for other species from 2019 to 2022, the species is highly mobile and the basin is likely to only be infrequently used if the species occurs in the local area. Further, the habitats within the basin are probably understood well enough to inform any subsequent impact assessment.
Erythrura gouldiae	Gouldian Finch	V	E	Feb-Oct: wooded hills with hollow-bearing Snappy Gums (*Eucalyptus brevifolia*) and *E. leucophloia* or Salmon Gums (*E. tintinans*); Nov-Jan (wet season): lowland drainages.	18	✓	✓	**Likely** – The species was detected on one occasion immediately adjacent to the basin in 2019. It was not a target species of the surveys however was observed for during the surveys for other species. While no breeding habitat (as reported in the species factsheet) is present within the basin, the species is highly likely to utilise the basin to forage in.
Falco hypoleucos	Grey Falcon	V	V	Sparsely timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm.	1	✓	✓	**Unlikely –** There is only one local record and the habitat description provided in the NT Threatened Species factsheet does not correspond to habitats within the basin.
Geophaps smithii smithii	Partridge Pigeon (eastern)	V	V	Principally in lowland eucalypt open forests and woodlands, with grassy understoreys.	287	✓	✓	**Likely** – Individuals were observed immediately adjacent to the basin and there was an unconfirmed sighting within the basin (Connect Environmental, 2019). However, extensive surveys targeting the species in 2019 and 2020 failed to detect it within the basin.

Scientific Name	Common Name	Status[40]		Preferred habitat[41]	Records within 20 km[42]	Identified in		Preliminary assessment of likelihood of occurrence
		NT	Nat.			PMST report	2018 TSSP	
Limosa lapponica baueri	Nunivak Bar-tailed Godwit	V	E	Intertidal mudflats or in shallow water, not far from the coast.	0	✓	✓	**Unlikely –** No areas of apparent suitable habitat exist within the basin.
Numenius madagascarien-sis	Eastern Curlew	CE	CE	Extensive tidal mudflats or sandflats, often near mangroves, and saltmarshes.	2	✓	✓	**Unlikely –** No areas of apparent suitable habitat exist within the basin.
Rostralata australis	Australian Painted Snipe	E	E	Shallow, vegetated, freshwater swamps, claypans or inundated grasslands or saltmarshes (including temporary wetlands) (Marchant & Higgins 1993 cited in DEWHA, 2010; Taylor *et al*., 2013). Likely to occur on any shallow ephemeral wetlands in central or southern NT. Possibly occurs in northern areas of the NT.	0	✓	✓	**Possible –** Suitable ephemeral swamps may be present though not expected to be frequently occupied by the species. No local records exist.
Tringa nebularia	Common Greenshank	LC	E	Edges of wetlands, in soft mud on mudflats, in channels, or within shallows around the edge of waterbodies, often situated near or among mangroves or other sparse, emergent or fringing vegetation such as sedges or saltmarsh. The bird occasionally feeds amongst seagrass beds.	0	✓	X	**Possible** – marginal habitat occurs, and the species may infrequently visit the site.
Tyto novaehollandiae kimberli	Masked Owl (northern)	V	V	Mainly in tall open eucalypt forests, especially those dominated by Darwin Woollybutt *Eucalyptus miniata* and Darwin Stringybark *E. tetrodonta*.	1	✓	✓	**Possible** – Despite extensive targeted surveys in 2019 and 2020 across the basin, the species was not detected. However, potentially suitable habitat exists and several 'suspect' calls were heard (though could not be confirmed as the species).
Threatened mammals								
Antechinus bellus	Fawn Antechinus	E	V	Savannah woodland and tall open forest of the top end.	11	✓	✓	**Unlikely –** Despite extensive camera surveys in 2019 and 2020, the species was not detected within the basin. However, suitable habitat has the potential to exist if suspected key threatened processes were able to be minimised.
Conilurus penicillatus	Brush-tailed Rabbit-rat	E	V	Eucalypt tall open forest. May also occur on coastal grasslands (with scattered large *Casuarina equisetifolia* trees, beaches, and stunted eucalypt woodlands on stony slopes). It shelters in tree hollows, hollow logs and, less frequently, in the crowns of pandanus or sand-palms. It has been demonstrated to prefer tall eucalypt forests away from wet areas in sites that had not been exposed to recent severe fires (Firth *et al*., 2006a; cited in TSSC, 2016a).	0	✓	✓	**Unlikely –** There are no records in the local area. Suitable habitat may occur however the threatened species factsheet (DEPWS, 2021a) states that the species is currently known only from the Cobourg Peninsula, Groote Eylandt and Bathurst, Melville and Inglis Islands.
Dasyurus hallucatus	Northern Quoll	CE	E	Wide range of habitats, but the most suitable habitats appear to be rocky areas.	99	✓	✓	**Possible** – While the species was not detected within the basin during extensive surveys in 2019 and 2020, it was detected at on the escarpment above Bamboo Springs and the Marrakai Track immediately west of the basin in 2020. No extensive surveys were conducted along the escarpment and, subsequently, it is unclear whether others also exist there.
Macroderma gigas	Ghost Bat	NT	V	Several roosts or perches are often used each night, but generally the same daytime roost is used. Daytime roosts are often in a deep crack or cave and may change seasonally. Females usually aggregate in maternity roosts when breeding, but few such sites are known. The largest known site is near Pine Creek.	9	✓	✓	**Unlikely –** While nine records exist in the NT Fauna Atlas within 20 km of the basin, the date of these was not recorded. Within 50 km of the basin, a total of 16 records appear in the NT Fauna Atlas, of which the most recent is in 1988. In addition, the current distribution is understood to occur to the south of the basin (south of Coomalie Creek), according to BatMap (ABS, 2023). Based on this, it appears unlikely that the species occurs within the AROWS basin.
Mesembriomys gouldii gouldii	Black-footed Tree-rat (Kimberley and mainland NT)	E	E	Mostly in lowland open forests and woodlands, particularly those dominated by *Eucalyptus miniata* and/or *E. tetrodonta* with well-developed shrubby understoreys.	21	✓	✓	**Known** – The species was detected on numerous cameras during the 2019 and 2020 surveys within the basin.

Scientific Name	Common Name	Status[40]		Preferred habitat[41]	Records within 20 km[42]	Identified in		Preliminary assessment of likelihood of occurrence
		NT	Nat.			PMST report	2018 TSSP	
Petrogale concinna canescens	Nabarlek	E	E	Rugged sandstone or granite rocky areas, especially on steep slopes with large boulders, caves and crevices.	0	✓	✓	**Unlikely** – While the top end sub-species is reported to occur from the Arafura Swamp in the east to the Daly River catchment in the west, there are very few recent records and it is thought that the species may now only occur in the western Arnhem Land escarpment (DEPWS, 2021b).
Phascogale pirata	Northern Brush-tailed Phascogale	E	V	Tall open forests dominated by *Eucalyptus miniata* and *E. tetrodonta* and shelters in hollows during the day.	0	✓	✓	**Unlikely –** Some areas of suitable habitat may exist within the basin however there are no local records, and the species was not detected during extensive fauna surveys in the basin in 2019 and 2020. Most records in the Top End are from the Garig Gunak Barlu, Kakadu and Litchfield National Parks.
Rattus tunneyi	Pale Field-rat	V	-	A wide range of habitats, including tall grasslands, rocky slopes, woodlands and monsoon forests with dense understoreys dominated by grasses and sedges.	19	X	✓	**Unlikely during survey period but possible otherwise –** While the species was not recorded in the AROWS basin during surveys in 2019 and 2020, **s**uitable habitat occurs and it is expected that its abundance and distribution across its range varies at the local scale in response to changing fire regimes, annual rainfall and cat predation success.
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheath-tailed Bat	NT	V	Mostly in eucalypt forests and woodlands, generally in near-coastal areas.	0	✓	X	**Possible** – The species is known to occur in north-eastern Queensland and the monsoonal tropics of the NT and is likely to occur in areas of the Kimberley in Western Australia. However, it is unclear whether, across this range, it is rare or it has a fragmented distribution.
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum	NT	V	Mainly in tall eucalypt open forests with large hollow-bearing trees (TSSC, 2021).	21	✓	X	**Known** – The species was detected on numerous cameras during the 2019 and 2020 surveys within the basin.
Xeromys myoides	Water Mouse	DD	V	Aquatic environments, including coastal saltmarsh, samphire shrublands, saline reed-beds and saline grasslands, mangroves, and coastal freshwater wetlands, and wet heathlands (DAWE, 2021).	0	✓	X	**Unlikely** – Suitable habitat does not occur within the AROWS basin.
Threatened frogs								
Uperoleia daviesae	Howard River Toadlet	V	V	Sandy inundated areas with sandsheet heath, areas of sandy soils with short vegetation that is inundated in the wet season, or in adjacent woodlands dominated by Melaleuca.	5	✓	✓	**Unlikely –** There are very few local records, and these are at least approximately 18 km to the north of the basin. The NT threatened species factsheet states that the species appears to be confined to the catchments of the Howard River, Elizabeth River, Berry Springs, Sunday Creek and the base of the Gunn Point peninsula close to Darwin. Further, the AROWS basin is not within the modelled distribution that is shown in SPRAT.
Threatened reptiles								
Acanthopsis hawkei	Plains Death Adder	V	V	In the top end, cracking soils on floodplains of the Adelaide, Mary and Alligator Rivers. However, it may occur more widely on floodplains and cracking soil plains across mainland northern Australia.	0	✓	✓	**Possible –** Small areas of suitable habitat in the form of floodplains with cracking soils exist within the AROWS basin.

Scientific Name	Common Name	Status[40]		Preferred habitat[41]	Records within 20 km[42]	Identified in		Preliminary assessment of likelihood of occurrence
		NT	Nat.			PMST report	2018 TSSP	
Tiliqua scincoides intermedia	Northern Blue-tongue Skink	LC	CE	While the species is known to occur in a wide variety of ecosystems, it is typically recorded in dense vegetation near seasonal or permanent water (Shea 1992; AWC unpublished data; DAC unpublished data; WAC unpublished data). Habitat critical to the survival of the species is described in the EPBC Act Conservation Advice as areas of dense vegetation that provide cool and moist conditions within otherwise hot, dry, and flammable landscapes that are within the historical distribution of the species. Examples include rainforests and vine thickets, riparian forests, well-vegetated creeks, gorges, and drainage lines, well-vegetated swamps, soaks, and springs, dense thickets within floodplains, grasslands, shrublands, savannas and woodlands, shady thickets in rocky ranges and gorges, well-watered and well-vegetated gardens.	8	✓	X	**Possible** – While there is a relatively limited number of records within 20 km, some suitable habitat may occur within the basin. This is primarily along creek lines which may provide some refuge from thermal extremes and predators. A preliminary assessment of potentially suitable habitat is shown in **Figure 19**. However, it is important to note that the Conservation Advice indicates that critical habitat provides moist and cool conditions in an otherwise hot, dry and flammable landscape. Drainage systems within the basin are probably not generally described in this manner, although some pockets of dense vegetation do occur and would provide relief from adjacent open habitats. The riparian habitats within the basin frequently burn (refer to **Section 3.3**) and are generally narrow drainage lines which were observed in 2019 mostly to be dry by August (Connect Environmental, 2019). Of the examples of 'critical habitat' provided in the Conservation Advice, only 'well-vegetation creeks / drainage lines' are of relevance within the basin, and within these areas, probably only small pockets of suitable refuge habitat occur.
Varanus mertensi	Merten's Water Monitor	V	E	Semi-aquatic, seldom seen far from water, also seen climbing on rocks and trees near water and basking on branches overhanging the water or on rocks in the middle of streams.	25	X	✓	**Known –** species detected in basin during surveys 2019.
Varanus mitchelli	Mitchell's Water Monitor	V	CE	Margins of watercourses, swamps and lagoons.	3	X	✓	**Possible** – not detected during surveys though potentially suitable habitat appears to exist.
Varanus panoptes	Yellow-spotted Monitor	V	-	A variety of habitats, including coastal beaches, floodplains, grasslands and woodlands.	5	X	✓	**Unlikely (though possible in the future)** – The species may have occurred within the basin and, in the future, may also occur. However, given it was not observed by ecologists or on extensive camera surveys in 2019 and 2020 across the basin, and there are only five records with the most recent being from 2001, it is not expected to be present in the AROWS basin at present. This is likely attributed, at least partly, to the presence of Cane Toads.

10 Appendix C: Migratory Species Likelihood of Occurrence Assessment

Species	Common name	Preferred habitat	Records within 20 km[43]	Likelihood of occurrence
Migratory marine species				
Apus pacificus	Fork-tailed Swift	**Important habitat**: A range of habitats, from inland open plains to wooded areas, where it is exclusively aerial (DoE, 2015).	43	**Possible** – suitable habitat exists.
Calonectris leucomelas	Streaked Shearwater	Coastal and oceanic habitats, particularly offshore islands and surrounding waters (DAWE, 2022).	0	**Unlikely** – no suitable habitat.
Phaethon lepturus	White-tailed Tropicbird		0	
Anoxypristis cuspidata	Narrow Sawfish	Estuaries, marine (Kyne & Pillans, 2014).	*	**Unlikely** – no suitable habitat.
Caretta caretta	Loggerhead Turtle	Oceanic, coastal waters, beaches (DEE, 2017).	*	
Chelonia mydas	Green Turtle		*	
Crocodylus porosus	Saltwater Crocodile	Tidal rivers, coastal floodplains and channels, billabongs and swamps (DoE, 2023)	*	**Possible** – small areas of suitable habitat exists (mostly in the intake corridor).
Dermochelys coriacea	Leatherback Turtle	Oceanic, coastal waters, beaches (DEE, 2017).	*	**Unlikely** – no suitable habitat.
Eretmochelys imbricata	Hawksbill Turtle		*	
Lepidochelys olivacea	Olive Ridley Turtle		*	
Manta alfredi	Reef Manta Ray	Estuaries, marine (DoE, 2023)	*	**Unlikely** – no suitable habitat.
Manta birostris	Giant Manta Ray		*	
Natator depressus	Flatback Turtle	Oceanic, coastal waters, beaches (DEE, 2017).	*	**Unlikely** – no suitable habitat.
Pristis pristis	Freshwater Sawfish	Rivers, estuaries, coastal and offshore waters (DoE, 2023)	*	**Unlikely** – no suitable habitat.
Pristis zijsron	Green Sawfish		*	

[43] *The number of local records for species with an asterix (*) was not analysed.*

Species	Common name	Preferred habitat	Records within 20 km[43]	Likelihood of occurrence
Sousa sahulensis as Sousa chinensis	Australian Humpback Dolphin		*	
Tursiops aduncus	Spotted Bottlenose Dolphin		*	
Migratory terrestrial species				
Cecropis daurica	Red-rumped Swallow	**Important habitat**: In Australia, non-breeding habitat only – predominately forages over wetlands and open well-watered grasslands (DoE, 2015).	0	**Possible** – suitable habitat exists.
Cuculus optatus	Oriental Cuckoo	**Important habitat**: In Australia, non-breeding habitat only – monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands (DoE, 2015).	9	**Possible** – suitable habitat exists.
Hirundo rustica	Barn Swallow	**Important habitat**: In Australia, non-breeding habitat only – occurs in the air above open vegetated areas including native and agricultural grasslands as well as over open water areas (DoE, 2015).	1	**Possible** – suitable habitat exists.
Motacilla cinerea	Grey Wagtail	**Important habitat**: In Australia, non-breeding habitat only – has a strong association with water, particularly rocky substrates along water courses but also lakes and marshes (DoE, 2015).	0	**Unlikely** – suitable habitat exists.
Motacilla flava	Yellow Wagtail	**Important habitat**: In Australia, non-breeding habitat only – mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangroves and other dense vegetation (DoE, 2015).	0	**Possible** – suitable habitat exists.
Rhipidura rufifrons	Rufous Fantail	**Important habitat**: Moist, dense habitats, including mangroves, rainforest, riparian forests and thickets, and wet eucalypt forests with a dense understorey (DoE, 2015).	81	**Possible** – suitable habitat exists.
Migratory wetland species				
Acrocephalus orientalis	Oriental Reed-warbler	**Important habitat**: In Australia, non-breeding habitat only – emergent aquatic vegetation along waterways and water bodies (DoE, 2015).	0	**Unlikely** – scarcity of local records and limited habitat.
Actitis hypoleucos	Common Sandpiper	Coastal wetlands, some inland wetlands, rocky shores, rarely on mudflats, estuaries and deltas of streams, banks upstream, lakes,	9	**Possible** – some marginal habitat exists.
Calidris acuminata	Sharp-tailed Sandpiper		2	

Species	Common name	Preferred habitat	Records within 20 km[43]	Likelihood of occurrence
Calidris ferruginea	Curlew Sandpiper	pools, billabongs, reservoirs, dams and claypans, occasionally piers and jetties, mangroves, wetlands, grassy areas adjoining wetlands (DoE, 2015).	2	
Calidris melanotos	Pectoral Sandpiper		0	
Charadrius leschenaultii	Greater Sand Plover		2	
Tringa nebularia	Common Greenshank		5	
Charadrius veredus	Oriental Plover	Estuarine mudflats, sandbanks, sandy or rocky ocean beaches or nearby reefs, near-coastal grasslands, semi-arid or arid grasslands, claypans, dry paddocks, playing fields, lawns and cattle camps, open areas that have been recently burnt, lightly wooded grasslands, terrestrial wetlands or flooded paddocks (DoE, 2015).	2	**Possible** – suitable habitat may exist.
Glareola maldivarum	Oriental Pratincole		5	**Possible** – suitable habitat may exist.
Pandion haliaetus	Osprey	**Important habitat**: Littoral and coastal habitats, terrestrial wetlands, offshore islands, mostly in coastal areas but occasionally inland along major rivers, particularly in northern Australia (DoE, 2015).	0	**Unlikely** – lack of local records, proximity of the AROWS basin away from the coast (>30 km) and lack of appropriate food (fish) within the basin.

11 Appendix D: EPBC Act Protected Matters Search Tool (PMST) Results

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: 05-Feb-2024

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:	44
Listed Migratory Species:	35

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	33
Whales and Other Cetaceans:	2
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	1
EPBC Act Referrals:	15
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
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 acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area	In feature area
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 feature area
Epthianura crocea tunneyi Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers) [67089]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area	In feature area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area	In feature area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Limosa lapponica baueri](#) Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	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 buffer area only
[Rostratula australis](#) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area	In feature area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area	In buffer area only
[Tyto novaehollandiae kimberli](#) Masked Owl (northern) [26048]	Vulnerable	Species or species habitat known to occur within area	In feature area
FROG			
[Uperoleia daviesae](#) Howard River Toadlet, Davies's Toadlet [85375]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
MAMMAL			
[Antechinus bellus](#) Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Conilurus penicillatus](#) Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat may occur within area	In feature area
[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
[Macroderma gigas](#) Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area	In feature area
[Mesembriomys gouldii gouldii](#) Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Petrogale concinna canescens](#) Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area	In feature area
[Phascogale pirata](#) Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat likely to occur within area	In feature area
[Saccolaimus saccolaimus nudicluniatus](#) Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area	In feature area
[Trichosurus vulpecula arnhemensis](#) Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Xeromys myoides](#) Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat likely to occur within area	In feature area
PLANT			
[Atalaya brevialata](#) [86125]	Critically Endangered	Species or species habitat may occur within area	In buffer area only
[Goodenia quadrifida](#) [56035]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Helicteres macrothrix](#) [86586]	Endangered	Species or species habitat known to occur within area	In feature area
[Stylidium ensatum](#) a triggerplant [86366]	Endangered	Species or species habitat may occur within area	In feature area
REPTILE			
[Acanthophis hawkei](#) Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area	In feature area
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area	In buffer area only
Tiliqua scincoides intermedia Northern Blue-tongued Skink [89838]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Varanus mertensi Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat known to occur within area	In feature area
Varanus mitchelli Mitchell's Water Monitor [1569]	Critically Endangered	Species or species habitat known to occur within area	In feature area
SHARK			
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat known to occur within area	In buffer area only
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat known to 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

Scientific Name	Threatened Category	Presence Text	Buffer Status
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area	In feature area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding likely to 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			
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Calonectris leucomelas Streaked Shearwater [1077]		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
Migratory Marine Species			
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely 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	Species or species habitat known to occur within area	In buffer area only
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	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 may occur within area	In buffer area only
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to 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 known to occur within area	In feature area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding likely to occur within area	In buffer area only
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Species or species habitat may 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 likely to occur within area	In buffer area only

Migratory Terrestrial Species

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Cecropis daurica](#) Red-rumped Swallow [80610]		Species or species habitat may occur within area	In feature area
[Cuculus optatus](#) Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area	In feature area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat likely to 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 likely to occur within area	In feature area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Species or species habitat known to occur within area	In feature area
Migratory Wetlands Species			
[Acrocephalus orientalis](#) Oriental Reed-Warbler [59570]		Species or species habitat may occur within area	In feature area
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area	In feature area
[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 may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
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
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area	In feature area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area overfly marine area	In feature area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
[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]	Vulnerable	Species or species habitat known to occur within area	In feature area
[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 may 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
[Cecropis daurica as Hirundo daurica](#) Red-rumped Swallow [80610]		Species or species habitat may occur within area overfly marine area	In feature area
[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 feature area
[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
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 known to occur within area	In feature area
Hirundo rustica Barn Swallow [662]		Species or species habitat likely to occur within area overfly marine area	In feature area
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 likely to occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area	In feature area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
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
Tringa nebularia			
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area	In buffer area only
Reptile			
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	Species or species habitat known to occur within area	In buffer area only
Crocodylus johnstoni			
Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area	In feature area
Crocodylus porosus			
Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area	In feature area
Dermochelys coriacea			
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat may occur within area	In buffer area only
Eretmochelys imbricata			
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Lepidochelys olivacea			
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area	In buffer area only
Natator depressus			
Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area	In buffer area only

Whales and Other Cetaceans			[Resource Information]
Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			

Current Scientific Name	Status	Type of Presence	Buffer Status
Sousa sahulensis Australian Humpback Dolphin [87942]		Species or species habitat may 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 likely to occur within area	In buffer area only

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Manton Dam Recreation Area	Other Conservation Area	NT	In buffer area only

Nationally Important Wetlands		[Resource Information]
Wetland Name	State	Buffer Status
Adelaide River Floodplain System	NT	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Proposed City of Weddell	2011/6090		Assessment	In buffer area only
Rehabilitation of former Rum Jungle mine site, near Batchelor, NT	2016/7730		Post-Approval	In buffer area only
Controlled action				
Browns Oxide Project, New Tailings Storage Facility(2)	2007/3558	Controlled Action	Completed	In buffer area only
Browns Oxide Project Extension	2007/3242	Controlled Action	Completed	In buffer area only
Compass Resources NL/Mining/Rum Jungle/NT/Copper, cobalt and nickel mine - Browns Oxide Project	2005/2011	Controlled Action	Post-Approval	In buffer area only
Darwin to Moomba Gas Pipeline	2001/213	Controlled Action	Completed	In feature area
Development of Area 55 Oxide Project	2010/5324	Controlled Action	Completed	In buffer area only
Glyde Point and Middle Arm Peninsula Infrastructure Support	2001/334	Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Glyde Point Industrial Estate and Associated Infrastructure	2004/1506	Controlled Action	Completed	In buffer area only
Noonamah Ridge Residential Estate, Lloyd Creek, NT	2014/7269	Controlled Action	Further Information Request	In buffer area only
Polymetallic Project-lead, copper, nickel, cobalt and silver	2001/535	Controlled Action	Completed	In buffer area only
Not controlled action				
Field trials for cultivation of microalga (Botryococcus braunii) to produce hydr	2007/3277	Not Controlled Action	Completed	In buffer area only
Magnesium Metal Mining	2001/225	Not Controlled Action	Completed	In buffer area only
Pilot Power Station to Utilise Fuel Gas from Mimosa Pigra	2002/841	Not Controlled Action	Completed	In buffer area only
Referral decision				
Yarram Iron Ore Project, near Batchelor, NT	2018/8209	Referral Decision	Referral Publication	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.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

12 Appendix E: Habitat Mapping

Habitat distribution modelling that has been prepared by the NT Government is presented here and includes:

- *Atalaya brevialata* (**Figure 12**)
- *Typhonium praetermissum*.

Species habitat mapping prepared by Connect Environmental based on survey results, vegetation communities, reported habitat descriptions and the TSSP is also presented here and includes:

- Partridge Pigeon
- Masked Owl
- Fawn Antechinus
- Northern Quoll
- Black-footed Tree-rat
- Pale Field-rat
- Northern Blue-tongue Skink (preliminary mapping – no surveys conducted to date for the species)
- Merten's and Mitchell's Water Monitors.

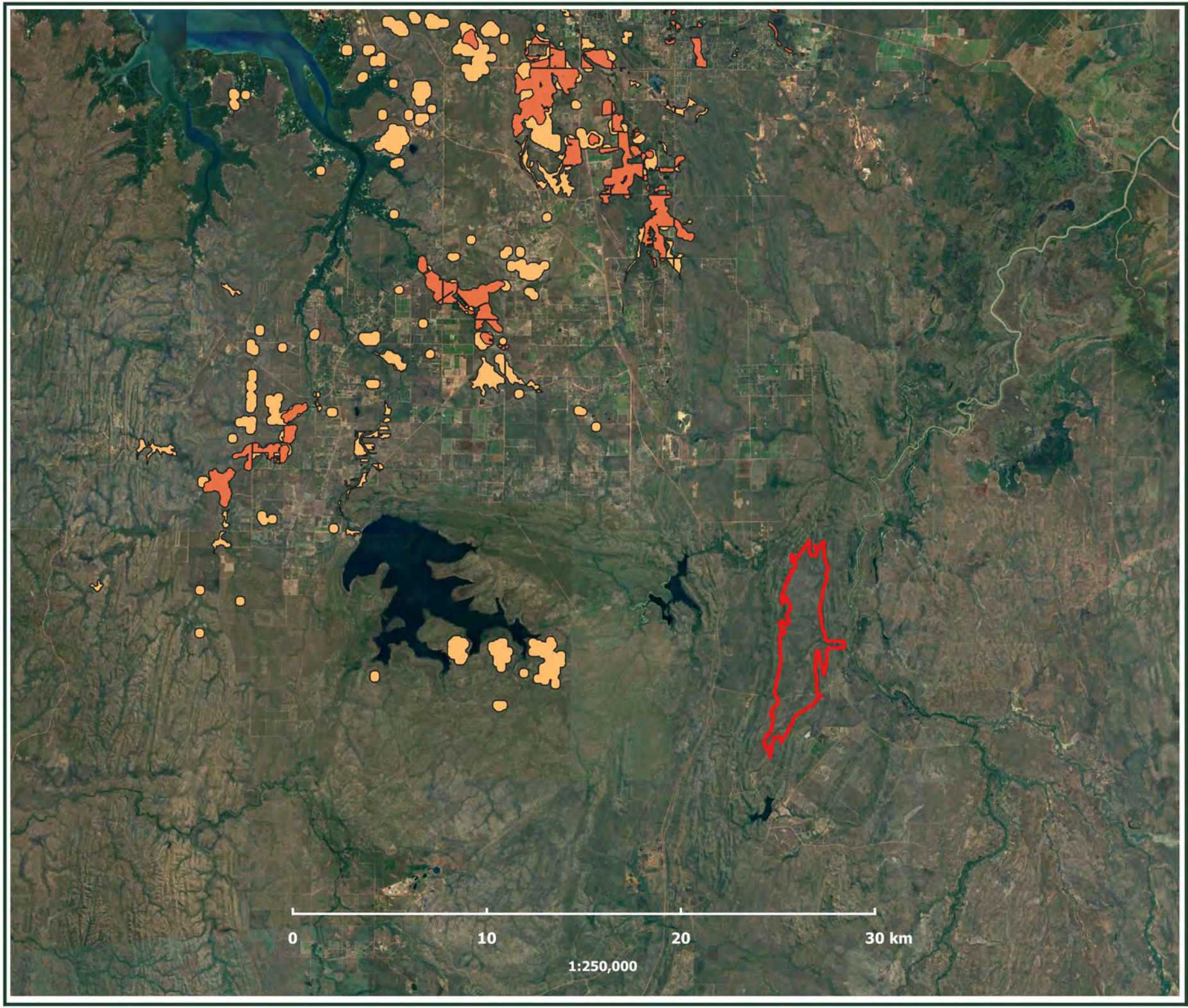

Figure 12
-
Atalaya brevialata modelled habitat distribution

Key

- AROWS basin (32 m AHD inundation boundary) and intake coridor
- Atalya brevialata - high likelihood (DLRM, 2016a)
- Atalaya brevialata - potential habitat (DLRM, 2016a)

Background - Google Satellite

Project: 2023 AROWS basin likelihood of occurrence assessment
Client: GHD
Author: M. Proos
Date: 24 August 2023

CONNECT environmental

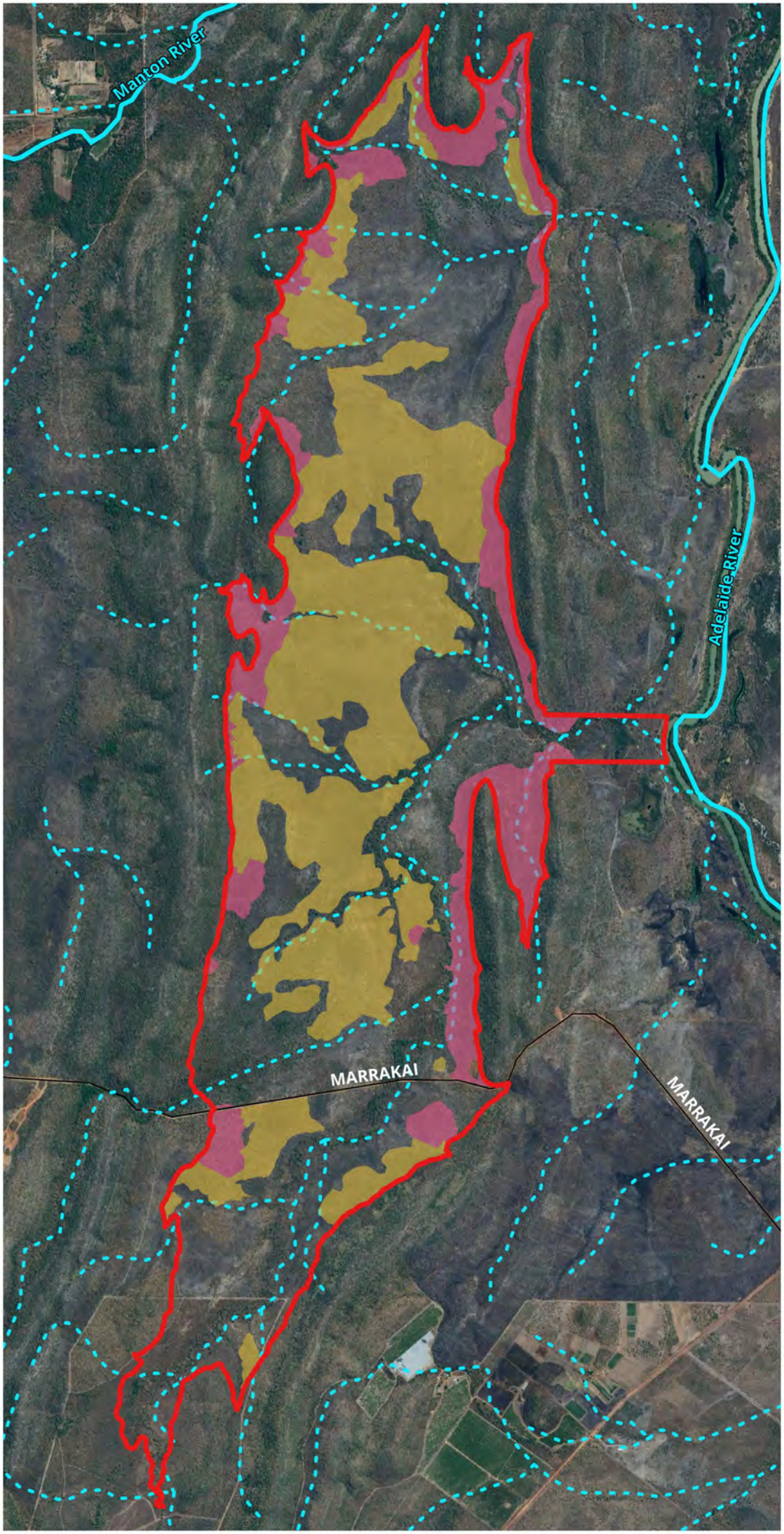

Figure 13 - Potential habitat for the Partridge Pigeon

Key

- High suitability habitat
- Low to moderate suitability habitat
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

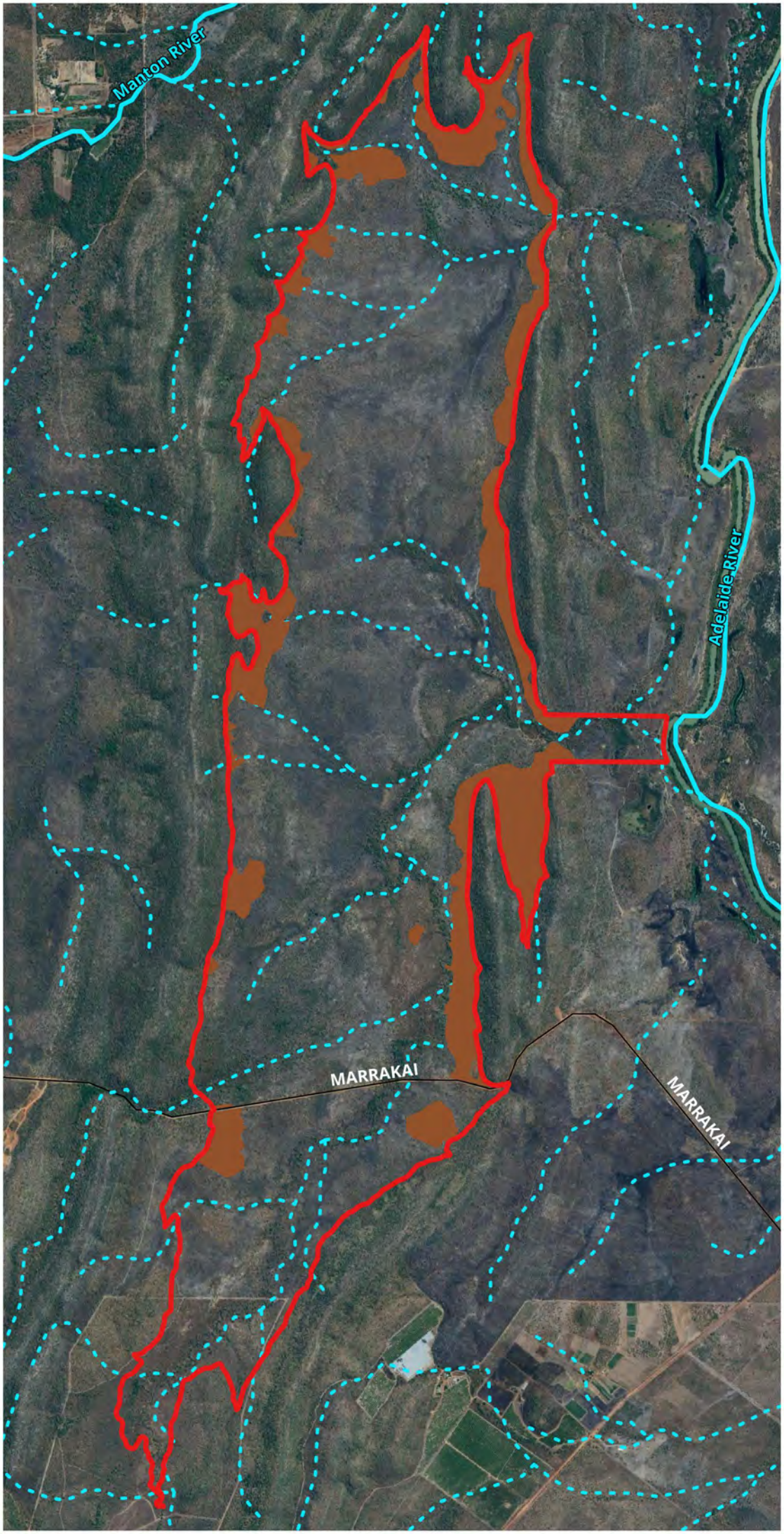

Figure 14 - Potential habitat for the Masked Owl

Key

- Potential breeding habitat
- 32 line basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

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1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

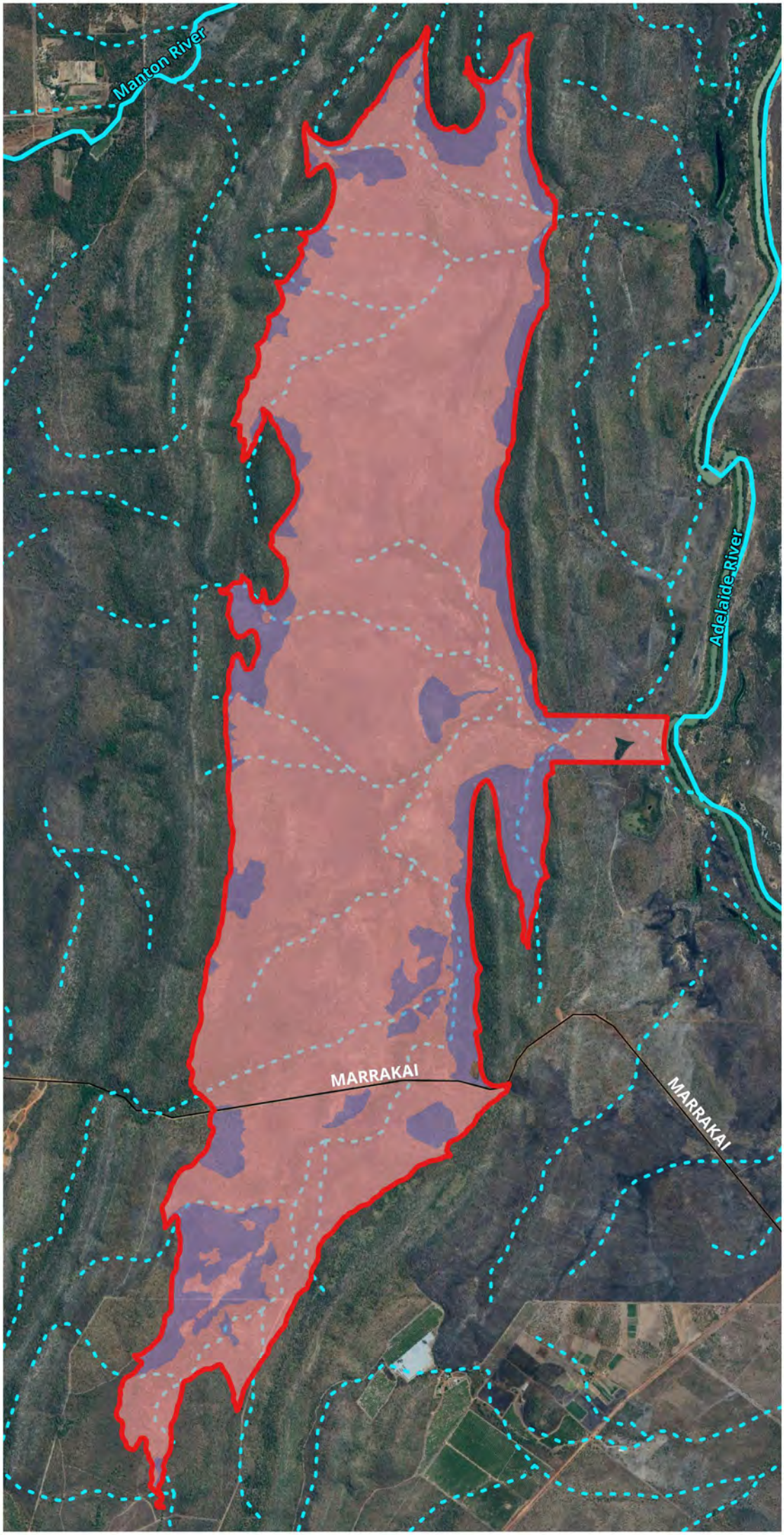

Figure 15 - Potential habitat for the Northern Quoll

Key

- Potential breeding and refuge habitat
- Potential foraging and dispersal habitat
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

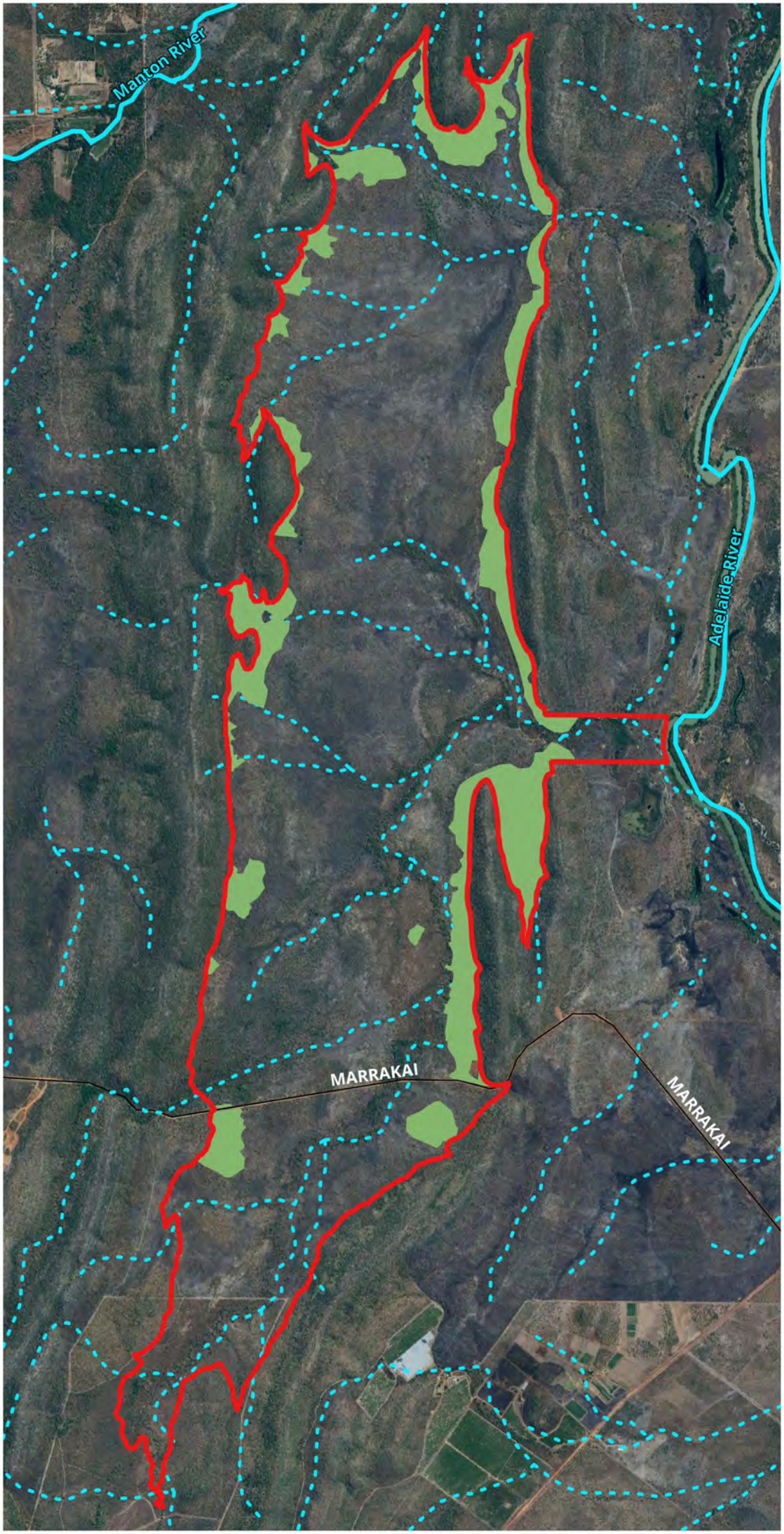

Figure 16 - Potential habitat for the Fawn Antechinus

Key

- Potential habitat
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

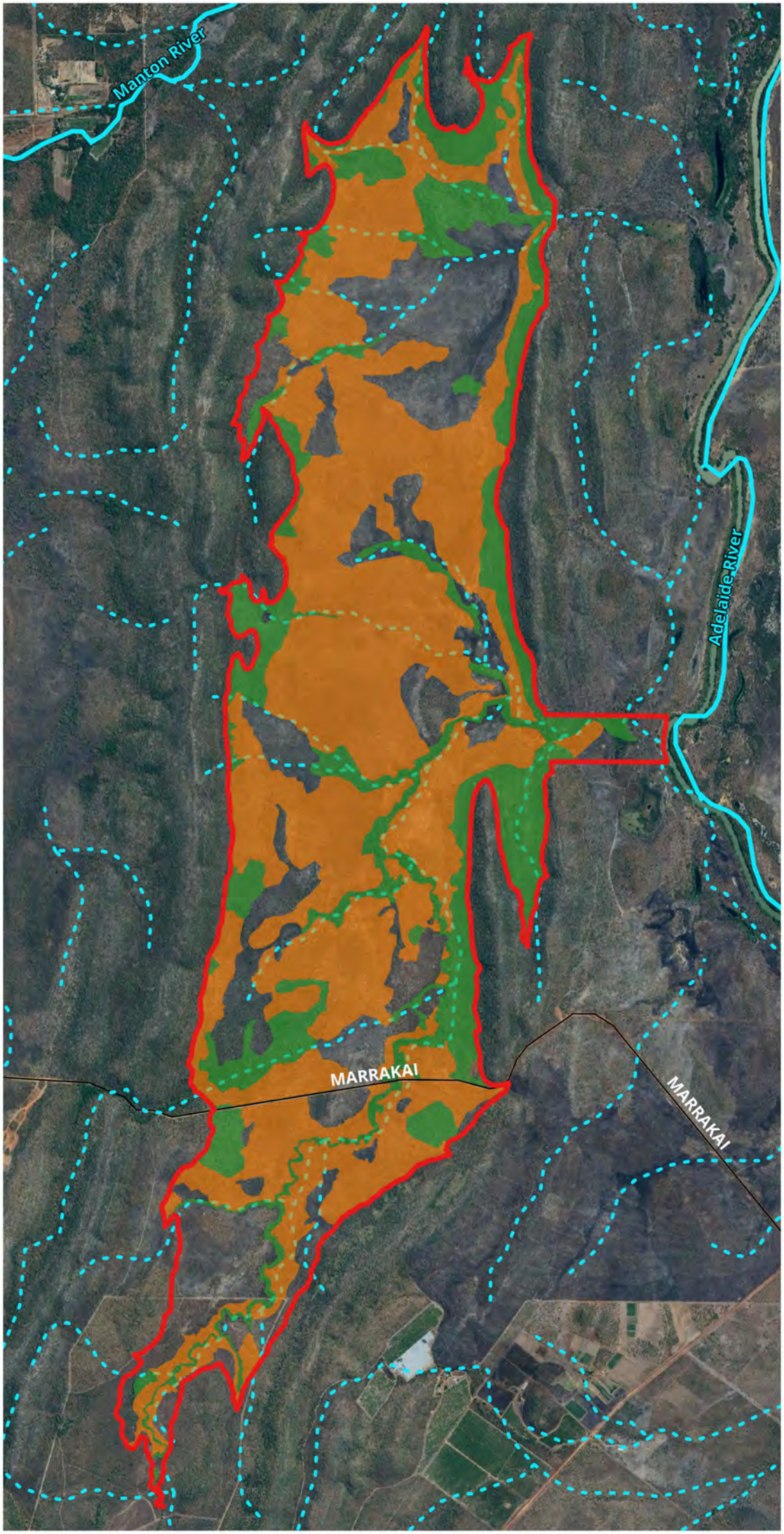

Figure 17 - Potential habitat for the Black-footed Tree-rat

Key

- Suitable habitat (detections within)
- Potential habitat
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

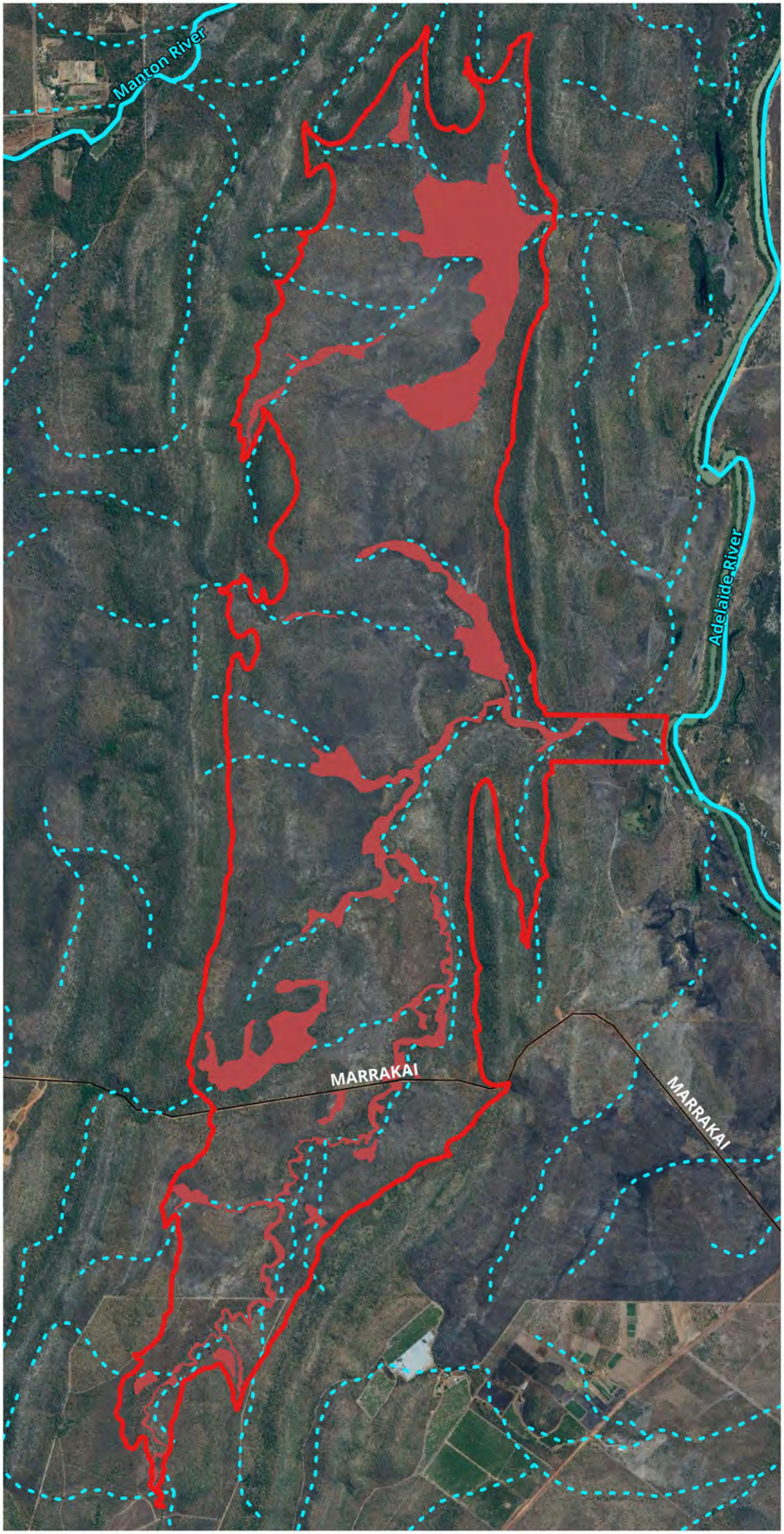

Figure 18 - Potential habitat for the Pale Field-rat

Key

- Potential habitat
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental

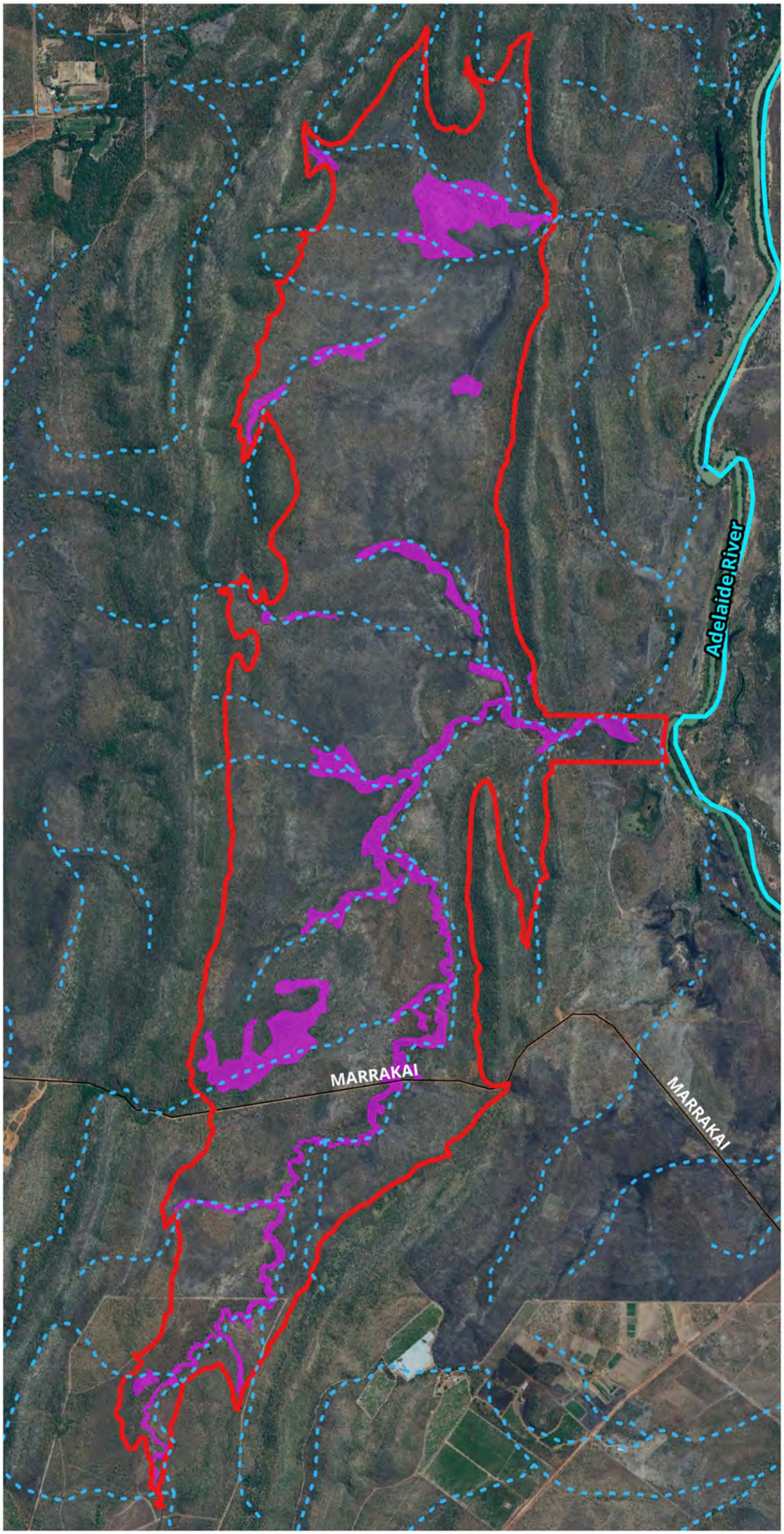

Figure 19 - Potential refuge habitat (preliminary assessment) for the Northern Blue-tongue Skink

Key

- Potential Northern Blue-tongue Skink refuge habitat (preliminary assessment)
- 32 m basin and intake corridor
- NT Government Road
- Stream (DEPWS, 2021)

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
20 February 2024

CONNECT environmental

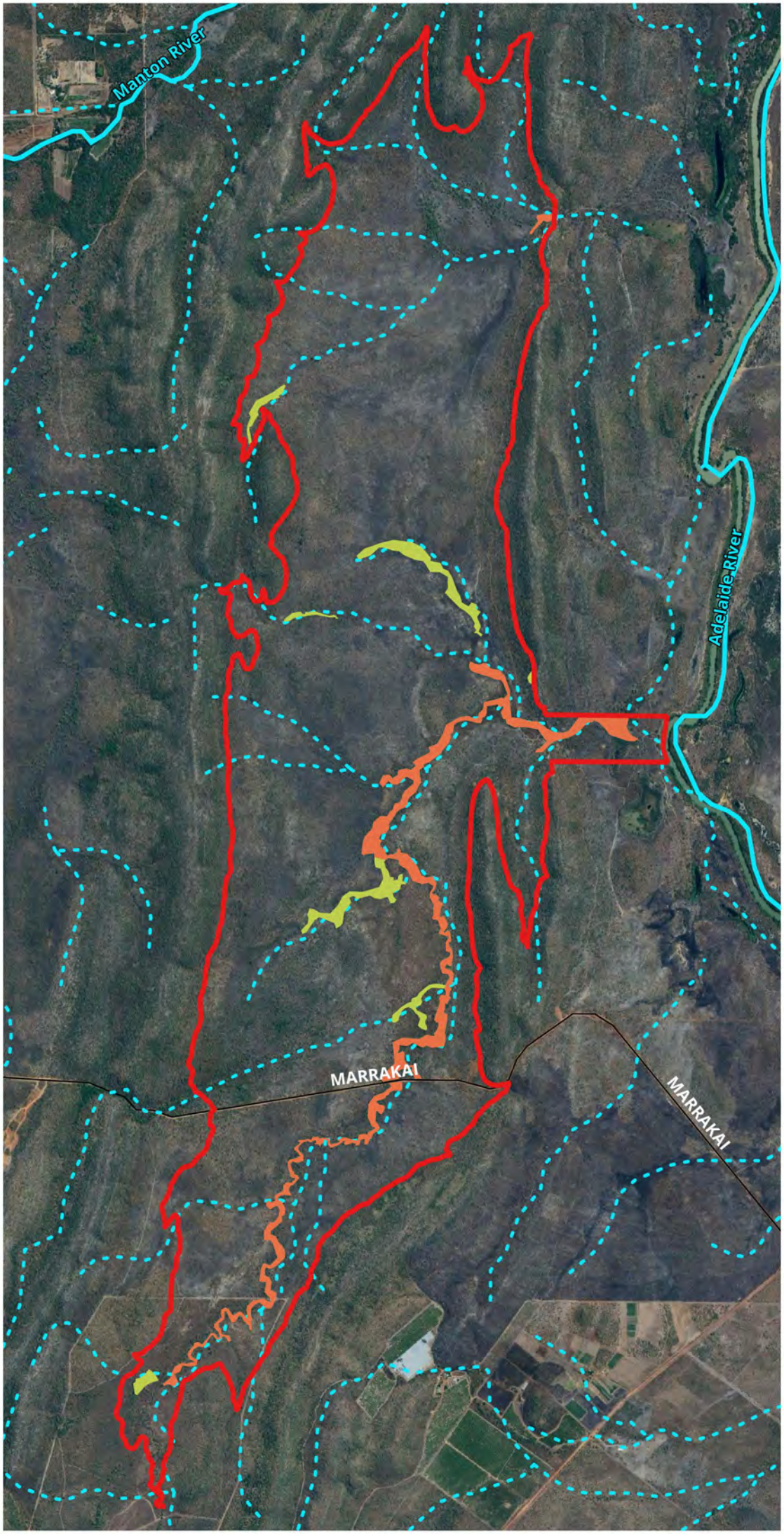

Figure 20 - Potential habitat for Merten's and Mitchell's Water Monitors

Key

- Suitable habitat
- Potential habitat
- 32 m basin and intake corridor
- NT Government Road
- Streams

Background - Google Satellite

N

0 0.5 1 1.5 km

1:40,000

Client: GHD
Author: M. Proos
Geodatum: GDA94 / Z52
21 February 2024

CONNECT environmental