

Appendix B

**Connect Environmental Biodiversity
Report**



THREATENED SPECIES SURVEY REPORT

Pirlangimpi, Pickertaramoor and
Milikapiti Roads, Melville Island, NT

Prepared for:

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Executive Summary

Introduction and Scope

The Department of Infrastructure, Planning and Logistics (DIPL) is planning to upgrade the roads on Tiwi Islands, which will be jointly funded by the Northern Territory (NT) and Australian Governments. The key objectives of the works are to improve motorist safety, reduce travel times, and provide driver amenities. The project will involve resurfacing the access roads using gravel from nominated existing gravel pits, or from new locations, and realigning several sections. The commencement of the road works is planned for the 2022 dry season and will continue over several years. The three roads applicable to this report are the Milikapiti, Pirlangimpi and Pickertaramoor Roads, all located on Melville Island.

Connect Environmental was contracted by GHD Australia Pty Ltd to undertake surveys for threatened species to gain a better understanding of their presence and distribution across the proposed disturbance footprint. The total extent of the survey area was approximately 1,520 ha and comprised potential gravel pit survey areas, road realignment areas and water points. However, the subsequent assessment of impacts to biodiversity within this report is for the Pirlangimpi and Pickertaramoor Roads only. The assessment of impacts on the Milikapiti Road will be assessed at a later stage.

Survey Effort

The survey area was divided into 22 'map areas' to assist with logistics and reporting. Fourteen threatened flora and fauna species were surveyed from February to April 2021, as follows:

- 20 February to 1 March:
 - *Typhonium* species (Phases 1 and 2) and *Cycas armstrongii* survey.
 - Deploy 50 camera trap sites.
- 8-10 March: *Typhonium* species (Phase 3) survey.
- 19-25 March:
 - Retrieve first 50 camera trap sites and deploy second lot of 50 sites.
 - Red Goshawk nest transects.
- 12-13 April: Reconnaissance trip to proposed pitfall trap sites with Tiwi Rangers.
- 15-30 April:
 - Pitfall trapping
 - Red Goshawk nest transects.
 - Retrieve second lot of 50 camera traps.

Results

Seventeen vegetation communities were mapped, including plantations and cleared areas. This includes two sensitive or significant communities, as defined in the NT *Land Clearing Guidelines*, as well as areas containing large hollow-bearing trees. Six additional communities were considered 'partially' significant.

Three threatened flora and ten threatened fauna species were detected, as shown in the following table.

Species	Common Name	No. of detections	Roads
Threatened flora			
<i>Cycas armstrongii</i>	Armstrong's Cycad	Patchy	Pirlangimpi, Pickertaramoor, Milikapiti
<i>Typhonium jonesii</i>	<i>Typhonium jonesii</i>	1,212	
<i>Typhonium mirabile</i>	<i>Typhonium mirabile</i>	772	
Threatened fauna			
<i>Erythrotriorchis radiatus</i>	Red Goshawk	2	Milikapiti
<i>Geophaps smithii smithii</i>	Partridge Pigeon	89	Pirlangimpi, Pickertaramoor, Milikapiti
<i>Tyto novaehollandiae melvillensis</i>	Masked Owl	3	Pickertaramoor, Milikapiti
<i>Conilurus penicillatus</i>	Brush-tailed Rabbit-rat	3	Pirlangimpi
<i>Mesembriomys gouldii melvillensis</i>	Black-footed Tree-rat	24	Pirlangimpi, Pickertaramoor, Milikapiti
<i>Phascogale pirata</i>	Brush-tailed Phascogale	4	Pirlangimpi, Pickertaramoor, Milikapiti
<i>Rattus tunneyi</i>	Pale Field-rat	7	Pirlangimpi, Milikapiti
<i>Sminthopsis butleri</i> (suspected)	Butler's Dunnart	5	Pirlangimpi, Milikapiti
<i>Trichosurus vulpecula arnhemensis</i>	Northern Brushtail Possum	72	Pirlangimpi, Pickertaramoor, Milikapiti
<i>Varanus mertensi</i>	Merten's Water Monitor	1	Pirlangimpi

Recommended Avoidance Buffers

Based on the results of the survey, two levels of avoidance restrictions were recommended:

1. Level 1 (highest priority):
 - a. Within 20 m of 'patches'¹ of *Typhonium jonesii* and/or *T. mirabile*.
 - b. Within 100 m of the following sensitive and/or significant vegetation communities:
 - i. W1a (*Grevillea pteridifolia* mid isolated trees over *Pandanus spiralis* mid sparse shrubland over *Eulalia mackinlayi*, *Eriachne burkittii* and *Ectrosia* sp. tall open tussock grassland)
 - ii. W2a (*Melaleuca viridiflora* and / or *M. nervosa* low open forest over *Pandanus spiralis*, *Grevillea pteridifolia* mid sparse shrubland over *Eriachne* sp., *Aristida* sp. mid tussock grassland).
 - c. Within 200 m of any threatened species classified as 'Endangered' (i.e., Brush-tailed Phascogales and Brush-tailed Rabbit-rats)
2. Level 2 (low to medium priority):

¹ A 'patch' has been defined as a group of five or more individuals within 50 m.

- a. Within 50 m preferred of 'patches'² of *Typhonium jonesii* and/or *T. mirabile*.
- b. Vegetation communities associated with seasonally saturated or inundated soils (potentially significant vegetation types) (six communities).

Level one (highest priority) avoidance restrictions are those areas that meet the NT *Land Clearing Guidelines* (DENR, 2021). Level two (medium) avoidance restrictions are those areas that may not strictly meet the NT *Land Clearing Guidelines* (DENR, 2021) however do exhibit elements of sensitivity or significance as related to the guidelines. As such, these areas were recommended to be avoided, where possible.

Refined Proposed Gravel Pit Areas

Based on the results of the surveys, and the subsequent avoidance buffer recommendations, DIPL reviewed the locations of the proposed gravel pit survey areas and selected smaller 'proposed gravel pit areas'. These areas border the area within which a 1 ha pit will be 'open' at any one time. These areas require geotechnical investigations as part of the next stage of works.

Impact Assessment

The subsequent 'disturbance footprint', measuring 300 ha (maximum) across 14 map areas, includes the 'proposed gravel pit areas', the road realignment area and water points *along the Pirlangimpi and Pickertaramoor Roads only*, except for a proposed gravel pit area at the southern end of Milikapiti Road (map 14). It is these areas that were the focus of the impact assessment.

The following summarises the detections and primary impacts related to the loss of individuals or habitats for threatened species:

- *Cycas armstrongii*: Two map areas were detected to contain high density patches.
- *Typhonium jonesii*: A total of 25 detected individuals occur within the proposed disturbance footprint, including a patch of 16 within the 100 m buffer of the existing water point EB1 (map area 12).
- *Typhonium mirabile*: A total of two detected individuals occur within the proposed disturbance footprint.
- Red Goshawk: A total of 247.5 ha of foraging habitat exists across the disturbance footprint. No nests were detected though potential nesting habitat may be present.
- Partridge Pigeon: A total of 247.5 ha of breeding and foraging habitat exists across the disturbance footprint.
- Masked Owl: A total of 247.5 ha of foraging habitat exists across the disturbance footprint. Potential nesting habitat may be present.
- Brush-tailed Rabbit-rat: Confirmed within one map area only, with 200 m avoidance buffers recommended around all detection points.
- Black-footed Tree-rat: Confirmed in six map areas.
- Brush-tailed Phascogale: Confirmed in four map areas, with 200 m avoidance buffers recommended around all detection points.
- Pale Field-rat: Confirmed in three map areas. Some suitable habitat may be removed.

² A 'patch' has been defined as a group of five or more individuals within 50 m.

- Butler's Dunnart: Suspected of occurring in two map areas. All detections occur a minimum 200 m from the disturbance footprint.
- Northern Brushtail Possum: Confirmed in eight map area. A total of 247.5 ha of breeding and foraging habitat exists across the disturbance footprint.
- Merten's Water Monitor: Confirmed in one map area. A total of 17.9 ha of 'seasonal' habitat exists in the disturbance footprint.

Impact mitigation

Minimum standards for environmental management for DIPL's civil and building works are described in the *Standard specification for environmental management* (version 2.0; DIPL, 2019). These relate to erosion and sedimentation, weeds, stockpiles, waste, water quality, vegetation, air quality and rehabilitation. As such, those measures are not repeated in this report. However, measures relating to specific areas or habitat attributes for relevant threatened species – designed to enhance DIPL's minimum controls – have been recommended. These are additional to the recommended avoidance buffers described above. They focus on the identification and avoidance of high-density patches of *Cycas armstrongii*, nests for Red Goshawks and Masked Owls and areas containing high densities of large hollow-bearing trees.

Conclusions

The threatened species identified in this report face several existing threats on the Tiwi Islands including inappropriate fire regimes, extensive and intense fires, cats and large-scale loss of critical or important habitat. It is reported that these are likely to be implicated in the apparent decline of these species on the Tiwi Islands. In comparison, the anticipated impacts from this project are unlikely to significantly impact the distribution or abundance of these species on the Tiwi Islands, although localised and small-scale impacts will be experienced by animals occupying those areas. Consequently, it is prudent to minimise these effects as much as possible.

While a maximum of approximately 270 ha of vegetation may be impacted, the composition of the disturbance footprint is important to recognise as this affects the nature and scale of impacts to the relevant species:

- The total clearance area is comprised of multiple smaller areas nominated for proposed gravel pits (23 areas), road realignments (14 sections (including the yellow ochre site)) and water source points (12 sites), rather than one large clearance area.
- In the proposed gravel pit areas (which comprise approximately 78% of the maximum clearance area), only 1 ha of clearance is proposed in any one proposed gravel pit area at any one time (as per the *Standard specification for environmental management, version 2.0* (DIPL, 2019)). Therefore, the extent of disturbance is likely to be much smaller than the numbers provided in the impact assessment.
- Much of the disturbance footprint is located along the existing roads or cleared areas for existing gravel pits or plantation. Such areas are likely to have reduced values for biodiversity associated with 'edge' effects – that is, the alteration of habitat characteristics resulting from increased levels of light, dust and noise and consequential changes to vegetation composition.

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1 Introduction

1.1 The Project

The Department of Infrastructure, Planning and Logistics (DIPL) is planning to upgrade the roads on Tiwi Islands, which will be jointly funded by the Northern Territory (NT) and Australian Governments. The key objectives of the works are to improve motorist safety, reduce travel times, and provide driver amenities. The project will involve resurfacing the roads using gravel from nominated existing gravel pits or from new locations. Several sections of the roads will also be realigned. In addition, one section of road will be realigned to avoid an identified yellow ochre site. The commencement of the road works is planned for approximately 2025 and will continue over several years. The three roads applicable to this requirement are:

- Milikapiti Road
- Pirlangimpi Road
- Pickertaramoor Road.

However, the assessment of impacts to biodiversity along Milikapiti Road does not form part of this report. The subsequent impact assessment is for the Pirlangimpi and Pickertaramoor Roads only, which includes the realignment at the site of the yellow ochre.

1.2 Purpose and Objectives

Connect Environmental was contracted by GHD Australia Pty Ltd (who hold the head contract with DIPL) to undertake threatened species surveys on Melville Island for the proposed road works. An Environmental Impact Assessment (EIA) was conducted in accordance with the *Environment Protection Act 2019* and *Environmental Impact Assessment and Environmental Approval in the Northern Territory - Environmental Impact Assessment Guidance Version 1.0* (2020). The EIA is designed to provide sufficient information for the NT EPA to assess the environmental risks of the project.

The purpose of the threatened species surveys is to inform project planning, determine the extent and distribution of threatened species within the survey area and inform management and risk minimization to threatened species. The total extent of the survey area is 1,520.7 ha and comprises potential gravel pit survey areas, road realignments and water points. **Table 1** provides a breakdown of these components. The total area shown in the table is the sum of each component within the survey area however this does not consider the overlap of some components, therefore the actual survey area is smaller.

The 'potential gravel pit survey areas' are deliberately larger than necessary so that biodiversity values could be determined and areas of higher value avoided, where possible. Consequently, the 'proposed gravel pit areas', which are much smaller, were the subject of the impact assessment (along Pirlangimpi and Pickertaramoor Roads only). Therefore, the 'disturbance footprint' includes these smaller 'proposed gravel pit areas', the 'road realignment areas' and the 'water points'.

Finally, a yellow ochre site was identified along Pirlangimpi Road as requiring a road diversion of approximately 300 m. This area was included within the impact assessment.

Table 1 Survey area components

Road	Potential gravel pit survey area (ha)	Road realignment area (ha)	Water Point (ha)	Total (ha)
Milikapiti Road	180	208.8	15.5	404.3
Pickertaramoor Road	464	15.5	9.3	488.8
Pirlangimpi Road	673	19.5	24.8	717.3
Total	1,317	243.8	49.6	1,610.4³

The terrestrial assessment was conducted in accordance with the following guidelines:

- The NT Environment Protection Authority (EPA) *Guidelines for Assessment of Impacts on Terrestrial Biodiversity (2013)* guideline
https://ntepa.nt.gov.au/_data/assets/pdf_file/0004/287428/guideline_assessment_terrestrial_biodiversity.pdf.
- The former Australian Department of the Environment, Water, Heritage and the Arts (2013) Significance Impact Guidelines regarding Matters of National Environmental Significance
<https://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance>.
- Version 7.0 of the Australian Vegetation Attribute Manual: National Vegetation Information System (2017)
<https://www.environment.gov.au/land/publications/australian-vegetation-attribute-manual-version-7>
- A guide for the use of remote cameras for wildlife survey in northern Australia (2015)
https://www.nespnorthern.edu.au/wp-content/uploads/2015/10/5.2.4_a_guide_to_use_of_remote_cameras_for_wildlife_surveys_final_web.pdf.

1.3 Components of the Project

The project was conducted by:

1. Analysing, reporting and mapping of relevant existing environmental information including:
 - a. Land unit / system patterns
 - b. Area of high biodiversity value
 - c. Vegetation communities including defining those which are ‘sensitive’ or ‘significant’ (under relevant NT legislation)
 - d. Fire history
 - e. Weeds including those which are declared under the NT *Weeds Management Act* as well as ‘Weeds of National Significance’
 - f. Threatened species records on the Tiwi Islands.

³ This is not the total extent of the survey area because some components overlap each other. The total survey area is 1520.7 ha.

2. Assessing the likelihood of occurrence of threatened species within the survey area.
3. Assessing the most appropriate assessment and survey approach for each threatened species with the potential to occur in the survey area.
4. Conducting surveys of vegetation communities and relevant threatened flora and fauna.
5. Providing an interim report to GHD / DIPL with details of significant apparent biodiversity constraints and recommendations for avoidance and/or mitigation measures. This was used to allow DIPL to determine the 'proposed gravel pit areas'.
6. Assessing the potential impacts of the refined gravel extraction areas and road realignment routes to relevant threatened and migratory species, and their significance. *Note that this applies to the Pirlangimpi and Pickertaramoor Roads only – the Milikapiti Road upgrades will be assessed at a later stage.*
7. Provide revised recommendations for impact mitigation.

1.4 Personnel

The core project team is shown in **Table 1**.

Table 2 Project Team

Team Member	Role
Mihkel Proos (Connect Environmental)	Project Manager, survey team leader for all components, reporting
Justin Bott (Connect Environmental)	Field Assistant (all field components), data entry
Sydney Collett (Connect Environmental)	Field Ecologist (all field components)
Jess Langridge (Connect Environmental)	Field Assistant (pitfall trapping), data entry
Alie Hvala (Connect Environmental)	Field Assistant (pitfall trapping)
Lucy Kania (Connect Environmental)	Field Ecologist (pitfall trapping)
Heather North (GHD)	Field Ecologist (all field components; administrative and logistical support; DIPL liaison)
Kym Brennan (sub-contractor)	Field Ecologist (<i>Typhonium</i> survey)

1.5 Definition of Terms

Key terms used in this report are defined in **Table 3**.

Table 3 Definition of terms

Term	Definition
Data point	A point where information has been collected regarding a threatened species, habitat or vegetation.
Detection	A photograph of a (identifiable) species on one camera, regardless of how many photos are taken of that species, or the timing of the photos.
Disturbance footprint	The combined areas of the 'proposed gravel pit areas', 'water points' and 'road realignment areas' (the latter includes a 300 m section of road diversion due to an identified yellow ochre site).
Potential gravel pit survey areas	General areas nominated for biodiversity survey to determine biodiversity values and subsequent development constraints, as shown in purple in the report figures.

Term	Definition
Map areas	Arbitrary boundaries created by Connect Environmental to aid in survey area delineation and logistics. These areas are referenced throughout this report.
Proposed gravel pit areas	Refined smaller areas within the ‘potential gravel pit survey areas’ where gravel extraction may occur. These areas only occur along the Pirlangimpi and Pickertaramoor Roads, except for one area which occurs at the southern end of Milikapiti Road. All these areas are not required for gravel extraction and further geotechnical testing will be required to determine quality of material suitable for the works and area of clearing required to achieve the volumes of material needed.
Road re-alignment areas	The proposed road re-alignments shown in green in the report figures.
Survey area	The combined total area of all ‘potential gravel pit survey areas’, ‘water points’ and ‘road realignment areas’.
Water points	Potential locations for new bores and water sources (shown in blue in the report figures) or existing bores (shown in orange in the report figures).

1.6 Acknowledgements

In addition to the core project team, numerous people substantially contributed to field work, logistics, expert advice, and information sharing for this project. Their contribution is appreciated. They include staff at the Tiwi Land Council (Murray Knyvett), Tiwi Land Rangers (Willi Rioli, Colin Kerinaia and others), Plantation Management Partners (Sarah Ryan, Hanna Lillicrap, Donna Snell), Auriga Marine Pty Ltd (Kerrie Taylor), Tiwi Enterprises (Yvonne Kelly) and NT Herbarium (Nick Cuff). A special thanks to Heather North (GHD) for her dedication and hard work throughout the project. Species information was also kindly provided by Hugh Davies and Hayley Geyle. Many thanks to everyone.

2 Existing Environmental Information

2.1 Land Units

Land units are areas that have similar bio-physical attributes including landform, soil and vegetation. They were originally mapped to describe the capability of each unit to support a range of land uses such as urban subdivision, farming, pasture improvement and resource extraction. Two sets of land unit mapping exist, though only on some parts of the survey area:

- Land units of areas adjacent to the Tuyu and Yapilika forestry plantations (1:16,000 scale; Wells & van-Cuylenburg, 1978) – maps 6, 10, 11 and 12.
- Land units of the Seventeen Mile Plain (1:50,000 scale; van-Cuylenburg & Dunlop, 1973) – maps 5 to 9, and 14 to 17.

These are shown in **Figure 1** and **Figure 2** and described in **Table 4** and **Table 5**.

2.2 Land Systems

Land system descriptions provide information in relation to the main features of the landscape (Lynch *et al.*, 2012). They are based on detailed information collected at specific sites. They have been mapped and described for the northern part of the NT by Lynch *et al.* (2012) at a scale of 1:250,000. The map areas encompass eight land systems (described in **Table 6** and shown in **Figure 3**, **Figure 4** and **Figure 5**).

Table 4 Wells & van-Cuylenburg (1978) land unit mapping descriptions

Land Unit	Aspect	Description
1a1	Landform	i. Plateau surfaces
		ii. Generally flat with slopes less than 2%
		iii. No outcrop, or surface gravels
	Site drainage	Moderately well
Soils	i. Deep loamy red massive earths	
	ii. Gradational; sandy loam to fine sandy clay loam	
	iii. No gravels	
	iv. Well drained	
Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>Corymbia nesophila</i> dominant; medium - dense understory of <i>Livistona humilis</i> , <i>Grevillea heliosperma</i> and <i>Acacia</i> spp; annual and perennial grasses	
1a2	Landform	i. Plateau surfaces
		ii. Flat to gently sloping 2 - 5%
		iii. No outcrop or surface gravels
Site drainage	Well drained, rapid runoff.	

Land Unit	Aspect	Description
	Soils	<ul style="list-style-type: none"> i. Deep, loamy red massive earths ii. Gradational, sandy loam to fine sandy clay loam iii. No gravels iv. Well drained
	Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>Corymbia nesophila</i> dominant; medium - dense understory of <i>Livistona humilis</i> and <i>Grevillea</i> spp.; annual and perennial grasses.
1b1	Landform	<ul style="list-style-type: none"> i. Plateau surfaces ii. Generally flat with slopes less than 2% iii. No outcrop, or surface gravels
	Site drainage	Well drained.
	Soils	<ul style="list-style-type: none"> i. Deep, sandy red massive earths ii. Gradational loamy sand to sandy clay loam iii. No gravels iv. Well drained
	Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>Corymbia nesophila</i> dominant; medium-dense to dense understory of <i>Livistona humilis</i> , <i>Grevillea</i> spp. and <i>Acacia</i> spp.; annual and perennial grasses.
1c2	Landform	<ul style="list-style-type: none"> i. Plateau surfaces, most commonly the peripheral areas ii. Slopes between 2-5% iii. Common laterite outcrop, 50-60% surface gravels
	Site drainage	Excessively well drained, rapid runoff.
	Soils	<ul style="list-style-type: none"> i. Shallow to moderately deep, gravelly red earths ii. Gradational loamy sand to gravelly sandy clay loam iii. 10-30% gravels throughout profile iv. Well-drained.
	Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>Corymbia nesophila</i> dominant with occasional <i>C. bleeseri</i> or <i>C. foelscheana</i> sparse shrub understory of <i>Acacia</i> spp. and <i>Grevillea</i> spp. annual and perennial grasses.
2a1	Landform	<ul style="list-style-type: none"> i. Plateau foot slopes and isolated scarps ii. Slopes less than 5% iii. Rare laterite outcrop, 10-60% surface gravels
	Site drainage	Well to excessively well drained, rapid runoff.
	Soils	<ul style="list-style-type: none"> i. Moderately deep gravelly red massive earths and rare sandy red massive earths ii. Gradational loamy sand to gravelly sandy clay loam iii. 5-20% gravels throughout profile iv. Well drained.
	Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>Corymbia nesophila</i> dominant, medium dense understory layer of <i>Acacia</i> spp., <i>Livistona humilis</i> , annual and perennial grasses.

Land Unit	Aspect	Description
2a2	Landform	<ul style="list-style-type: none"> a. Plateau foots lopes and isolated scarps b. Slopes 5-10% c. Common laterite outcrop, 20-80% surface gravels
	Site drainage	Excessively well drained, rapid runoff
	Soils	<ul style="list-style-type: none"> a. Shallow to moderately deep, gravelly red massive earths and less commonly lithosols b. Gradational loamy sand to gravelly sandy clay loam c. 10-30% gravels throughout profile d. Well drained
	Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. bleeseri</i> , dominant with occasional <i>C. nesophila</i> trees widely spaced with open areas contained few shrubs, <i>Acacia</i> spp.; mostly perennial grasses.
2a4	Landform	<ul style="list-style-type: none"> a. Plateau slopes and scarps, frequent cliffs b. Slopes greater than 15% c. Abundant to massive rock outcrop, 50-80% surface gravel cover
	Site drainage	Excessively well drained, very rapid runoff
	Soils	<ul style="list-style-type: none"> a. Very shallow stony red lithosols b. Uniform sand to loamy sand with gravels c. 10-30% gravels throughout profile d. Well drained
	Vegetation	Variable - Open forest of <i>C. nesophila</i> , <i>E. tetradonta</i> , <i>E. miniata</i> with sparse shrub layer of <i>Acacia</i> spp., <i>Livistona humilis</i> and <i>Petalostigma</i> spp., to shrubland of <i>Boronia</i> spp., <i>Calytrix</i> spp. and <i>Livistona humilis</i> .
3a	Landform	<ul style="list-style-type: none"> i. Gently sloping areas below the plateau surfaces ii. Long colluvial slopes and plains, slopes less than 2% iii. No rock outcrop or surface gravels
	Site drainage	Moderately well- well drained.
	Soils	<ul style="list-style-type: none"> i. Deep sandy red massive earths and loamy red massive earths ii. Gradational sandy loam or loamy sand to fine sandy clay loam iii. No gravels iv. Well drained
	Vegetation	Open forest: <i>E. miniata</i> dominant with odd <i>Corymbia nesophila</i> or <i>C. latifolia</i> , moderately dense understory of <i>Grevillea heliosperma</i> , <i>Erythrophleum chlorostachys</i> , <i>Acacia aulacocarpa</i> , <i>Alphitonia</i> spp. and <i>Livistona humilis</i> mostly perennial grasses, <i>Eulalia mackinlayi</i> , <i>Eriachne avenacia</i> and <i>Eriachne trisetata</i> .
3b	Landform	<ul style="list-style-type: none"> i. Flat to gently sloping areas within the sand plain country ii. Slopes less than 2% iii. Very rare rock outcrop, 20-60% surface gravels

Land Unit	Aspect	Description
	Site drainage	Moderately well- well drained.
	Soils	<ul style="list-style-type: none"> i. Generally moderately deep gravelly red massive earths ii. Gradational loamy sand to gravelly sandy clay loam iii. 5-20% gravels throughout profile iv. Well drained
	Vegetation	Open forest: <i>E. miniata</i> dominant with occasional <i>C. nesophila</i> , <i>C. porrecta</i> : moderately dense understory of <i>C. bleeseri</i> , <i>Banksia</i> spp., <i>Acacia</i> spp., and <i>Erythrophleum chlorostachys</i> , perennial grasses <i>Sorghum plumosum</i> , <i>Eriachne trisetata</i> and <i>Eulalia mackinlayi</i> .
4c	Landform	<ul style="list-style-type: none"> i. Sloping terrain, generally at low levels within the landscape ii. Slopes up to 4% iii. Very rare rock outcrop, 20-80% surfaces gravels
	Site drainage	Well drained.
	Soils	<ul style="list-style-type: none"> i. Shallow to moderately deep gravelly yellow massive earths ii. Gradational loamy sand to gravelly sandy clay loam iii. 5-20% gravels throughout iv. Soils are superficially well drained but are often underlain by a mottled gravel pan which perches water in the subsoil and causes some drainage impedece.
	Vegetation	Tall open shrubland to low woodland: <i>C. porrecta</i> or <i>Eugenia bleeseri</i> may be dominant, understory variable, mainly <i>Grevillea pteridifolia</i> . <i>Acacia</i> spp; <i>Tristania lactiflua</i> and <i>Persoonia falcata</i> ; grasses mainly perennial: <i>Eriachne avenacea</i> , <i>E. squarrosa</i> , <i>Planchonella pohmaniana</i> , <i>Aristida</i> sp.
7a	Landform	<ul style="list-style-type: none"> i. Drainage flats associated with springs, creeks and drainage lines. ii. Slopes less than 1% iii. No rock outcrop or surface gravels, slight 'debil debil' surface appearance
	Site drainage	Poor, inundated for considerable periods during wet season, very slow runoff.
	Soils	<ul style="list-style-type: none"> i. Sandy, apedal mottled yellow duplex soils ii. Duplex, loamy sand to mottled light to medium clay iii. Approximately 5% gravel in deep subsoil iv. Poorly drained
	Vegetation	Grassland (wet) with tall open shrubland patches. Tree species include <i>Grevillea pteridifolia</i> , <i>Tristania</i> and scattered clumps of <i>Pandanus</i> . <i>Melaleuca</i> and <i>Eugenia bleeseri</i> ; grasses mainly dense of perennials <i>Eulalia mackinlayi</i> , <i>Eriachne burkittii</i> and <i>Ectrosia</i> .

van-Cuylenburg & Dunlop (1973) Land Unit Mapping (1:50,000 scale) - Available in Maps 5, 6, 7, 8, 9, 14, 15, 16, 17

- Key**
- Map areas
 - Existing bores 100 m buffer
 - Water points 100 m buffer
 - Gravel extraction area
 - Road realignment
- Background - OpenStreetMap (main map), ESRI satellite (inset maps)

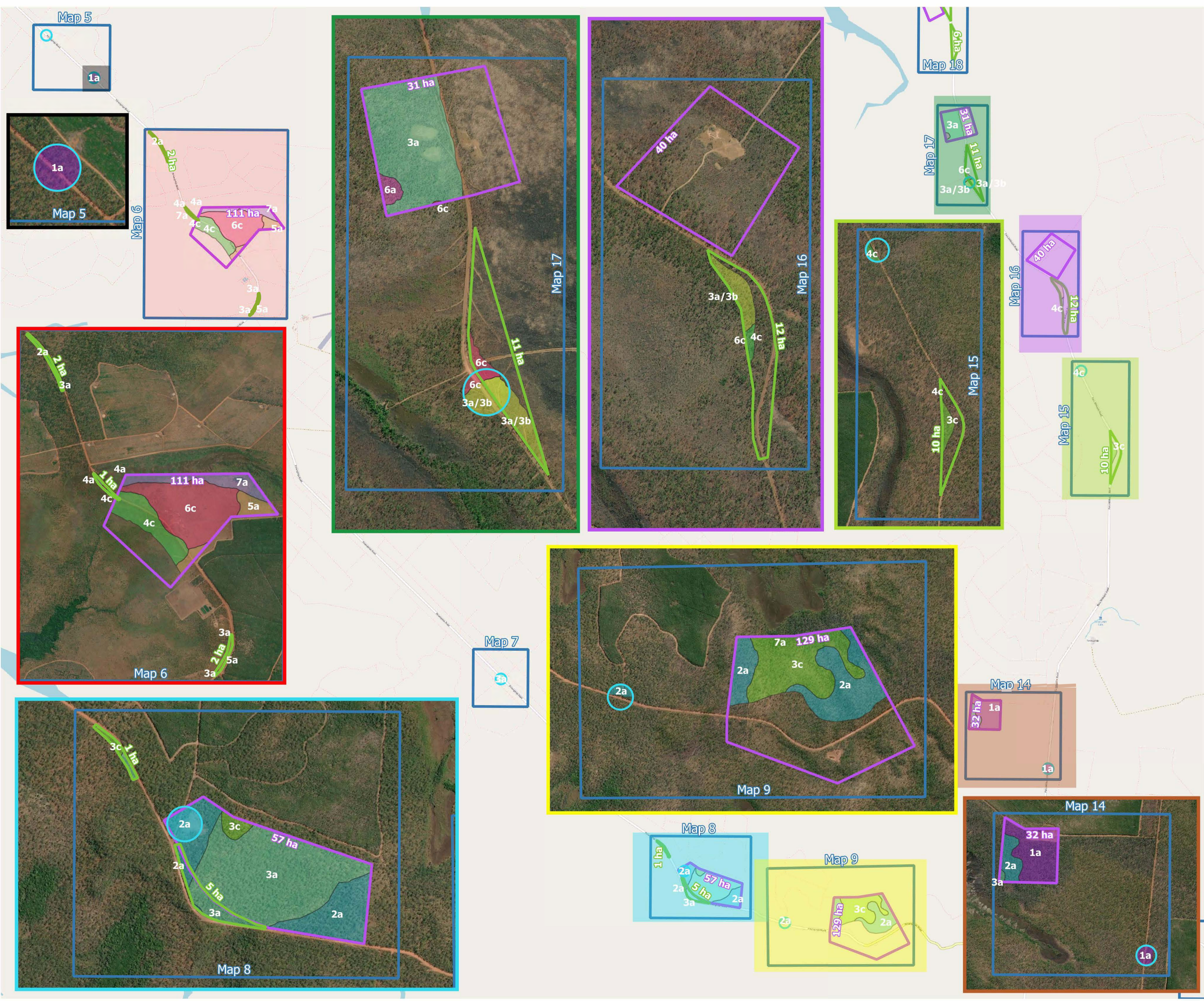
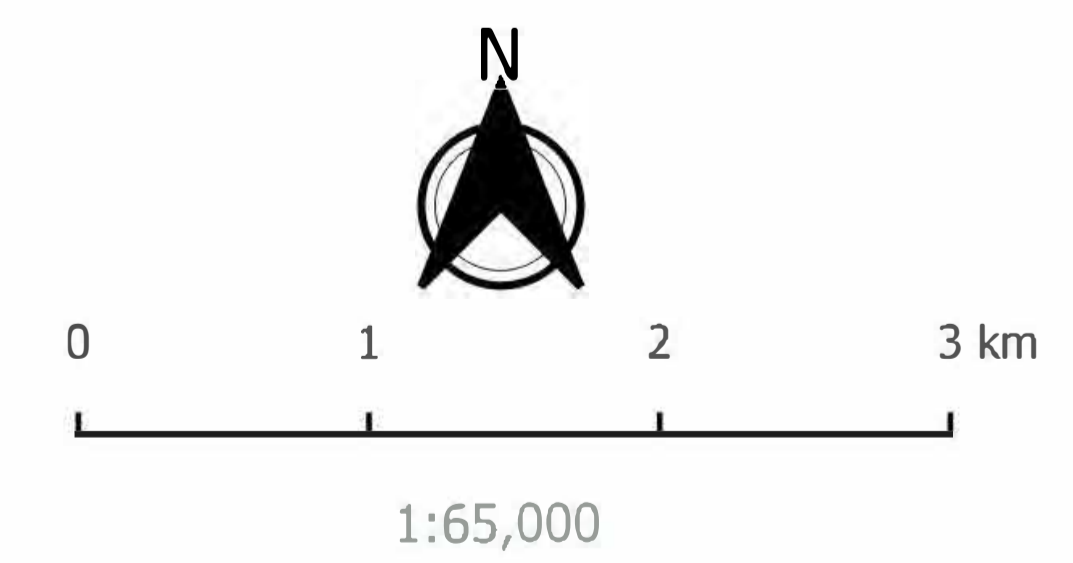


Figure 2



Project Name: Tiwi Islands Biodiversity Surveys (2020-030)
Client: GHD
Date: 27 May 2021
Datum: WGS84



Table 5 van-Cuylenburg & Dunlop (1973) land unit mapping descriptions

Land Unit	Aspect	Description
1a	Landform	Plateau surfaces, generally flat but may be slightly undulating.
	Soils	Red earths (Berrimah family series II), deep, with occasional gravels and some lateritic outcrop in the unit.
	Vegetation	Open forest: <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. nesophila</i> dominant with an understorey of <i>Grevillea pteridifolia</i> , <i>Livistona</i> and <i>Acacia</i> spp., occasional <i>Cycas</i> and <i>Pandanus</i> sp. Annual and perennial grasses.
2a	Landform	Slopes generally 10-15% with occasional cliffs, usually fairly rugged.
	Soils	Very shallow, red lithosols (Irgul).
	Vegetation	<i>C. nesophila</i> - <i>E. miniata</i> open forest, tall shrub understorey (<i>Grevillea heliosperma</i> , <i>Cochloerium fraseri</i> , <i>Grevillea pteridifolia</i>); ground cover sparse, of mainly annual grasses
3a	Landform	Long colluvial slopes below the plateau surfaces, separated from the plateau by scarps. Slopes are normally 1-3% but can be greater. Some remnant areas occur in the main body of the plains isolated from their parent scarp and plateau.
	Soils	Deep sandy red earths (Killuppa family series II); no gravel or laterite outcrop were noted in this unit. Soils of the Berrimah family are sometimes found in this unit.
	Vegetation	Open forest: <i>E. miniata</i> , <i>C. nesophila</i> dominant with the occasional <i>E. tetradonta</i> . Tall understorey of <i>G. heliosperma</i> , <i>Erythrohleum</i> , <i>Livistona</i> with few <i>G. pteridifolia</i> and ground cover of shrubs, annual grasses (<i>Eriachne trisetata</i> , <i>Thaumastochloa major</i>) and perennial grasses (<i>Sorghum plumosum</i> , <i>Eulalia mackinlayi</i> , <i>Eriachne squarrosa</i>).
3b	Landform	Gently sloping - undulating areas associated with units 1a, 2a and 3a.
	Soils	Gravelly red earths (Hotham family); with some laterite outcrop.
	Vegetation	Woodland: <i>C. bleeseri</i> dominant, understorey- sparse (<i>Livistona humilis</i> , <i>Calytrix exstipulata</i>). Ground cover- short grasses, mainly <i>Eriachne avenacea</i> .
3c	Landform	Footslopes or lower slopes of the rugged terrain or gently undulating timbered areas.
	Soils	Deep earthy sands (Cockatoo family series II).
	Vegetation	Open forest: <i>C. nesophila</i> or <i>E. miniata</i> - <i>E. tetradonta</i> dominant. Understorey of tall shrubs <i>G. heliosperma</i> , <i>G. pteridifolia</i> , <i>Acacia latescens</i> , <i>Alpitonia</i> sp.), ground cover of annual and perennial grasses (<i>Eriachne trisetata</i> , <i>Eragrostis</i> sp., <i>Eriachne avenacea</i> , <i>Sorghum plumosum</i>).
4a	Landform	Lower slopes, up to 3%.
	Soils	Deep sandy yellow earths (Ramil family series II).

Land Unit	Aspect	Description
4c	Vegetation	Tall shrubland; low woodland. Shrubs dominant (<i>Banksia dentata</i> , <i>Acacia</i> spp.) with <i>G. pteridifolia</i> , <i>Tristania emergens</i> . Ground cover of suckers, of tree species <i>C. ptychocarpa</i> , <i>Melaleuca</i> , <i>Eugenia bleeseri</i>) and perennial grasses (<i>Eriachne avenacea</i> , <i>E. squarrosa</i> , <i>Eulalia mackinlayi</i>).
	Landform	Undulating terrain with some slopes as great as 4%; these are at low levels in the landscape.
	Soils	Lateritic yellow earths, (Koolpinyah family).
5a	Vegetation	Tall shrubland; low woodland. <i>C. porrecta</i> or <i>C. confertiflora</i> may be dominant in patches or in other areas. <i>G. pteridiifolia</i> , <i>Tristania</i> and <i>Livistona</i> may be dominant. Understorey variable, mainly <i>Acacia</i> spp., <i>Grevillea</i> spp. and suckers of tree species (<i>Buchanania</i> , <i>Planchonia</i> , <i>Terminalia</i> , <i>Eugenia</i>). Grasses mainly perennial: <i>Eriachne avenacea</i> , <i>E. squarrosa</i> , <i>Eulalia mackinlayi</i> .
	Landform	Flat to gently undulating terrain; some slopes to 2%.
	Soils	Deep sandy red earths (Killuppa family) on colluvium.
6a	Vegetation	Low open woodland; low shrubland. Shrubs (<i>Banksia dentata</i> , <i>Acacia</i> spp.) dominant with suckers of tree species (<i>Eugenia bleeseri</i> , <i>Tristania</i> , <i>C. ptychocarpa</i> , <i>Planchonia</i>). Overstorey of scattered small trees: <i>G. pteridifolia</i> , <i>Livistona humilis</i> . Almost total cover of perennial grasses: <i>Eulalia mackinlayi</i> , <i>Eriachne avenacea</i> , <i>Sorghum plumosum</i> .
	Landform	Low lying areas in the landscape with maximum slopes of 1%.
	Soils	Lateritic podzolics (Mirrikau family series I & II). These soils have high amounts of gravel in the lower A and upper B horizons
6c	Vegetation	Low woodland. <i>Melaleuca viridiflora</i> dominant, understorey of tall shrubs (<i>G. pteridifolia</i> , <i>Acacia dimidiata</i>) and occasional small trees (<i>Pandanus</i> , <i>Livistona</i>). Ground cover of tree species as suckers (<i>Planchonia</i> , <i>Buchanania</i> , <i>Terminalia</i>) and perennial grasses (<i>Eriachne avenacea</i> , <i>E. squarrosa</i> , <i>Eulalia mackinlayi</i>).
	Landform	Low lying areas, generally flat with maximum slopes of 1%.
	Soils	Lateritic podzolics (Mirrikau family series I & II). High amounts of gravel in the lower A and upper B horizons.
7a	Vegetation	Tall open-shrubland: <i>Banksia dentata</i> and <i>G. pteridifolia</i> dominant with a variety of other shrub species (<i>Acacia</i> , <i>Grevillea</i> , <i>Petalostigma</i>) and suckers of tree species – <i>E. tetrodonta</i> , <i>Eugenia</i> , <i>Tristania</i> , <i>Melaleuca</i>). Annual and perennial grasses equally numerous: Annual <i>Sorghum</i> , <i>Schizachrium</i> , <i>Eriachne squarrosa</i> , <i>Eulalia mackinlayi</i> .
	Landform	Springs, creeks and drainage flats.
	Soils	Humic gleys and Gleyed podzolics, Murrabibbi and Marrakai family respectively. Soft weak subsoils.
7a	Vegetation	Grassland (wet) with tall open-shrubland patches. Grasses: annual <i>Sorghum</i> , <i>Eriachne</i> , <i>Coelorachis</i> and sedges forming a complete ground cover. Trees: scattered clumps of <i>Grevillea pteridifolia</i> , <i>Pandanus</i> . Ground cover of tree species as suckers (<i>C. ptychocarpa</i> , <i>E. tetrodonta</i>).

Table 6 Land system descriptions (Lynch et al, 2012) for all map areas only

Land system	Landscape class	Landscape class description	Landform description	Soil (original description)	Vegetation description
Callemondah	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Colluvial slopes included weathered plateau remnants and plateau footslopes	Shallow sandy and gravely red massive earths	Mid-high open forest of <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. nesophila</i> , <i>C. confertiflora</i> , <i>Erythrophleum chlorostachys</i> with a moderately dense understory of <i>Livistona humilis</i> , <i>Pandanus</i> sp, <i>Cycas</i> sp, <i>Petalostigma pubescens</i> over <i>Imperata cylindrica</i>
Dundas	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating plains formed on deposits overlying Van Diemen sandstone	Deep sandy and loamy red earths	Mid-high open forest of <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. nesophila</i> , <i>C. confertiflora</i>
Mirikau	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Undulating erosional rises, commonly incised by drainage lines	Sandy red earths	Tall woodland of <i>E. miniata</i> , <i>C. nesophila</i> , <i>E. tetradonta</i> with moderately dense understory of <i>Acacia</i> spp, <i>Grevillea pteridifolia</i> , <i>Persoonia falcata</i> over perennial grasses (<i>Eriachne trisetata</i> , <i>Eulalia mackinlayi</i>)
Moonkinu	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Broad, flat to gently undulating plains and associated drainage lines	Sandy red earths	Low open shrubland of <i>Grevillea pteridifolia</i> , <i>Persoonia falcata</i> and <i>Acacia oncinocarpa</i> over <i>Eulalia mackinlayi</i> , <i>Eriachne avenacea</i> and <i>Eriachne trisetata</i>
Pickertaramoor	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Rolling low hills and rises on Van Diemen sandstone	Shallow skeletal soils	Tall open forest of <i>C. nesophila</i> , <i>E. tetradonta</i> , <i>E. miniata</i>
Rugged	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Rugged terrain deeply dissected by many creeks and drainage lines	Very shallow soils	Tall open forest of <i>C. nesophila</i> , <i>E. tetradonta</i> , <i>E. miniata</i>
Tiwi	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating plains on deeply weathered Van Diemen sandstone	Deep sandy red earths	Tall open forest of <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. nesophila</i> and <i>C. confertiflora</i> over <i>Imperata cylindrica</i> , <i>Pseudopogonatherum</i> and <i>Eriachne trisetata</i>
Van Diemen	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Broad, gently dissected plateau surface on strongly weathered Tertiary Van Diemen sandstone	Deep sandy and loamy red earths	Tall open forest of <i>E. miniata</i> , <i>E. tetradonta</i> , <i>C. nesophila</i> over tropical tall grass (<i>Sorghum</i> spp, <i>Chrysopogon</i> spp, <i>Heteropogon</i> spp)

**Land System Mapping
(Lynch et al, 2012)
- Maps 1-6**

Key

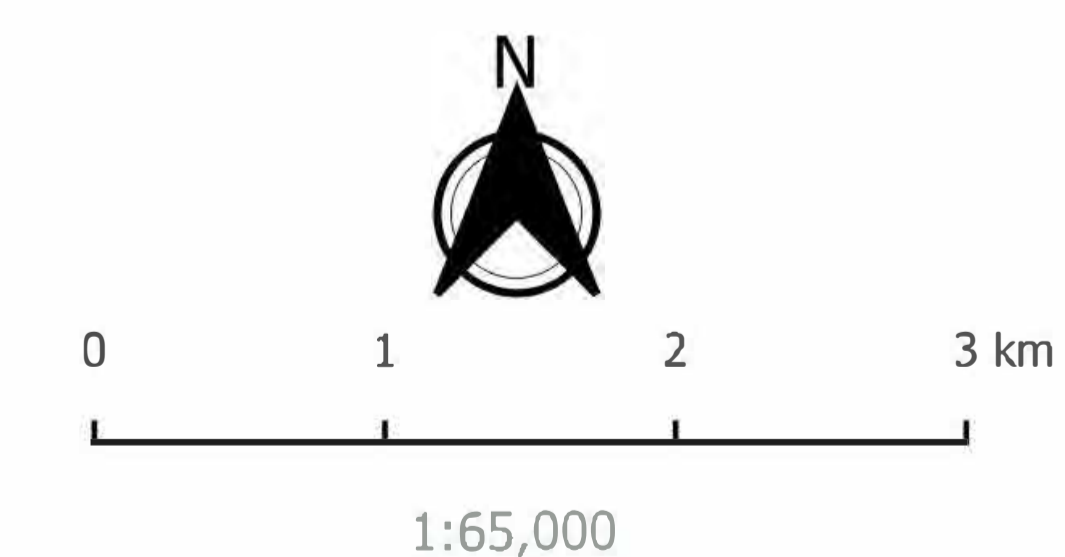
- Map areas
- Existing bores 100 m buffer
- Water points 100 m buffer
- Gravel extraction area
- Road realignment

Land systems

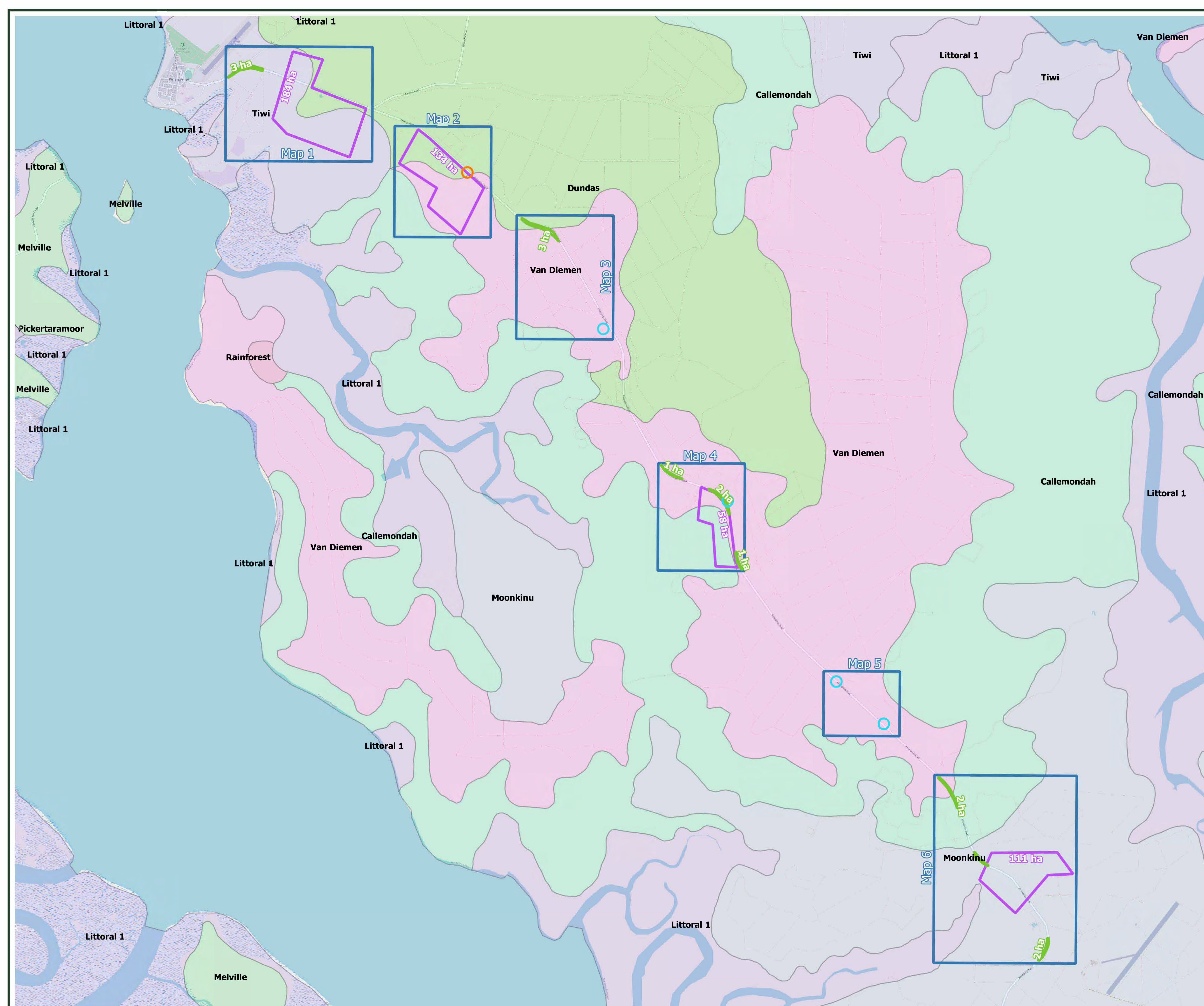
- Callemondah
- Dundas
- Mirikau
- Moonkinu
- Pickertaramoor
- Rugged
- Tiwi
- Van Diemen

Background - OpenStreetMap

Figure 3



Project Name: Tiwi Islands Biodiversity Surveys
(2020-030)
Client: GHD
Date: 27 May 2021
Datum: WGS84



**Land System Mapping
(Lynch et al, 2012)
- Maps 7-15**

Key

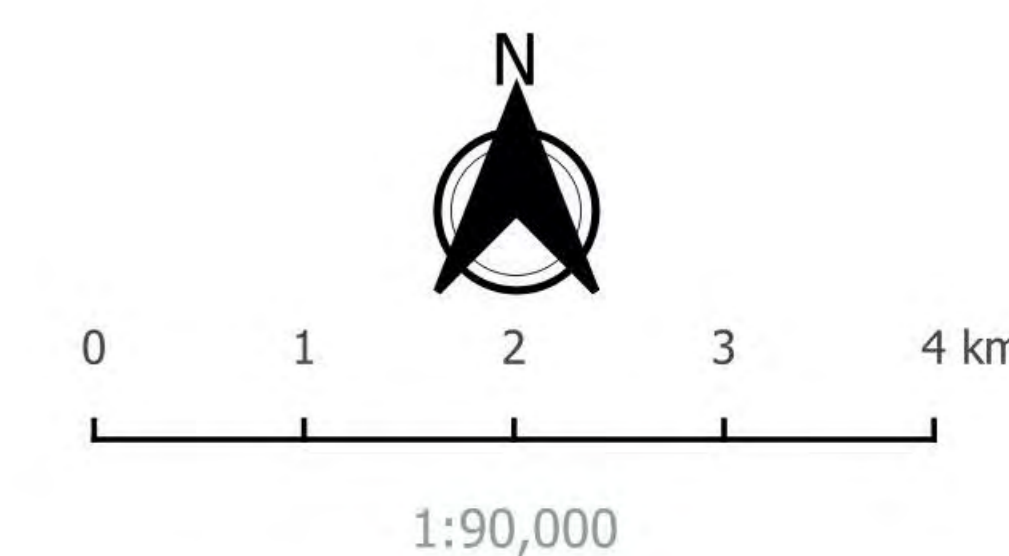
- Map areas
- Existing bores 100 m buffer
- Water points 100 m buffer
- Gravel extraction area
- Road realignment

Land systems

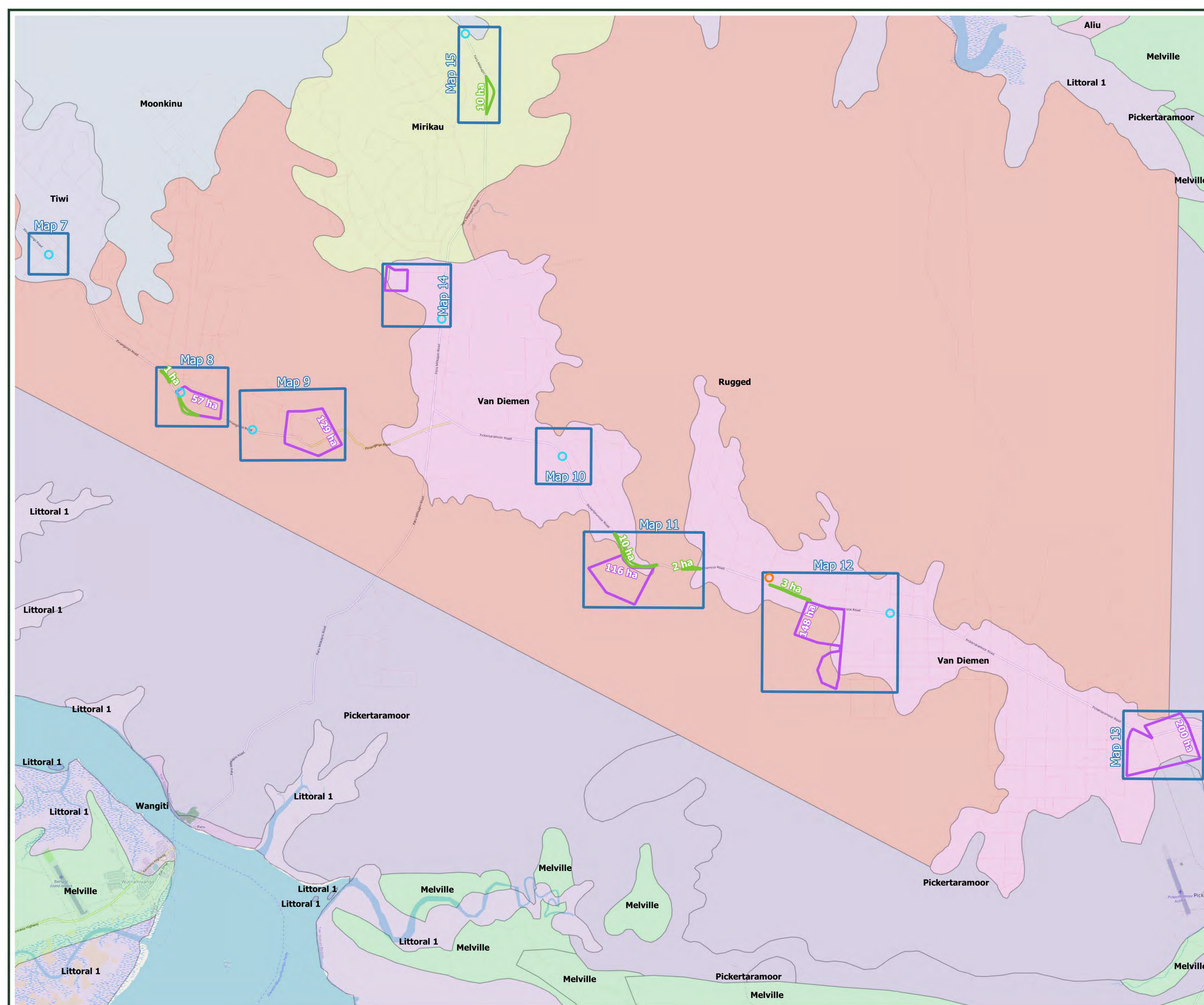
- Callemondah
- Dundas
- Mirikau
- Moonkinu
- Pickertaramoor
- Rugged
- Tiwi
- Van Diemen

Background - OpenStreetMap

Figure 4



Project Name: Tiwi Islands Biodiversity Surveys
(2020-030)
Client: GHD
Date: 27 May 2021
Datum: WGS84






**Land System Mapping
(Lynch et al, 2012)
- Maps 15-22**

Key

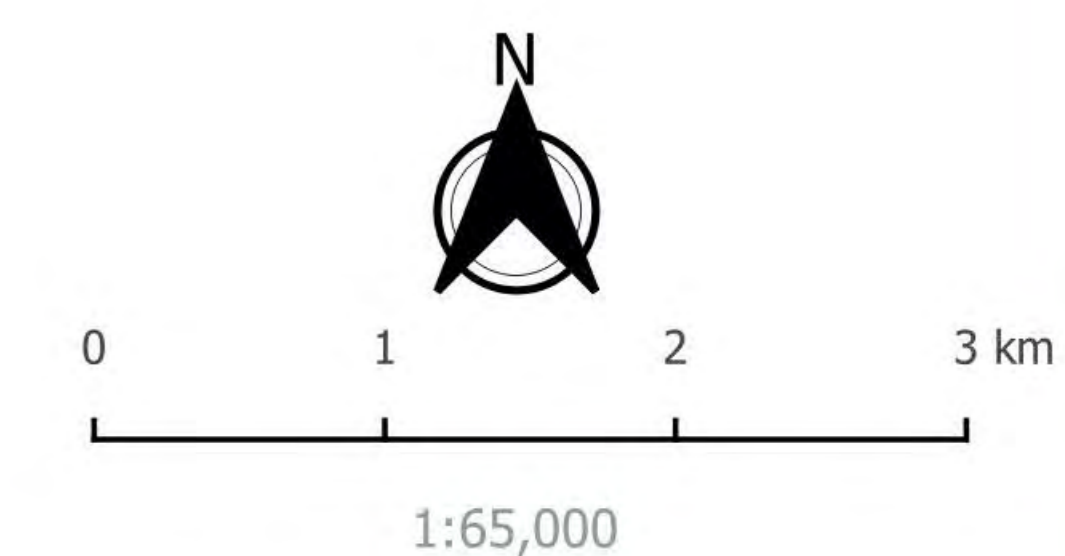
-  Map areas
-  Existing bores 100 m buffer
-  Water points 100 m buffer
-  Gravel extraction area
-  Road realignment

Land systems

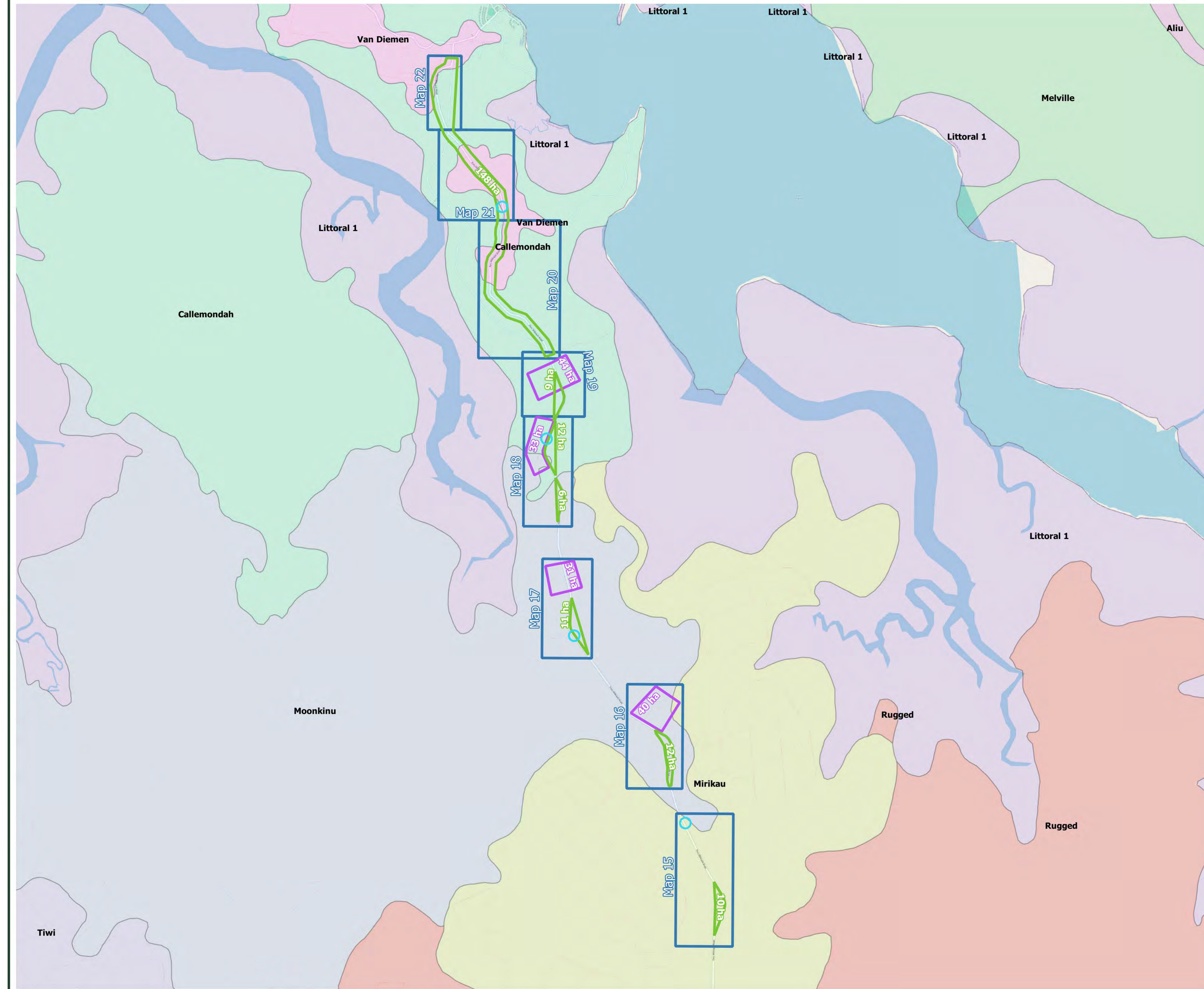
-  Callemondah
-  Dundas
-  Mirikau
-  Moonkinu
-  Pickertaramoor
-  Rugged
-  Tiwi
-  Van Diemen

Background - OpenStreetMap

Figure 5



Project Name: Tiwi Islands Biodiversity Surveys
(2020-030)
Client: GHD
Date: 27 May 2021
Datum: WGS84



2.3 Topography

Topography (contours), and associated slope modelling (conducted by GHD), across the survey area is shown in **Appendix A**.

2.4 Vegetation Communities

Vegetation datasets available for the Tiwi Islands (as shown on NR Maps) include:

- Regionalisation of Mangrove Communities along the Northern Territory Coast (updated 2016; scale 1:250k).
- DRAFT Melaleuca Survey of the Northern Territory (updated 2013; scale 1:100k).
- Vegetation Survey of the Northern Territory, Australia 1990 (updated 2006; scale 1:1M).
- NVIS - National Vegetation Information System, NT Data Compilation (1750 and 2007) (updated 2013; scale 1:1M).
- The History and Natural Resources of the Tiwi Islands, Northern Territory (updated 2005; scale 1:250k).

None offer greater detail than the existing land unit mapping (described in **Section 2.1**) or land system mapping (**Section 2.2**), and therefore these are not mapped here. However, for context and to aid in the assessment of impacts for this project, **Table 7** lists the vegetation types, and their extents, on the Tiwi Islands (Woinarski *et al.*, 2003).

Table 7 Vegetation types on the Tiwi Islands, and their relative extent (source: Woinarski et al., 2003)

Class	Description	Area (km ²)		
		Bathurst	Melville	Total
Wet rainforest	Floristically diverse tall closed forests around springs and some sheltered watercourses.	4.4	21.7	26.1
Dry rainforest	Coastal thickets and dry slopes of broken plateau edge	29.7	102.8	132.5
Mangroves	Tall dense forests to low open woodlands in tidally inundated coastal areas, with a range of dominant species including <i>Sonneratia alba</i> , <i>Rhizophora stylosa</i> , <i>Bruguiera parviflora</i> , <i>Xylocarpus mekongensis</i> and <i>Ceriops tagal</i> .	275.6	515.8	791.4
Sand and salt flats	Typically saline coastal areas intermixed with mangals, and supporting no vegetation, coastal dunefields, or grasslands dominated by <i>Sporobolus virginicus</i> .	14.8	115.5	130.3
Sedgeland and grasslands	Mostly seasonally inundated areas, typically dominated by <i>Eleocharis dulcis</i> and <i>Scirpus litoralis</i> .	13.2	159.7	172.9
<i>Melaleuca</i> open forests	Forests dominated by a range of <i>Melaleuca</i> spp. (typically including <i>M. leucadendra</i> and <i>M. viridiflora</i>) in riparian areas and swamplands	13.7	47.1	60.8
<i>Melaleuca</i> low woodlands	Low woodlands or shrublands typically on poorly drained sites, dominated by <i>M. nervosa</i> and/or <i>M. viridiflora</i>	3.8	12.5	16.3
Treeless plains	Low open woodlands typically dominated by <i>Acacia</i> spp., <i>Grevillea pteridifolia</i> and <i>Banksia dentata</i>	22.1	160.7	182.8

Class	Description	Area (km ²)		
		Bathurst	Melville	Total
Eucalypt forest (dense)	Tall forest dominated by <i>Eucalyptus miniata</i> , <i>E. tetradonta</i> and/or <i>Corymbia nesophila</i> (often with ironwood <i>Erythrophleum chlorostachys</i> subdominant), typically with dense tall understorey (variably including <i>Acacia</i> spp., <i>Gronophyllum</i> , <i>Livistona</i>); also including smaller areas of <i>Lophostemon lactifluus</i> and <i>Eucalyptus ptychocarpa</i> in drainage lines	610.0	1384.5	1994.5
Eucalypt forest (mid-open)	Tall forest dominated by <i>Eucalyptus miniata</i> , <i>E. tetradonta</i> and/or <i>Corymbia nesophila</i> , typically with grassy understorey	477.7	2130.9	2608.6
Eucalypt forest (open)	Forest typically dominated by <i>Corymbia bleeseri</i> with open grassy understorey	152.6	873.5	1026.1
Eucalypt woodland	Woodland dominated by <i>Eucalyptus oligantha</i> or <i>Corymbia latifolia</i> or <i>E. alba</i> with grass understorey	1.1	94.8	94.8
Plantations	-	2.2	78.9	81.1
Built-up area	-	18.4	6.2	25.7
Total	-	1639.3	5704.6	7344

2.5 Sensitive and Significant Vegetation Types

The NT *Land Clearing Guidelines* (DENR, 2021) describe ‘sensitive’ or ‘significant’ vegetation as rainforest, vine thicket, closed forest, riparian vegetation, mangroves, monsoon vine forest, sand sheet heath and vegetation containing large trees with hollows suitable for fauna.

In addition, the NT EPA, in its Terms of Reference for several projects, have referred to such sensitive or significant vegetation, though has also included important habitat corridors, wetlands and groundwater dependent ecosystems.

Based on the analysis of existing datasets, sensitive and/or significant vegetation types within the survey area are described in **Table 8**.

Table 8 Sensitive and/or significant vegetation types within the survey area based on existing mapping datasets

Map	Sensitive / significant vegetation type	Data source
6	Springs, creeks and drainage flats	Land units of the Seventeen Mile Plain (van-Cuylenburg & Dunlop, 1973)
8	Wet evergreen spring rainforest	The History and Natural Resources of the Tiwi Islands, Northern Territory (PWCNT, 1998)
11	Drainage flats associate with springs, creeks and drainage lines	Land units of areas adjacent to the Tuyu and Yapilika forestry plantations (Wells & van-Cuylenburg, 1978)
12	Wet evergreen spring rainforest	The History and Natural Resources of the Tiwi Islands, Northern Territory (PWCNT, 1998)
	Drainage flats associate with springs, creeks and drainage lines	Land units of areas adjacent to the Tuyu and Yapilika forestry plantations (Wells & van-Cuylenburg, 1978)

Map	Sensitive / significant vegetation type	Data source
17	<i>Melaleuca viridiflora</i> low woodland	Land units of the Seventeen Mile Plain (van-Cuylenburg & Dunlop, 1973)
18	<i>Melaleuca</i> open forest – riparian / billabong	The History and Natural Resources of the Tiwi Islands, Northern Territory (PWCNT, 1998)
20	Dry rainforest, semi-deciduous rain forest	The History and Natural Resources of the Tiwi Islands, Northern Territory (PWCNT, 1998)

2.6 Rainfall

The nearest weather station to the project area that has adequate recent rainfall data is Pirlangimpi (Bureau of Meteorology station number 14142). It receives approximately 2,017 mm of rain annually on average (calculated from data starting in 1963; BOM, 2021) (**Table 9**).

Table 9 Wet season rainfall at Pirlangimpi Weather Station over the last three wet seasons

Year	Month	Monthly rainfall (mm)	Total wet season rainfall (mm)
2018/19	December	117	980
	January	203	
	February	176	
	March	363	
	April	121	
2019/20	December	180	1,416
	January	540	
	February	187	
	March	282	
	April	227	
2020/21	December	301	1,698
	January	701	
	February	404	
	March	155	
	April	137	
Average annual rainfall - 1980-2019⁴			2,017

⁴ Note that this is the annual average, not wet season average.

2.7 Fire History

Fire frequency from 2000 to 2020 across the survey area, as well as the frequency of 'late' fires (i.e., after 31 July) during the same period, has been obtained from the North Australia and Rangelands Fire Information service (NAFI, 2021). Fire frequency has been mapped in **Appendix B**. This information aids in assessing the condition and/or suitability of habitats for threatened species.

2.8 Threatened Species Records

Existing records of threatened flora and fauna species, as of January 2021 (i.e., immediately prior to the commencement of survey for this project), within or in the vicinity of the survey areas are mapped in **Appendix C** and tabulated in **Appendix D** (preliminary threatened species likelihood of occurrence assessment). These records aid in the assessment of the likelihood of occurrence of threatened species within the survey areas and the development of the subsequent survey approach.

Existing data of threatened flora and fauna records was initially obtained in January 2021. Since then, it is possible that the NT flora and fauna atlas databases have been updated with new records. Consequently, the finalised impact and risk assessment in **Section 10** contains all records, for relevant species, up to October 2021.

2.9 Existing Terrestrial Fauna Surveys

A summary of existing terrestrial fauna surveys is provided in **Table 10**. Where species are not confirmed (✓), it may be because records weren't included within the survey report, data was not located or records were unclear. The NT Fauna Atlas was also searched and an association was attempted with fauna surveys conducted during the date of those records (based on date, species, recorder, description etc.). In addition, there are records in the NT Fauna Atlas that may not have been from any of these fauna surveys and may be incidental sightings or from surveys not recorded here. Lastly, it is unclear what surveys have taken place, and continue to, for the plantation forestry or other developments on the Tiwi Islands. Often, as far as is understood, these records are generally not made public.

Consequently, records within this list may be incomplete. However, it provides some indication of the dates of records from which further investigation can occur for each target species (as in **Section 10**).

Table 10 Terrestrial fauna surveys conducted on the Tiwi Islands

Year	Method	Reference	Species detected ⁵												
			HR	HB	RG	PP	MO	BTRR	BFTR	BTP	PFR	BD	NBP	MWM	
Early-mid 1900's	Uncertain	Woinarski <i>et al.</i> , 2003b (references within)	✓	✓	✓	✓	✓	✓	✓	-	-	✓	-	✓	
1990-1992	18 rainforest patches and adjacent habitat over 10 weeks						✓	✓	✓	-	✓	✓	✓		
1996	Riparian sites, 2 weeks, Melville Is. (MAGNT)								✓		✓	✓	✓	✓	
1996	Broad-scale collection of birds (CSIRO)						✓	-	-	-	-	-	-	-	-
1998	4-day survey for plantation EIA; then a 10-day survey (PWCNT)						?	?	?	?	?	?	?	?	?
2000-2002	351 sites consisting of 50x50m quadrats with 20 Elliotts, 4 cages and 4 pitfalls	Woinarski <i>et al.</i> , 2003b					✓	✓	✓	✓	✓	✓	✓	✓	
2006-2008	Six surveys (methods and results uncertain)	?													
2013-2015	Camera trapping in 18 fire plots for two years	Davies <i>et al.</i> , 2018b							✓	✓	✓	✓	? ⁶	✓	
2013-2016	Cameras and live trapping during an extensive survey of mammals across ~370,000 km ² of monsoonal northern Australia (including the Tiwi Islands)	Stobo-Wilson <i>et al.</i> , 2020a, 2020b					✓	✓			✓	? ⁷			
2015	82 sites consisting of 50x50m quadrats with 16 Elliotts and 8 cages, plus cameras at each site	Davies <i>et al.</i> , 2018a							✓	✓	X	✓	X	✓	-
	6 sites using cameras only (as part of above study)														

⁵ HR = Hooded Robin; HB = Horsfield's Bushlark; RG = Red Goshawk; PP = Partridge Pigeon; MO = Masked Owl; BTRR = Brush-tailed Rabbit-rat; BFTR = Black-footed Tree-rat; BTP = Brush-tailed Phascogale; PFR = Pale Field-rat; BD = Butler's Dunnart; NBP = Northern Brush-tailed Possum; MWM = Merten's Water Monitor

⁶ Butler's Dunnart was grouped with other dunnart and mouse species.

⁷ Butler's Dunnart was grouped with the Red-cheeked Dunnart

Year	Method	Reference	Species detected ⁵												
			HR	HB	RG	PP	MO	BTRR	BFTR	BTP	PFR	BD	NBP	MWM	
2016-2017	Six sites, pitfalls and cameras at each. Melville Is.	Potter, 2017	-	-	-	✓	-	✓	✓	-	✓	✓	-	-	
June 2018 to May 2019	50 cameras (tree-mounted 3 m above ground) at Taracumbi (Melville Island)	Geyle <i>et al.</i> , 2020	-	-	-	-	-	X	✓	✓	X	X	✓	-	
2019 (June and September)	Live trapping at four sites (two on Bathurst Island and two on Melville Island), twice, using one trapping grid (30 rows of 10) at each site.	Davies <i>et al.</i> , 2021	-	-	-	-	-	X	✓	✓	✓	✓	✓	-	
2021	Fauna surveys for the Paru Road upgrade	AECOM, 2021	-	-	?	✓	✓	X	✓	X	✓	✓		✓	
Annually	Surveys for forestry plantations	No reference.	?	?	?	?	?	?	?	?	?	?	?	?	

3 Preliminary Assessment of the Likelihood of Occurrence of Threatened Species

The likelihood of occurrence of threatened species within the survey area was assessed using information collated in **Section 2** and records from the NT Flora and Fauna Atlases. Fourteen species were identified as potentially occurring in the survey area. Subsequently, these were the focus of the surveys (**Table 11**). The full likelihood of occurrence assessment is provided in **Appendix D**.

A fourth threatened flora species, *Calochilus caeruleus* (a terrestrial orchid; listed as vulnerable under the NT TPWC Act), is known to occur with the vicinity of the survey area (along Milikapiti Road), in seasonally inundated flats and *Melaleuca* woodlands, similar to those in or near map area 16 and 17. However, its most recent detection was in 1992 and it was not recorded during substantial flora and fauna surveys conducted across the Tiwi Islands from 1999 to 2002 (Kerrigan & Cowie, 2012; Woinarski *et al.*, 2003). Consequently, the species was considered unlikely to occur and not targeted during these surveys. Either way, the species is detectable during December and January (Kerrigan & Cowie, 2012), which was prior to the survey period for this project.

Table 11 Preliminary likelihood of occurrence assessment summary (only species known to be present or those that are likely to, or possibly, occur)

Likelihood	Scientific name	Common name	Status*	
			NT	Cth^
Present	<i>Cycas armstrongii</i>	Darwin Cycad	VU	-
Likely	<i>Typhonium jonesii</i>	<i>Typhonium jonesii</i>	EN	EN
	<i>Typhonium mirabile</i>	<i>Typhonium mirabile</i>	EN	EN
	<i>Geophaps smithii</i>	Partridge Pigeon	VU	VU
	<i>Trichosurus vulpecula arnhemensis</i>	Northern Brushtail Possum	-	VU
Possible	<i>Erythrotriorchis radiatus</i>	Red Goshawk	VU	VU
	<i>Tyto novaehollandiae kimberli</i>	Masked Owl (northern)	VU	VU
	<i>Conilurus penicillatus</i>	Brush-tailed Rabbit-rat	EN	VU
	<i>Mesembriomys gouldii melvillensis</i>	Black-footed Tree-rat (Melville Island)	VU	VU
	<i>Phascogale pirata</i>	Northern Brush-tailed Phascogale	EN	VU
	<i>Rattus tunneyi</i>	Pale Field-rat	VU	-
	<i>Sminthopsis butleri</i>	Butler's Dunnart	VU	VU
	<i>Varanus mertensi</i>	Mertens' Water Monitor	VU	-
	<i>Varanus panoptes</i>	Yellow-spotted Monitor	VU	-

* CR = critically endangered; EN = endangered; VU = vulnerable.

^ Cth = Commonwealth (*Environment Protection and Biodiversity Conservation Act*)

4 Preliminary Assessment of Inherent Risks

A preliminary assessment of the level of potential inherent impact to species of concern was conducted to determine whether further surveys and/or assessment is required for that species. It is specifically related to those species determined to be ‘possible’ or ‘likely’ to occur in the project area (as per **Section 3**). It considers *inherent* risks only (i.e., pre-mitigation) and does not quantify such risks. Potential impacts are listed in **Table 12**. Definitions for the consequence of impacts are in **Table 13** and are taken from the Species Expert Assessment Plan (SEAP) Manual (TSSC, 2015). The results of the preliminary assessment of inherent risks are in **Table 14**. Species identified as not requiring a survey in **Table 14** may still require surveys if the development footprint changes.

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 analyses is warranted, potentially including surveys.

The assessed risk may change following the on-site surveys once the true abundance of relevant species and potentially suitable habitat is better understood. Risk is re-assessed and quantified in **Section 10** following the surveys and interpretation of survey data.

Table 12 Potential impacts on biodiversity as a result of the project

Potential impact	During construction (immediate)	Residual (long-term)
Loss of vegetation and habitat	✓	✓
Habitat fragmentation	✓	✓
Unauthorised or inadvertent vegetation clearing (outside defined clearance boundaries)	✓	
Introduction or spread of weeds	✓	✓
Dust emissions resulting in reduced air quality, smothering of adjacent vegetation (and flow-on effects to fauna) and public nuisance	✓	
Noise	✓	✓
Erosion and sedimentation	✓	✓
Altered storm water flows	✓	✓
Fire (i.e., accidental or deliberate ignition of vegetation)	✓	
Hydrocarbons and/or hazardous materials spills resulting in reduced water or soil quality	✓	✓
Inappropriate waste disposal.	✓	✓

Table 13 Impact consequence definitions for threatened species (TSSC, 2015b)

Consequence	Insignificant	Minor	Moderate	Major	Critical
Impact on population³	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 result 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 occupancy⁴	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 species⁵	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 cycle⁶	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 disease⁷	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 result 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 14 Preliminary assessment of inherent risk (grey shading indicates the species that require further assessment)

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact ⁸ (bold shows greatest level)				
			Population	Habitat connectivity	Critical habitat ⁹	Breeding cycle	Invasive species
Threatened Flora							
<i>Calochilus caeruleus</i>	-	NT: Vulnerable; Nat.: Not listed	Moderate	Minor	Moderate	Insignificant	Minor
<i>Cycas armstrongii</i>	Darwin Cycad	NT: Vulnerable; Nat.: Not listed	Minor	Insignificant	Insignificant	Insignificant	Minor
<i>Typhonium jonesii</i>	<i>Typhonium jonesii</i>	NT: Vulnerable; Nat.: Not listed	Moderate	Moderate	Moderate	Moderate	Moderate
<i>Typhonium mirabile</i>	<i>Typhonium mirabile</i>	NT: Endangered; Nat.: Endangered					
Threatened Fauna							
<i>Erythrotriorchis radiatus</i>	Red Goshawk	NT: Vulnerable; Nat.: Vulnerable	Minor	Insignificant	Insignificant	Minor	Moderate
<i>Geophaps smithii</i>	Partridge Pigeon	NT: Vulnerable; Nat.: Vulnerable	Insignificant	Insignificant	Insignificant	Insignificant	Moderate
<i>Mesembriomys gouldii gouldii</i>	Black-footed Tree-rat	NT: Vulnerable; Nat: Endangered	Minor	Insignificant	Minor	Minor	Minor
<i>Rattus tunneyi</i>	Pale Field-rat	NT: Vulnerable; Nat.: Not listed	Minor	Minor	Minor	Minor	Moderate
<i>Tyto novaehollandiae melvillensis</i>	Tiwi Masked Owl	NT: Endangered; Nat.: Endangered	Minor	Insignificant	Minor	Insignificant	Minor
<i>Conilurus penicillatus</i>	Brush-tailed Rabbit-rat	NT: Endangered; Nat.: Vulnerable	Minor	Insignificant	Minor	Insignificant	Moderate
<i>Phascogale pirata</i>	Northern Brush-tailed Phascogale	NT: Endangered; Nat.: Vulnerable	Minor	Insignificant	Minor	Insignificant	Moderate
<i>Sminthopsis butleri</i>	Butler's Dunnart	NT: Vulnerable; Nat.: Vulnerable	Minor	Minor	Minor	Minor	Moderate
<i>Varanus mertensi</i>	Mertens' Water Monitor	NT: Vulnerable; Nat.: Not listed	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

⁸ That is, if a population of the species occurs within the disturbance footprint, what is the anticipated level of impact to each aspect listed in **Table 13**?

⁹ As defined in the EPBC Act Significant Impact Guidelines (DoE, 2013), regardless of whether they are listed under the EPBC Act or the TPWC Act

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact ⁸ (bold shows greatest level)				
			Population	Habitat connectivity	Critical habitat ⁹	Breeding cycle	Invasive species
<i>Varanus panoptes</i>	Floodplain Monitor	NT: Vulnerable; Nat.: Not listed	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

5 Survey Methods

As a result of the desktop literature review (**Section 2**), preliminary threatened species likelihood of occurrence assessment (**Section 3**) and preliminary assessment of inherent risks (**Section 4**), on ground surveys were conducted to determine the presence, or potential presence, of threatened species. Survey methodology was informed by:

- *Survey guidelines for Australia's threatened mammals* (DSEWPaC, 2011).
- *Survey guidelines for Australia's threatened birds* (DEWHA, 2010).
- *Survey protocol for Butler's dunnart *Sminthopsis butleri** (Ward, 2009).
- *A guide for the use of remote cameras for wildlife survey in northern Australia* (Gillespie et al., 2015).

5.1 Study Area Breakdown

The survey area was divided into 22 separate areas (numbered Maps 1 to 22) that captured groupings of the various components of the development which were used to aid in project management, logistics and reporting. These areas are referenced throughout this report and are shown in most maps.

5.2 Target Species and Schedule

Table 15 lists the species targeted for on ground surveys and describes the survey type, location and effort. Five survey trips were completed (all in 2021):

- 20 February to 1 March:
 - *Cycas armstrongii* and *Typhonium* spp. (Phases 1 and 2) survey.
 - Deploy first tranche of fauna camera traps (50 cameras).
- 8-10 March: *Typhonium* spp. Phase 3 survey.
- 19-25 March:
 - Retrieve first tranche of camera traps and deploy second tranche (the same 50 cameras).
 - Red Goshawk nest transects.
- 12-13 April: Reconnaissance trip to proposed pitfall trap sites with Tiwi Rangers.
- 15-30 April:
 - Pitfall trapping (20 sites, each comprising two 100 m lines with ten pits and fenced).
 - Red Goshawk nest transects.
 - Retrieve second lot of 50 cameras.

Table 15 Target species and overview of survey effort

Element	Survey objective	Survey type	Habitat and key features	Survey dates	Effort
Flora					
<i>Typhonium jonesii</i>	Extent and density	Presence / absence transects (15 m) Count transects (5 m)	Rocky or lateritic hills in <i>Eucalyptus miniata</i> and <i>Eucalyptus tetradonta</i> woodlands (Kerrigan & Cowie, 2006)	20 February to 10 March 2021	Five ecologists over an area of approximately 355 ha
<i>Typhonium mirabile</i>		Random meander in other areas	Eucalypt woodland on lateritic and sandy soils (Kerrigan <i>et al.</i> , 2007).		
Darwin Cycad	Density estimate	Random point surveys	Well-drained woodland on foothills and slopes	February to April 2021	>1,500 data points (total for all data collected)
Fauna					
Red Goshawk	Presence and distribution of nests	Visit previous nest records Nest search transects Incidental observations	Tall forests within 1 km of water	March 2021	Approximately 1 km of nest search transects
Partridge Pigeon	Presence	Camera traps	Less frequently burnt patches and late dry season waterholes in well-drained open eucalypt woodlands	February to April 2021	3,195 camera trap nights (100 camera traps)
Brush-tailed Phascogale			Woodland with diverse mid-storey and riparian		
Brush-tailed Rabbit-rat					
Black-footed Tree-rat					
Pale Field-rat			Dense vegetation near drainage lines in grassy woodland		
Butler's Dunnart	Presence	Pitfall and camera traps	Eucalypt woodland		20 pitfall trapping sites (400 pits) Cameras

5.3 Vegetation

5.3.1 Vegetation Community Mapping

The vegetation mapping utilised the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst *et al.* 2007) and the *Australian Vegetation Attribute Manual, Version 7.0* (NVIS Technical Working Group, 2017). However, detailed floristics identification was not conducted as, in parts of the survey area, existing land unit, land system and vegetation reports and datasets provided sufficient breakdown of vegetation communities to aid in informing the survey approach for threatened species. In the remaining areas, vegetation identification and subsequent mapping was conducted by undertaking vegetation ‘check’ sites which involved determining the most dominant flora species in each stratum and (at most sites) estimating cover and height values. The location of each point was recorded with a field tablet with GPS capabilities. This information was then used to prepare vegetation maps (using QGIS).

5.3.2 Sensitive or Significant Vegetation

The NT *Land Clearing Guidelines* (DEPWS, 2021) define sensitive and significant vegetation types as ‘ecosystems easily impacted by neighbouring or adjacent land uses or management’ and ‘spatially restricted habitat types that are important to a relatively large number of wildlife species’. This includes rainforest, monsoon vine forest or vine thicket, sandsheet heath, riparian vegetation and mangroves.

Such vegetation types were identified during the surveys while examining and delineating vegetation types. These communities were subsequently highlighted in the mapped vegetation communities.

Areas of vegetation containing large trees with hollows suitable for fauna were not systematically surveyed and mapped as they were widespread and systematic surveys determining the density of ‘large’ trees would have been extremely time consuming. Rather, general observations (e.g., species, approximate tree height, presence of large hollows, approximate density of trees) of large hollow-bearing trees were recorded across the survey area. These observations then informed the delineation of areas that could be classified as significant vegetation. Once these areas were highlighted, consideration of the need for a more detailed assessment was made (if necessary) once DIPL had chosen their preferred gravel pit areas (see **Section 8**).

5.4 Threatened Flora

Threatened flora species identified as having a moderate to high likelihood of being present in the survey area were targeted for survey. These were:

- *Cycas armstrongii*
- *Typhonium mirabile*
- *Typhonium jonesii*.

5.4.1 *Cycas armstrongii*

The objectives of the survey for *Cycas armstrongii* were to:

1. Determine the apparent presence or absence of cycads in each survey area.
2. Where present, estimate the density range of cycads in that area, including locations that contained high or very high densities of cycads. This information (i.e., locations of high or very high densities) will subsequently be used in the assessment of potential impacts.

Given the large size of the total survey area (1,610.4 ha), the survey approach involved either conducting random (non-systematic) counts of cycads within a 20 m x 20 m quadrat or recording general density cycad estimates (usually where cycads were absent, or the density appeared low). Counts and observations were incorporated into surveys for other flora and fauna species.

Importantly, the identity of not all cycads were confirmed. Given the known hybridisation between *C. armstrongii* and *C. maconochiei*, and the subsequent difficulties in confirming these hybrids, cycads (or groups of cycads) which appeared to meet the physiological characteristics of either species (not the hybrid) were counted. The characteristics described in FloraNT (<http://eflora.nt.gov.au/home>) for each species were used to aid in identification.

Table 16 Corresponding number of adult stems and densities for *Cycas armstrongii*

Density	Adult stems / ha	Corresponding no. stems per 400 m ²
None	0	0
Low	1-129	1-5
Moderate	130-399	6-16
High	400-699	17-28
Very High	≥700	>28

5.4.2 *Typhonium jonesii* and *T. mirabile*

5.4.2.1 Objectives

The objectives of the survey for *Typhonium jonesii* and *T. mirabile* were to:

1. Determine the presence or absence of the species in the proposed development footprint.
2. Where detected, determine the abundance and distribution of individuals.

Typhonium jonesii and *T. mirabile* are detectable during the wet season only and are surveyed ideally during January or February (Bickerton *et al.*, 2020). They are cryptic species due to their small size (i.e., leaves to 8 cm), and individuals can be scattered, sparsely distributed, or highly clustered (Bickerton *et al.*, 2020). As such, the survey was conducted using an approach that optimised detection.

The survey was conducted from 20 February to 2 March 2021, then a second round from 8 to 10 March 2021. Visibility of individuals was considered satisfactory, though where ground layer vegetation was dense, the pace of searching slowed and width of transects reduced to account for the reduction in effective visibility.

5.4.2.2 Survey Area and Method

Mapping of potential habitat for *Typhonium jonesii* and *T. mirabile* was provided by the NT Government and used to inform the approach for the survey. The model categorises ‘high’, ‘moderate’ and ‘low’ potential for the species to occur. The survey was divided into three phases, based on the modelling, as advised by the NT Herbarium:

1. Phase 1: All areas modelled high and moderate suitability were surveyed (355 ha in total) (see **Table 17**), except where unsuitable habitat occurred (e.g., inundated melaleuca wetlands). A two-step approach was used in these areas:

- a. Firstly, transects were walked 15 m apart searching for individuals. A 15 m x 50 m grid was placed over the georeferenced maps to aid in transect spacing accuracy. It was expected that the effective transect width was 1-5 m, subject to the density of ground vegetation. For the purposes of calculating an effective coverage area, a distance of 3 m either side of the centreline was used (refer to the results in **Section 6.5.2**).
 - b. Where individuals were detected during phase 1a, the distance between transects was reduced to approximately 5 m to determine the abundance and distribution of individuals in that area. This was continued for 20-30 m beyond the last detected individual.
2. Phase 2: Where individuals of either species were detected close to the edge of the modelled high and moderate, a survey would continue outside these areas until no further individuals were detected for 50 m.
 3. Phase 3: A random meander survey was conducted in all areas not modelled as high or moderate suitability, except where the habitat appeared obviously unsuitable. These areas were not surveyed in detail under the assumptions that either no individuals occurred, or they occurred very infrequently, based on advice from the NT Herbarium (pers. Comm. N. Cuff, 5 March 2021).

5.4.2.3 Identification of *T. jonesii* and *T. mirabile*

The species morphological characteristics were studied prior to the survey by all ecologists. Several ecologists were also experienced in surveying for these and other *Typhonium* species. During the surveys, numerous detected individuals of each species were viewed by all team members, particularly when unusual leaf forms were observed.

In addition, molecular samples were collected from ten *Typhonium* plants to improve confidence in the delineation of species. Samples were sent to the Australian Tropical Herbarium at James Cook University for analysis.

5.4.2.4 Survey Team and Equipment

The *Typhonium* survey team consisted of Mihkel Proos, Kym Brennan, Heather North, Justin Bott and Sydney Collett. Each surveyor carried a GPS-enabled field tablet with georeferenced maps or a GPS. Where individuals of either species were detected, the species, quantity of plants, any unusual leaf characteristics, whether it was fruiting, and the location were recorded on the device. Photos were also taken of numerous plants.

5.4.2.5 Limitations

It is likely that some individuals were not detected within the survey area. However, given the survey methodology, which was conducted in accordance with guidance provided by the NT Herbarium, it is unlikely that additional significant ‘patches’ of either species were not detected.

Table 17 The area of modelled *Typhonium jonesii* habitat within the survey area

Modelled habitat	TOTAL (ha)
Low (i.e., everywhere that is not moderate or high likelihood)	1,242
Moderate	211
High	144
TOTAL	1,597

5.5 Threatened Fauna

5.5.1 Target Species and Overview of Approach

Based on analysis of local records, vegetation mapping and aerial imagery, at least eight threatened fauna species were determined to potentially occur within the survey area (**Table 18**). Further details on each survey type are provided in the following sections. Habitat for other species that were determined unlikely to occur within the survey area were verified during the on-ground surveys.

Table 18 Target species and overview of survey approach

Scientific Name	Common Name	Survey approach	Justification
<i>Erythrotriorchis radiatus</i>	Red Goshawk	Nest surveys Check for presence and/or condition of known historic nests Incidental observations	Red Goshawks are known to occur across the Tiwi Islands though at low densities. Therefore, rather than conducting comprehensive surveys to re-affirm their presence, the assessment will primarily focus on locating nests and/or determining the suitability of foraging and nesting habitats.
<i>Geophaps smithii</i>	Partridge Pigeon	Cameras Incidental observations	Partridge Pigeons are relatively abundant throughout suitable habitat on the Tiwi Islands. Systematic surveys not expected to be required.
<i>Tyto novaehollandiae kimberli</i>	Masked Owl (northern)	Habitat verification. <i>Call playback to confirm their presence was considered not necessary.</i>	Masked Owls were assumed to occur in the survey area given their widespread distribution on the Tiwi Islands and the numerous recent records. As such, rather than re-affirming their presence, suitable habitat was recorded in general across the survey area.
<i>Conilurus penicillatus</i>	Brush-tailed Rabbit-rat	Cameras	Species is detectable with cameras.
<i>Mesembriomys gouldii</i>	Black Footed Tree Rat	Cameras	Black-footed Tree-rats are readily identifiable on cameras. Cameras have proven to be an adequate method to detect the species in an area, should it occur there.
<i>Phascogale pirata</i>	Northern Brush-tailed Phascogale	Cameras	Species is potentially detectable with cameras, though recent surveys that detected this species on the Tiwi Islands utilised tree-mounted cameras.
<i>Sminthopsis butleri</i>	Butler's Dunnart	Cameras Pitfall traps	Cameras for surveying most top end small mammals are likely to be more cost effective compared to pitfall or Elliot trapping. However, the Butler's Dunnart requires physical capture to accurately identify individuals.
<i>Varanus mertensi</i>	Mertens' Water Monitor	Incidental observations	Unlikely to be significantly impacted.
<i>Varanus panoptes</i>	Yellow-spotted Monitor		

5.5.2 Cameras

Cameras were utilised to survey for five threatened species, as shown in **Table 18**, with locations shown in **Appendix H**. The camera set-up for each species varied depending on the target species. The decision to utilise cameras for this project, and the subsequent set up design, utilised guidance from *A Guide for the use of remote cameras for wildlife survey in northern Australia* (Gillespie *et al.*, 2015) and *Camera trapping SOP for the Top End Long-term Monitoring Program* (Gillespie *et al.*, 2017). The primary study objective was to confirm a target species' presence within the survey area. To achieve this, the following factors were taken into consideration:

1. Each potentially occurring species was assessed against the Decision Key 1 and 2 in the 'camera guidelines'. This resulted in a list of species of interest to which we could then determine an appropriate camera site design set-up.
2. The target species.
3. The size of the survey area (1,610 ha). The road realignment areas along the Pirlangimpi and Pickertaramoor Roads were omitted from the camera survey given their proximity to the potential gravel pit survey areas and roads. However, the road realignment corridor along the northern end of Milikapiti Road was included.
4. The layout of each section of survey area. Two configurations of camera site layout were used – either three cameras were placed at a site with each camera approximately 50-100 m apart, or a grid pattern where cameras were placed at approximately equal distances from each other across an area.

Cameras were deployed for four weeks. All cameras were Reconyx HP2W (white flash). The set up was as follows:

1. Cameras were placed on trees (alive and >10 cm diameter) at a height of 50-70 cm to the top of the camera.
2. A bait station was placed 1.5-2.5 m from the base of the tree and consisted of a wooden or metal stake with the bait housing at 30 cm above the ground.
3. Cameras were aimed so that the centre of the image was pointed at the base of the bait station.
4. All vegetation was cleared between the camera and the bait station, to 1 m around the tree on which the camera was placed, and 1.5 m around the bait station.
5. Bait was a mixture of peanut butter, oats and honey.

Where suitable (i.e., where there was potential to detect a small mammal such as the Pale Field-rat from dense creek line vegetation), the camera set was set along a drift fence as follows:

1. Cameras were placed on trees (alive and >10 cm diameter) at a height of 65 cm to the top of the camera.
2. A square corkboard (30 cm x 30 cm) was placed so that the middle of it was 65 cm from the base of the camera tree. The corkboard was secured on each corner with tent pegs.
3. A bait station was placed at the rear of the corkboard and consisted of a wooden or metal stake with the bait housing at 30 cm above the ground.
4. Using a rake-hoe, a 30 cm wide path was cleared for 4 m from the left and right edges of the corkboard (when facing corkboard standing at the camera) and a 4 m long pit fence was placed outwards from each of the two edges of the corkboard so that they ran perpendicular to the line of the camera to corkboard.
5. The fence was pulled tight and held upright by metal pegs. The entire lip of each fence was facing the same way. Excess dirt was placed along the base of the fence so there were no gaps.
6. The camera was pointed at the middle of the corkboard (so the camera was angled at 45°).

A total of 100 camera traps were deployed in two lots over a period of approximately two months (**Table 19**). The figures show the location of cameras overlaying the vegetation mapping produced as part of the project.

Table 19 Camera trap deployment periods

Lot no.	Map no.	No. cameras	Date deployed	Date retrieved	Traps nights per camera	Total trap nights per map area
1	8	4	21/02/2021	22/03/2021	29	116
1	9	9	21/02/2021	22/03/2021	29	261
1	11	9	20/02/2021	19/03/2021	27	243
1	12	9	20/02/2021	19/03/2021	27	243
1	13	12	20/02/2021	19/03/2021	27	324
1	14	3	21/02/2021	22/03/2021	29	87
1	15	1	21/02/2021	20/03/2021	27	27
1	16	3	21/02/2021	20/03/2021	27	81
2	1	12	23/03/2021	26/04/2021	34	408
2	2	8	22/03/2021	28/04/2021	37	296
2	4	4	22/03/2021	26/04/2021	35	140
2	6	3	22/03/2021	27/04/2021	36	108
2	16	1	20/03/2021	26/04/2021	37	37
2	17	5	20/03/2021	26/04/2021	37	185
2	18	5	20/03/2021	27/04/2021	38	190
2	19	4	20/03/2021	26/04/2021	37	148
2	20	3	20/03/2021	26/04/2021	37	111
2	21	2	20/03/2021	27/04/2021	38	76
2	22	3	20/03/2021	27/04/2021	38	114
TOTAL	22	100	-	-	-	3,195

5.5.3 Butler's Dunnart

Based on advice received from the NT Government Department of Environment, Parks and Water Security, the survey for Butler's Dunnart was conducted using pitfall traps in 20 locations along the Pirlangimpi, Milikapiti and Pickertaramoor Roads over a period of 14 days. The survey was conducted in accordance with the *Survey protocol for Butler's Dunnart Sminthopsis butleri* (Ward, 2009). See **Appendix H** for locations of pitfalls. The following methodology was used:

- One site per approximately 80 ha (mapped using a 500m buffer between sites). Each site was located approximately 150-500 m from the road.
- A single site consisted of two 100 m transects lines, each with ten pitfall traps spaced 10 m apart in a linear fashion (see **Figure 6**).
- Holes were approximately 60 cm deep and 28 cm wide.
- A deep pitfall bucket was placed in each hole so the top was level with the ground. Each bucket was constructed using two 20L white plastic buckets, one having the bottom cut out to fit into the second bucket.

- Each pitfall contained one cork sanding block to act as a float, and soil and leaf litter for shelter. Small holes were drilled into the base of each bucket to allow any rainwater to drain. A small amount of water was added to each bucket, to keep a moist environment for amphibians. Where necessary, a small amount of ant bait was added around each bucket to minimize invertebrate attacks on trapped vertebrates.
- A 30 cm high drift fence was pegged along each transect, held up by metal pegs.
- The bottom section of the fence was buried to reduce the likelihood of fauna passing underneath.
- The traps were opened within three hours of sunset, and then checked and closed within three hours of sunrise.
- Each site generally remained opened for six nights, though several were opened only for four or five nights for logistical or timing reasons.



Figure 6 Pitfall trapping line at Pit 8 (in map area 8)

5.6 Assumptions, Exclusions and Limitations

The following assumptions, exclusions and limitations apply:

- The surveys were just a snapshot in time. Over time, including from season to season, habitat conditions and population abundance and distributions may change. In this regard, any cryptic or transient fauna may have not been detected, even though they may occur in the local area.
- The surveys occurred along substantial linear sections of western Melville Island only and, apart from existing records, the distribution of species elsewhere is unclear.
- A species may occupy a chosen site; however, the species may not be photographed. This is called a false negative and has been 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 has been minimised as much as possible by extending the period of camera deployment to four weeks, which is likely to be enough time between visits to the site of most species.
- Flora and fauna records (obtained through the NT Flora and Flora Atlases) 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.
- The densities of large trees (diameter at breast height greater than 40 cm) across the survey area were not measured given the large extent of the survey area (1,520 ha) and the anticipated extensive time required to measure and map the trees. Rather, general observations were made in relation to the relative size and density of trees in each part of the survey area, and in conjunction with the threatened fauna survey results, were expected to aid in the subsequent delineation of the refined 'proposed gravel pit areas' and the impact assessment for each species.
- Assessments and conclusions made by Connect Environmental are based on available information at the time of preparation of this report.
- Detailed floristic identification was not conducted as it was considered not necessary to achieve the objectives of this assessment. Vegetation communities were only identified to a level considered sufficient to understand habitat characteristics for the targeted threatened species.
- Some parts of the survey area were not traversed (normally the outer sections / those furthest from the road) to obtain precise boundaries of communities. Rather, satellite imagery was interpreted to inform boundaries in those areas.

6 Results

6.1 Overview

Three threatened flora and nine threatened fauna species were detected during the surveys. One additional species (Butler's Dunnart) was suspected of occurring, though not confirmed. A discussion of these species is provided in the following sections. The number of records does not necessarily reflect the number of individuals that occupy an area. Each detection is either:

- A recorded observation of a threatened species by an Ecologist, or
- A record of that species from a camera or pitfall trap, regardless of how many times an animal was photographed at that camera trap or the number of nights that species was recorded at that camera or pitfall trap.

6.2 Vegetation Communities

6.2.1 All Described Communities

Seventeen vegetation communities were mapped, including plantations and cleared areas. These are described in **Table 20** and shown in **Appendix H**.

Table 20 Vegetation communities in the survey area

Code	Area (ha)	Short name ¹⁰	Other (non-dominant) species	Landform	Description	Comments	Association ¹¹
Eucalypt communities							
E1	428.5	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>E. tetradonta</i> (Darwin Stringybark), <i>Corymbia nesophila</i> (Melville Island Bloodwood) tall open forest	Mid: <i>Acacia</i> spp., <i>Grevillea</i> spp.	Plateau surface with slopes less than 2%	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>E. tetradonta</i> (Darwin Stringybark), <i>Corymbia nesophila</i> (Melville Island Bloodwood) tall open forest over <i>Livistona humilis</i> (Sand Palm), <i>Grevillea heliosperma</i> (Rock Grevillea), <i>Terminalia ferdinandiana</i> (Billygoat Plum), <i>Planchonia careya</i> (Cocky Apple) tall shrubland over <i>Heteropogon triticeus</i> , <i>Sorghum intrans</i> , <i>Mnesithea rottboellioides</i> tall open tussock grassland.	It is the predominant vegetation community on the plateau.	Land units 1a1, 1a2, 1b1, 1b2 (Wells & van-Cuylenburg, 1978))
E2	258.3	<i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>Eucalyptus miniata</i> (Darwin Woollybutt) tall open forest	Upper: <i>Eucalyptus tetradonta</i> (Darwin Stringybark), <i>Corymbia bleeseri</i> (Glossy-leaved Bloodwood), <i>C. foelscheana</i> Mid: <i>Acacia</i> spp.	Periphery of plateau surface with slopes from 2-10%	<i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>Eucalyptus miniata</i> (Darwin Woollybutt) tall open forest over <i>Livistona humilis</i> (Sand Palm), <i>Acacia</i> spp. and <i>Grevillea</i> spp. tall shrubland over tall tussock grassland.	Secondary community on plateau, mostly occurring towards the periphery. Slightly different composition of species and landscape position than E1.	Land units 1c1, 1c2, 2a2 (Wells & van-Cuylenburg, 1978) Land unit 2a (van-Cuylenburg & Dunlop, 1973)
E3	86.0	<i>Eucalyptus tetradonta</i> (Darwin Stringybark) and <i>E. miniata</i> (Darwin Woollybutt) mid sparse to open woodland	Mid: <i>Banksia dentata</i>	Plateau escarpment edge with slopes 5-10%+	<i>Eucalyptus tetradonta</i> (Darwin Stringybark) and <i>E. miniata</i> (Darwin Woollybutt) mid sparse to open woodland over <i>Acacia</i> spp., <i>Livistona humilis</i> (Sand Palm), <i>Calytrix exstipulata</i> (Turkey Bush), <i>Petalostigma pubescens</i> (Quinine Bush) tall shrubland over mixed species tall tussock grassland.	Upper storey sometimes sparse with dense shrubland comprising 1-2 dominant species.	Land units 2a3, 2a4 (Wells & van-Cuylenburg, 1978)
E4	375.6	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>E. tetradonta</i> (Darwin Stringybark) tall open forest	Upper: <i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>Erythrophleum chlorostachys</i> (Ironwood)	Plateau upper foot slopes with slopes of 5-10%	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>E. tetradonta</i> (Darwin Stringybark) tall open forest over <i>Livistona humilis</i> , <i>Acacia</i> spp. and <i>Grevillea</i> spp. tall shrubland over <i>Eulalia mackinlayi</i> , <i>Eriachne</i> spp. tall tussock grassland.	Predominant community immediately below escarpment edge.	Land units 2a2, 3a1 (Wells & van-Cuylenburg, 1978)
E5	107.1	<i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>Eucalyptus miniata</i> (Darwin Woollybutt) tall open forest	Upper: <i>Lophostemon lactifluus</i> , <i>Melaleuca viridiflora</i> , <i>M. nervosa</i> , <i>Erythrophleum chlorostachys</i> .	Plateau lower foot slopes with slopes of 2-5%	<i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>Eucalyptus miniata</i> (Darwin Woollybutt) tall open forest over <i>Acacia</i> spp. and <i>Livistona humilis</i> (Sand Palm) tall shrubland over <i>Eriachne</i> spp. and mixed species tall tussock grassland.	Lower footslopes, often dominated by tall <i>Corymbia nesophila</i> (Melville Island Bloodwood). Occasional <i>Melaleuca</i> spp. (<i>M. viridiflora</i> or <i>M. nervosa</i>).	Land units 2a1, 3c, 3a2, 5a (Wells & van-Cuylenburg, 1978)
E6	21.5	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>C. latifolia</i> mid open forest	Mid: <i>Livistona humilis</i> (Sand Palm)	Often near head of drainage area in rugged terrain.	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>C. latifolia</i> mid open forest over <i>Grevillea heliosperma</i> , <i>Erythrophleum chlorostachys</i> , <i>Acacia</i> spp. tall open shrubland over <i>Eulalia mackinlayi</i> , <i>Eriachne</i> spp.	Only occasionally encountered on plateau surface (not elsewhere).	Land unit 1d, 3a (Wells & van-Cuylenburg, 1978)
E7a	29.0	<i>Corymbia bleeseri</i> , <i>C. nesophila</i> mid woodland	Upper: <i>Eucalyptus miniata</i> (Darwin Woollybutt)	Gently sloping mid-landscape position.	<i>Corymbia bleeseri</i> , <i>C. nesophila</i> mid woodland over <i>Calytrix</i> spp., <i>Banksia dentata</i> mid open shrubland	Rapidly draining community only found in Map 13.	Land unit 2a3 (Wells & van-Cuylenburg, 1978)
E7b	36.7	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>Corymbia bleeseri</i> (Glossy-leaved Bloodwood) mid woodland	Upper: <i>Melaleuca viridiflora</i> (Broad-leaved Paperbark), <i>M. nervosa</i> (Paperbark), <i>Corymbia porrecta</i> .	Plateau lower footslopes adjacent to <i>Melaleuca</i> woodlands / wetlands.	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>Corymbia bleeseri</i> (Glossy-leaved Bloodwood) mid woodland over <i>Acacia</i> spp. mid open shrubland over <i>Sorghum plumosum</i> , <i>Eriachne</i> spp. and <i>Eulalia mackinlayi</i> tall tussock grassland.	Occurred along Milikapiti Road below the plateau close to <i>Melaleuca</i> woodland / wetlands.	3b (Wells & van-Cuylenburg, 1978)

¹⁰ Dominant upper storey species and structure¹¹ Association with an existing land unit or vegetation dataset

Code	Area (ha)	Short name ¹⁰	Other (non-dominant) species	Landform	Description	Comments	Association ¹¹
Grasslands							
W1a	5.5	<i>Pandanus spiralis</i> (Screw Palm) mid sparse shrubland	-	Shallow, broad open depressions – gently undulating to level run-on plains.	<i>Grevillea pteridifolia</i> (Fern-leaved Grevillea) mid isolated trees over <i>Pandanus spiralis</i> (Screw Palm) mid sparse shrubland over <i>Eulalia mackinlayi</i> , <i>Eriachne burkittii</i> (Wanderrie Grass) and <i>Ectrosia</i> sp. tall open tussock grassland.	Considered to be a sensitive vegetation type.	7a
W1b	44.7	<i>Grevillea pteridifolia</i> low isolated tree over <i>Sorghum</i> spp. tall closed tussock grassland	(none observed) ¹²	Low lying in the landscape, generally flat.	<i>Grevillea pteridifolia</i> low isolated trees over <i>Pandanus spiralis</i> tall isolated shrubs over <i>Sorghum</i> spp. tall closed tussock grassland	Sparsely wooded ('treeless') plain on eastern side of road in Map 6.	Land unit 6b (van-Cuylenburg & Dunlop, 1973) Vegetation community 5 (PWCNT, 1998)
Seasonally saturated or inundated (Melaleuca) areas							
W2a	34.7	<i>Melaleuca viridiflora</i> and / or <i>M. nervosa</i> low open forest	Upper: <i>Grevillea pteridifolia</i> (Fern-leaved Grevillea) Mid: <i>Pandanus spiralis</i> (Screw Palm), <i>Syzigium eucalyptoides</i> ssp. <i>bleeseri</i>	Shallow, broad open depressions and gently undulating to level run-on plains.	<i>Melaleuca viridiflora</i> and / or <i>M. nervosa</i> low open forest over <i>Pandanus spiralis</i> , <i>Grevillea pteridifolia</i> mid sparse shrubland over <i>Eriachne</i> sp., <i>Aristida</i> sp. mid tussock grassland.	A primarily Melaleuca-dominated woodland / woodland community where few other mid storey species exist. Inundated during wet season (February 2021) and considered to be a sensitive vegetation type.	Land unit 6a (van-Cuylenburg & Dunlop, 1973)
W2b	13.5	<i>Lophostemon lactifluus</i> , <i>Melaleuca viridiflora</i> , <i>Buchanania obovata</i> low woodland	Mid: <i>Petalostigma pubescens</i> , <i>G. heliosperma</i> , <i>Eugenia bleeseri</i>	Slightly sloping, low in the landscape	<i>Lophostemon lactifluus</i> , <i>Melaleuca viridiflora</i> , <i>Buchanania obovata</i> low woodland over <i>Pandanus spiralis</i> , <i>Livistona humilis</i> , <i>Grevillea pteridifolia</i> tall shrubland over <i>Eriachne burkittii</i> , <i>Eulalia mackinlayi</i> mid tussock grassland.	Often a transition community between <i>Melaleuca</i> and <i>Eucalyptus</i> woodlands	Land unit 6b (van-Cuylenburg & Dunlop, 1973) Land unit 4c (Wells & van-Cuylenburg, 1978)
W2c	66.5	<i>Melaleuca viridiflora</i> +/- <i>M. nervosa</i> , <i>Grevillea pteridifolia</i> low open woodland	Mid: <i>Acacia</i> spp., <i>Petalostigma pubescens</i> ,	Slightly sloping, low in the landscape	<i>Melaleuca viridiflora</i> +/- <i>M. nervosa</i> , <i>Grevillea pteridifolia</i> low open woodland over <i>Livistona humilis</i> , <i>Pandanus spiralis</i> mid open to sparse shrubland over <i>Eriachne</i> sp., <i>Aristida</i> sp. mid tussock grassland.	A more open community than W2a and generally without <i>Lophostemon lactifluus</i> . It includes areas where the canopy and shrub layers are often only sparsely present.	Land units 6a and 6c (van-Cuylenburg & Dunlop, 1973)
W2d	9.2	<i>Grevillea pteridifolia</i> , <i>Grevillea heliosperma</i> , <i>Planchonia careya</i> low open woodland	Upper: <i>Corymbia ptychocarpa</i> Mid: <i>Acacia</i> spp. (unconfirmed <i>A. latescens</i> and <i>A. difficilis</i>), <i>Grevillea heliosperma</i>	Flat to gently undulating terrain, moderately rapid drainage	<i>Grevillea pteridifolia</i> , <i>Grevillea heliosperma</i> , <i>Planchonia careya</i> low open woodland over <i>Livistona humilis</i> (Sand Palm) mid shrubland over <i>Sorghum plumosum</i> , <i>Eriachne</i> spp. mid tussock grassland.	Denser 'shrubland' with some eucalyptus / <i>Corymbia</i> species (mostly as juveniles). Moderately rapid drainage relative to adjacent <i>Melaleuca</i> communities.	Land unit 4a, 4b, 5b (Wells & van-Cuylenburg, 1978) Land unit 5b (van-Cuylenburg & Dunlop, 1973)
Corymbia-dominated seasonally saturated communities							
W3a	3.9	<i>Corymbia porrecta</i> (unconfirmed), <i>Melaleuca nervosa</i> +/- <i>M. viridiflora</i> , <i>Grevillea pteridifolia</i> low open woodland	Mid: <i>Acacia</i> spp., <i>Planchonia careya</i> , <i>Buchanania obovata</i>	Slightly undulating terrain; generally low in the landscape	<i>Corymbia porrecta</i> (unconfirmed), <i>Melaleuca nervosa</i> +/- <i>M. viridiflora</i> , <i>Grevillea pteridifolia</i> low open woodland over <i>Livistona humilis</i> , <i>Acacia</i> spp. mid open shrubland over <i>Sorghum</i> spp. tall tussock grassland.	A variable community though is basically W2c with the addition of <i>Corymbia</i> species in the canopy and increased <i>Sorghum</i> in the grass layer. The <i>Corymbia</i> species and <i>Grevillea pteridifolia</i> may be isolated or in patches.	Land unit 4c (van-Cuylenburg & Dunlop, 1973)

¹² This community in Map 6 was not traversed in its entirety.

Code	Area (ha)	Short name ¹⁰	Other (non-dominant) species	Landform	Description	Comments	Association ¹¹
Other							
C	69.8	Cleared	Various native and weed species.	Various	Cleared open space (including tracks) with no or little revegetation. Sometimes they contain grasses (such as <i>Sorghum plumosum</i>) or isolated shrubs (such as <i>Melaleuca viridifolia</i> or <i>Grevillea pteridifolia</i>). Importantly, these previously cleared areas may also rapidly revegetate (some already are) and may consist of dense forests within a relatively short amount of time (especially in wetter areas). Such areas comprise habitat for biodiversity.	Mainly present in or adjacent to roads, tracks or existing gravel pits. Only tracks and other cleared areas wider than approximately 5 m are mapped. May contain sparse or occasional disturbed or undisturbed remnant vegetation though is minor.	-
P	4.7	Plantation	-	-	Plantation	-	-

6.2.2 Sensitive or Significant Vegetation Communities

The NT *Land Clearing Guidelines* (DENR, 2021) describe ‘sensitive’ or ‘significant’ vegetation as rainforest, vine thicket, closed forest, riparian vegetation, mangroves, monsoon vine forest, sand sheet heath and vegetation containing large trees with hollows suitable for fauna. In addition, the NT EPA, in its Terms of Reference for several projects, have referred to sensitive or significant vegetation as also including important habitat corridors, wetlands and groundwater dependent ecosystems.

Using these definitions, two communities have been classified as sensitive or significant, with areas of large hollow-bearing trees also meeting the definition (**Table 21**). Vegetation containing large trees with hollows occur extensively in the survey areas. However, several other vegetation communities contain elements that are significant and therefore have been highlighted as ‘partially’ significant. These are discussed in **Table 22**.

Table 21 Sensitive and/or significant vegetation communities

Community code	Description	Map numbers	Comments
W1a	<i>Grevillea pteridifolia</i> (Fern-leaved Grevillea) mid isolated trees over <i>Pandanus spiralis</i> (Screw Palm) mid sparse shrubland over <i>Eulalia mackinlayi</i> , <i>Eriachne burkittii</i> (Wanderric Grass) and <i>Ectrosia</i> sp. tall open tussock grassland.	6, 12, 13	A drainage depression community containing elements of riparian vegetation, often in the upper reach of a stream.
W2a	<i>Melaleuca viridiflora</i> and / or <i>M. nervosa</i> low open forest over <i>Pandanus spiralis</i> , <i>Grevillea pteridifolia</i> mid sparse shrubland over <i>Eriachne</i> sp., <i>Aristida</i> sp. mid tussock grassland	6, 17, 18	A sand sheet community considered to be a restricted vegetation type in the NT and a hotspot for biodiversity (DENR, 2018b). Only one area of this community exists, in the Seventeen Mile Plain area (Map 6). Here, it is associated with seasonally saturated or inundated woodlands and is habitat for several <i>Utricularia</i> species identified during the field surveys.
N/A	Large trees with hollows suitable for fauna – defined in the NT Land Clearing Guidelines (DENR, 2021) in <i>Eucalyptus miniata</i> and <i>E. tetradonta</i> communities as a minimum of five or more stems greater than 50cm diameter per hectare and/or 30 or more stems greater than 40cm diameter per hectare.	2, 8, 9, 11, 13, 19	Surveys of large hollow-bearing trees were not systematically conducted, but rather random counts and general observations were made. In this regard, such areas appearing to meet the definition of significant vegetation for large, hollow-bearing trees have been highlighted. However, as a precaution, and given the large extent of area for potential gravel extraction, it is recommended that specific counts be conducted in 1 ha sites nominated for gravel extraction.

Table 22 Partially significant vegetation communities

Community code	Description	Comments
E5	<i>Corymbia nesophila</i> (Melville Island Bloodwood), <i>Eucalyptus miniata</i> (Darwin Woollybutt) tall open forest over <i>Acacia</i> spp. and <i>Livistona humilis</i> (Sand Palm) tall shrubland over <i>Eriachne</i> spp. and mixed species tall tussock grassland.	This community occurs in run-on areas of the lower footslopes and often includes <i>Lophostemon lactifluus</i> and <i>Melaleuca</i> spp. Shrub layer frequently either sparse or absent.
E7b	<i>Eucalyptus miniata</i> (Darwin Woollybutt), <i>Corymbia bleeseri</i> (Glossy-leaved Bloodwood) mid woodland over <i>Acacia</i> spp. mid open shrubland over <i>Sorghum plumosum</i> , <i>Eriachne</i> spp. and <i>Eulalia mackinlayi</i> tall tussock grassland Additional species present include <i>Melaleuca viridiflora</i> (Broad-leaved Paperbark), <i>M. nervosa</i> (Paperbark) and <i>Corymbia porrecta</i> .	Area of upland drainage
W1b	<i>Grevillea pteridifolia</i> low isolated trees over <i>Pandanus spiralis</i> tall isolated shrubs over <i>Sorghum</i> spp. tall closed tussock grassland	This community predominantly occurs in the Seventeen Mile Plain area (Map 6). Substantial parts of it appear to have been previously disturbed, based on analysis of aerial imagery.
W2b	<i>Lophostemon lactifluus</i> , <i>Melaleuca viridiflora</i> , <i>Buchanania obovata</i> low woodland over <i>Pandanus spiralis</i> , <i>Livistona humilis</i> , <i>Grevillea pteridifolia</i> tall shrubland over <i>Eriachne burkitii</i> , <i>Eulalia mackinlayi</i> mid tussock grassland	-
W2c	<i>Melaleuca viridiflora</i> +/- <i>M. nervosa</i> , <i>Grevillea pteridifolia</i> low open woodland over <i>Livistona humilis</i> , <i>Pandanus spiralis</i> mid open to sparse shrubland over <i>Eriachne</i> sp., <i>Aristida</i> sp. mid tussock grassland	-
W3a	<i>Corymbia porrecta</i> (unconfirmed), <i>Melaleuca nervosa</i> +/- <i>M. viridiflora</i> , <i>Grevillea pteridifolia</i> low open woodland over <i>Livistona humilis</i> , <i>Acacia</i> spp. mid open shrubland over <i>Sorghum</i> spp. tall tussock grassland	The only occurrence of this mixed community occurs in previously disturbed areas of the Seventeen Mile Plain (Map 6)

6.3 Camera Traps

A total of 100 camera traps were established in the survey area. The species captured on each camera are listed in **Table 23** (mammals), **Table 24** (birds) and **Table 25** (reptiles). A total of 15 mammal, 14 bird and five reptile species was detected. Several photos of fauna are shown from **Figure 7** to **Figure 14**. A 'detection' is defined as a species being photographed on one camera, regardless of how many photos are taken of that species, or the timing of the photo.

Table 23 Mammals detected by camera traps (green shading indicates a threatened species)

Site	Camera	Lot no.	Map no.	Wild Dog (<i>Canus lupus dingo</i>)	Brush-tailed Rabbit-rat (<i>Conilurus penicillatus</i>)	Cat (<i>Felis catus</i>)	Horse (<i>Equus caballus</i>)	Northern Brown Bandicoot (<i>Isodon macrourus</i>)	Agile Wallaby (<i>Macropus agilis</i>)	Grassland Melomys (<i>Melomys burtoni</i>)	Black-footed Tree-rat (<i>Mesembriomys gouldii</i>)	Brush-tailed Phascogale (<i>Phascogale pirata</i>)	Delicate Mouse (<i>Pseudomys delicatulus</i>)	Pseudomys sp (unknown)	Pale Field-rat (<i>Rattus tunneyi</i>)	Northern Brush-tail Possum (<i>Trichosurus vulpecula</i>)	Dunnart (unknown species) (<i>Sminthopsis</i> sp.)	Red-cheeked Dunnart (<i>Sminthopsis virginiae</i>)	TOTAL	Notes
47-1	3	2	1		x			x											2	
47-2	43.2	2	1					x					x			x			3	
47-3	47.2	2	1		x			x	x										3	
47-4	19.2	2	1					x	x				x						3	
47-5	45.2	2	1	x				x			x								3	
47-6	4.2	2	1					x	x				x			x			4	
47-7	30	2	1										x			x			2	
47-8	48.2	2	1					x	x				x				x*		4	*Appears to be Butler's Dunnart
47-9	46	2	1						x										1	
47-10	39	2	1	x				x	x				x						4	
47-11	7	2	1		x				x		x		x			x			5	
47-12	38.2	2	1					x	x		x		x			x			5	
46-1	14.2	2	2					x	x		x				x	x		x	6	
46-2	27	2	2					x	x		x		x						4	
46-3	17	2	2					x	x		x					x		x*	5	*Appears to be Butler's Dunnart
46-4	42	2	2					x	x		x							x*	4	*Appears to be a Red-cheeked Dunnart though photo is slightly blurry
46-5	49	2	2					x	x									x*	3	*Appears to be Butlers Dunnart
46-6	50.2	2	2					x	x				x			x			4	
46-7	24.2	2	2					x	x		x					x		x	5	
46-8	12	2	2					x	x		x		x			x			5	
45-1	21.2	2	4	x				x	x										3	
45-2	41.2	2	4					x	x									x*	3	*Appears likely to be Red-cheeked Dunnart
45-3	29	2	4	x				x	x		x				x	x			6	
45-4	51.2	2	4					x	x	x						x			4	
44-1	40.2	2	6					x			x				x			x	4	
44-2	36.2	2	6					x	x						x			x	4	
44-3	44.2	2	6					x	x		x				x				4	
11-1	43	1	8						x		x					x			3	
11-2	45	1	8										x			x			2	
11-3	44	1	8																0	
11-4	40	1	8						x							x			2	
12-1	24	1	9					x	x							x			3	
12-2	47	1	9					x				x	x						3	
12-3	4	1	9					x	x										2	
13-1	19	1	9						x							x			2	
13-2	50	1	9													x			1	
13-3	36	1	9						x					*x					2	*Possibly Pseudomys nanus (Western Chestnut Mouse)
14-1	14	1	9			x		x	x						x	x			5	
14-2	38	1	9					x	x							x			3	
14-3	48	1	9													x			1	
15-1	30	1	11					x	x				x						3	
15-2	7	1	11			x		x	x							x			4	
15-3	26	1	11			x		x	x										3	
16-1	11	1	11			x			x							x			3	
16-2	13	1	11			x			x				x			x			4	
16-3	32	1	11						x				x			x			3	
17-1	22	1	11					x											1	
17-2	1	1	11													x			1	
17-3	34	1	11						x							x			2	
18-1	20	1	12						x			x				x			3	
18-2	17	1	12													x		x*	2	*Unclear though appears to be a Dunnart
18-3	37	1	12						x							x			2	

Site	Camera	Lot no.	Map no.	Wild Dog (<i>Canus lupus dingo</i>)	Brush-tailed Rabbit-rat (<i>Conilurus penicillatus</i>)	Cat (<i>Felis catus</i>)	Horse (<i>Equus caballus</i>)	Northern Brown Bandicoot (<i>Isodon macrourus</i>)	Agile Wallaby (<i>Macropus agilis</i>)	Grassland Melomys (<i>Melomys burtoni</i>)	Black-footed Tree-rat (<i>Mesembriomys gouldii</i>)	Brush-tailed Phascogale (<i>Phascogale pirata</i>)	Delicate Mouse (<i>Pseudomys delicatulus</i>)	Pseudomys sp (unknown)	Pale Field-rat (<i>Rattus tunneyi</i>)	Northern Brush-tail Possum (<i>Trichosurus vulpecula</i>)	Dunnart (unknown species) (<i>Sminthopsis</i> sp.)	Red-cheeked Dunnart (<i>Sminthopsis virginiae</i>)	TOTAL	Notes
19-1	31	1	12									x				x			2	
19-2	29	1	12																0	
19-3	3	1	12						x							x			2	
20-1	33	1	12																0	
20-2	18	1	12																0	
20-3	28	1	12										x			x			2	
21-1	16	1	13					x	x		x					x			4	
21-2	15	1	13					x			x					x			3	
21-3	23	1	13					x			x					x			3	
22-1	2	1	13					x	x		x					x			4	
22-2	12	1	13					x								x			2	
22-3	9	1	13					x								x			2	
23-1	5	1	13					x	x		x					x			4	
23-2	39	1	13					x	x		x					x			4	
23-3	10	1	13								x					x			2	
24-1	8	1	13										x			x			2	
24-2	6	1	13						x							x			2	
24-3	35	1	13													x			1	
25-1	41	1	14						x							x			2	
25-2	51	1	14						x		x					x			3	
25-3	21	1	14						x			x				x			3	
34-1	27	1	15					x					x			x			3	
27-1	46	1	16					x								x			2	
27-2	42	1	16						x							x			2	
27-3	49	1	16	x					x				x			x			4	
42-1	9	2	16						x							x			2	
35-1	31	2	17	x				x	x							x			4	
35-2	16	2	17					x	x						x				3	
36-1	34	2	17						x				x			x			3	
36-2	15	2	17						x							x			2	
36-3	23	2	17	x									x			x			3	
41-1	8	2	18					x	x							x	x*		4	*Unclear photos though indicative of Butlers Dunnart
41-2	35	2	18						x							x			2	
41-3	2	2	18	x												x			2	
41-4	26	2	18						x				x			x			3	
41-5	5	2	18													x			1	
37-1	6	2	19						x				x			x			3	
37-2	1	2	19						x							x			2	
37-3	32	2	19					x	x								x*		3	*Appears to be Butlers Dunnart
37-4	11	2	19	x				x	x							x			4	
38-1	13	2	20					x	x				x	x		x			5	
38-2	33	2	20					x	x							x			3	
38-3	20	2	20																0	
40-1	18	2	21					x	x				x			x			4	
40-2	10	2	21	x				x	x		x					x			5	
39-1	37	2	22					x					x			x			3	
39-2	22	2	22					x	x		x				x	x			5	
39-3	28	2	22	x			x	x	x							x	x*		6	*Not sufficient clarity to identify
TOTAL	100 camera traps	2	22	11	3	5	1	55	68	1	23	4	27	2	8	72	9	4	15 species	

Table 24 Birds detected on camera traps (green shading indicates a threatened species)

Site	Camera	Lot	Map no.	Bar-shouldered Dove	Blue-winged Kookaburra	Brown Quail	Bush-stone Curlew	Chestnut-backed Button Quail	Common Bronzewing	Grey-crowned Babbler	Partridge Pigeon	Pheasant Coucal	Peaceful Dove	Pied Butcherbird	Tawny Frogmouth	Torresian Crow	Yellow-throated Miner	TOTAL
47-1	3	2	1									x					x	2
47-4	19-2	2	1									x						1
47-5	45-2	2	1		x						x				x			3
47-8	48-2	2	1														x	1
47-10	39	2	1									x						1
46-1	14-2	2	2									x					x	2
46-3	17	2	2							x							x	2
46-4	42	2	2														x	1
46-5	49	2	2					x										1
46-6	50-2	2	2														x	1
46-7	24-2	2	2			x												2
46-8	12	2	2							x						x		1
47-12	38-2	2	2								x							1
45-1	21-2	2	4															1
45-2	41-2	2	4							x							x	2
45-3	29	2	4								x							1
44-1	40-2	2	6										x					1
44-3	44-2	2	6			x												1
11-3	44	1	8			x												1
12-1	24	1	9					x										1
12-3	4	1	9					x										1
14-1	14	1	9									x						1
14-2	38	1	9							x								1
15-1	30	1	11							X								1
15-3	26	1	11									x		x				2
16-1	11	1	11							x								1
16-3	32	1	11							x	x							2
17-1	22	1	11									x						1
17-2	1	1	11					x										1
17-3	34	1	11	x						x								2
18-1	20	1	12						x	x						x		3
19-1	31	1	12							x	x					x		3
19-2	29	1	12									X						1
19-3	3	1	12								x							1
21-1	16	1	13									x						1
21-2	15	1	13											x				1
22-2	12	1	13							x								1
23-1	5	1	13							x								1
24-2	6	1	13															1
25-1	41	1	14					x										1
25-2	51	1	14					x										1
25-3	21	1	14														x	1
34-1	27	1	15									x						1
27-1	46	1	16			x												1
27-2	42	1	16			x												1
42-1	9	2	16	x												x		2
35-1	31	2	17			x												1
35-2	16	2	17			x						x						2
36-1	34	2	17				x							x				2
36-2	15	2	17											x		x		2
36-3	23	2	17				x											1
41-1	8	2	18													x		1
41-3	2	2	18													x		1
41-4	26	2	18										x					1
37-3	32	2	19		x													1
38-1	13	2	20								x					x		2
38-3	20	2	20														x	1
39-1	37	2	22									x	x					2
TOTAL	58	2		2	2	7	2	6	1	12	7	12	3	4	1	10	9	14 species

Table 25 Reptiles detected by camera traps

Site	Camera	Lot no.	Map no.	Brown Tree Snake (<i>Boiga irregularis</i>)	<i>Ctenotus</i> sp.	Frilled-neck Lizard (<i>Chlamydosaurus kingii</i>)	<i>Varanus gouldii</i>	<i>Varanus scalaris</i>	TOTAL
47-6	4.2	2	1				x		1
44-3	44.2	2	6		x	x			2
14-1	14	1	9	x					1
36-2	15	2	17			x			1
37-3	32	2	19			x			1
38-1	13	2	20					x	1
TOTAL	6 cameras	2	6	1	1	3	1	1	5 species



Figure 7 Frill-necked Lizard at Site 36-2



Figure 8 Northern Brush-tailed Possums at Site 15-2 (Map 11)



Figure 9 Chestnut-backed Button Quail at Site 12-3 (Map 9)



Figure 10 Agile Wallaby at Site 12-3 (Map 9)



Figure 11 Brown Quails at Site 44-3 (Map 6)



Figure 12 Bush-stone Curlew at Site 36-1 (Map 17)



Figure 13 Red-cheeked Dunnart (apparent) at Site 46-1 (Map 2)



Figure 14 Yellow-throated Miner at Site 46-6 (Map 2)

6.4 Pitfall Traps

Pitfall trapping results are shown in **Table 26**. A total of 21 reptile, five frog and four mammals species were captured in the pitfall traps.

Table 26 Pitfall results

Map no.		1			2		4	8	9		11		12			13			14	18	19
Pit no.		1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	22	23
Reptiles																					
<i>Anilius unguirostris</i>	Claw-snouted Blind Snake														✓						
<i>Carlia munda</i>	Shaded-litter Rainbow Skink			✓									✓	✓	✓	✓		✓			
<i>Carlia rufilatus</i>	Red-sided Rainbow Skink	✓							✓												
<i>Carlia</i> sp.	Rainbow Skink									✓											
<i>Chlamydosaurus kingii</i>	Frill-necked Lizard						✓														
<i>Cryptoblepharus</i> sp.	Snake-eyed Skink (species not confirmed)																	✓	✓		
<i>Ctenotus borealis</i>	White-faced Ctenotus														✓						
<i>Ctenotus essingtonii</i>	Lowlands Plain-backed Ctenotus														✓						
<i>Ctenotus</i> sp.	Ctenotus (species not confirmed)														✓						
<i>Diporiphora bilineata</i>	Two-lined Dragon		✓																	✓	
<i>Eriamiascincus douglasi</i>	Orange-sided Bar-lipped Skink	✓	✓	✓	✓	✓				✓					✓	✓		✓		✓	
<i>Furina ornata</i>	Orange-naped Snake						✓														
<i>Glaphyromorphus darwiniensis</i>	Top End Mulch-Skink	✓	✓				✓	✓		✓					✓	✓		✓		✓	✓
<i>Heteronotia binoei</i>	Bynoe's Gecko	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Lialis burtonis</i>	Burton's Legless Lizard											✓					✓				✓
<i>Menetia greyii</i>	Common Dwarf Skink																		✓		
<i>Menetia</i> sp.	Dwarf Skink (species not confirmed)					✓															
<i>Morethia storii</i>	Northern Fire-tailed Skink					✓									✓						
<i>Ramphotyphlops</i> sp.	Blind Snake (species unconfirmed)						✓														
<i>Varanus tristis</i>	Spotted Tree Monitor			✓																	
<i>Vermicella multifasciata</i>	Narrow-banded Bandy Bandy			✓								✓									
Frogs																					
<i>Austrochaperina adelphe</i>	Northern Territory Frog	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

Map no.		1			2		4	8	9		11		12			13			14	18	19
Pit no.		1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	22	23
<i>Limnodynastes convexiusculus</i>	Marbled Frog				✓								✓							✓	
<i>Litoria nasuta</i>	Striped Rocket Frog			✓	✓					✓										✓	
<i>Platyplectrum ornatum</i>	Ornate Burrowing Frog								✓	✓	✓	✓		✓				✓	✓	✓	✓
<i>Uperoleia inundata</i>	Flood Plain Toadlet								✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Mammals																					
<i>Melomys burtoni</i>	Grassland Melomys								✓												
<i>Pseudomys delicatus</i>	Delicate Mouse	✓		✓		✓		✓	✓	✓				✓			✓				
<i>Pseudomys nanus</i>	Western Chestnut Mouse		✓						✓					✓							
<i>Sminthopsis virginiae</i>	Red-cheeked Dunnart	✓		✓	✓		✓												✓		
TOTAL No. SPECIES		7	6	9	5	5	6	3	8	9	3	5	5	11	9	5	4	9	8	7	4

6.5 Threatened Flora

6.5.1 *Cycas armstrongii*

Cycas armstrongii appeared relatively widespread in the survey area, apart from lower-lying seasonally saturated areas. The densities of *C. armstrongii* in each map area are described in **Table 27**. Six map areas contained patches of high-density cycads.

Table 27 *C. armstrongii* density observations in each survey area (areas highlighted green contain areas of high-density cycads)

Map	Density	Map	Density
1	Low to moderate	12	Low to moderate
2	Mostly low, occasionally moderate patch	13	Low to high
3	Low to moderate	14	None
4	Low to moderate	15	None
5	Moderate to high	16	None
6	None	17	None
7	Low to moderate	18	None
8	None	19	Low to high
9	None	20	Low to high
10	Low	21	Low to high
11	None	22	Low to high

6.5.2 *Typhonium jonesii* and *T. mirabile*

The effective survey coverage area was estimated to be 542 ha. This was calculated using a width of 3 m either side of the transect centre line. In practice, the effective transect width would have been from 1-5 m, depending on the density of ground vegetation.

A total of 1,212 *T. jonesii* individuals and 772 *T. mirabile* individuals was detected (**Table 28**). Locations are provided in **Appendix E** with coordinates in **Appendices F and G**. Photos are shown in **Figure 15** to **Figure 18**.

As of the date of this report, these results are considered preliminary whilst awaiting the results of the genetic testing of the *Typhonium* samples.

Table 28 The number of individuals detected of each species within each map area

Road Name	Map	Number of individuals detected	
		<i>T. jonesii</i>	<i>T. mirabile</i>
Pirlangimpi	1	0	0
	2	10	10
	3	0	0
	4	0	6

Road Name	Map	Number of individuals detected	
		<i>T. jonesii</i>	<i>T. mirabile</i>
	5	1	2
	6	0	0
	7	0	0
	8	56	21
	9	7	0
Pickertaramoor	10	1	0
	11	2	0
	12	25	0
	13	194	0
Milikapiti	14	0	0
	15	0	0
	16	0	0
	17	0	0
	18	139	543
	19	43	3
	20	402	6
	21	201	4
22	131	177	
Total	22 map areas	1,212	772



Figure 15 A *Typhonium jonesii* individual (Map 20)



Figure 16 A *Typhonium jonesii* individual (Map 20)



Figure 17 A *Typhonium mirabile* individual (presumed, Map 20)



Figure 18 A *Typhonium mirabile* individual (presumed, Map 21)

6.6 Threatened Fauna

The following sections describe the observations made during the surveys of threatened fauna, any evidence of their presence, the presence or absence of key habitat attributes, noted threats to their existence within the survey area and any other characteristics that may influence the likelihood of their presence across the survey area (e.g., prey, predators, other disturbances etc.).

For camera detections, a ‘detection’ is defined as a photograph of the animal on a camera regardless of when, or how many times, it was photographed. For all detections, it is not known whether the same individual was captured by more than one camera or how many individuals occupy that area.

6.6.1 Summary

Nine threatened fauna species were detected across the survey area, as shown in **Table 29** and **Table 30**. The number of detections, map areas and vegetation communities are categorised for each species.

Table 29 Threatened species detections according to road and map location, and vegetation community

Species	Common Name	No. of detections	Locations		Vegetation community
			Road	Map	
<i>Erythrotriorchis radiatus</i>	Red Goshawk	2	Milikapiti	19	E4

Species	Common Name	No. of detections	Locations		Vegetation community
			Road	Map	
<i>Geophaps smithii smithii</i>	Partridge Pigeon	89 ¹³	Pirlangimpi	1, 2, 3, 4, 5, 6, 8, 9	E1, E2, E5, W2c, C
			Pickertaramoor	11, 12, 13	E2, E4, C
			Milikapiti	14, 18, 19, 20, 22	E1, E2, E3, E4, E6, W2a
<i>Tyto novaehollandiae melvillensis</i> ¹⁴	Masked Owl	3	Pickertaramoor	10	C
			Pirlangimpi	9	C
<i>Conilurus penicillatus</i>	Brush-tailed Rabbit-rat	3	Pirlangimpi	1	E1
<i>Mesembriomys gouldii melvillensis</i>	Black-footed Tree-rat	24	Pirlangimpi	1, 2, 4, 6, 8	E1, E2, W2b, W3a
			Pickertaramoor	13	E4, E5
			Milikapiti	14, 21, 22	E1, E2, E4
<i>Phascogale pirata</i>	Brush-tailed Phascogale	4	Pirlangimpi	9	E5
			Pickertaramoor	12	E2
			Milikapiti	14	E1
<i>Rattus tunneyi</i>	Pale Field-rat	7	Pirlangimpi	2, 4, 6, 9	E1, E5, W1b, W2b, W3a
			Milikapiti	17	E5
<i>Sminthopsis butleri</i>	Butler's Dunnart	5			
<i>Trichosurus vulpecula arnhemensis</i>	Northern Brushtail Possum	72	Pirlangimpi	1, 2, 4, 8, 9	E1, E2, E3, E5
			Pickertaramoor	11, 12, 13	E2, E3, E4, E5
			Milikapiti	14, 15, 16, 17, 18, 19, 20, 21, 22	E1, E2, E3, E4, E5, E7b, W2c
<i>Varanus mertensi</i> ¹⁵	Merten's Water Monitor	1	Pirlangimpi	6	C

Table 30 Threatened fauna detections by map

Species	Map number																						Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Red Goshawk																			✓				1

¹³ This includes detections from outside the survey area such as along roadsides.

¹⁴ Targeted surveys were not conducted for this species

¹⁵ Targeted surveys were not conducted for this species

Species	Map number																						To tal
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Partridge Pigeon	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓				✓	✓	✓		✓	16
Masked Owl										✓													1
Brush-tailed Rabbit-rat	✓																						1
Black-footed Tree-rat	✓	✓		✓		✓		✓					✓	✓							✓	✓	9
Brush-tailed Phascogale									✓			✓		✓									3
Pale Field-rat		✓		✓		✓			✓									✓					5
Butler’s Dunnart	?	?																	?	?			4
Northern Brushtail Possum	✓	✓		✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	17
Merten’s Water Monitor						✓																	1
TOTAL	5	5	1	4	1	4	0	3	4	1	2	3	3	4	1	1	2	3	4	2	2	3	

6.6.2 Red Goshawk

6.6.2.1 Observations

Two Red Goshawks (*Erythrotriorchis radiatus*) were observed in total – one flying over the Map 19 area near Milikapiti and the other near the Milikapiti airport (outside the survey area). There were no other detections, including of nests, during the surveys.

Three areas were searched for nests:

- Four pre-defined locations that appeared to meet the criteria for the species’ nesting habitat (i.e., tall trees within 1 km of permanent water (TSSC, 2015a). See **Appendix H** for these areas.
- When checking cameras and pits, one Ecologist (Mihkel Proos) observed any large trees for nests.
- The locations of four known historic nests (further information is provided in **Section 10.3.2**). The age, or any context, of these four historic nests was unknown upon provision of their locations.

The species’ breeding cycle is reported to court in April, lay from May to October, and juveniles leave their natal territories in December (Aumann and Baker-Gabb, 1991 cited in DERM, 2012). As such, it appears that surveys were conducted prior to the commencement of nest-building. Nevertheless, given that nests are reported as occurring at least 6.5 km apart, with most being near permanent water, the chance of detecting many nests within the survey area was probably low.

6.6.2.2 Habitats

The species is known to occur in tall open forests and woodlands (Marchant & Higgins, 1993 cited in TSSC, 2015). This habitat was prevalent across the survey area and it is expected that much of comprises suitable foraging habitat. Habitat quantification is provided in **Section 10.3.2**.

6.6.3 Partridge Pigeon

6.6.3.1 Observations

There were 89 detections of Partridge Pigeons (*Geophaps smilthii*) during the surveys, including seven on camera and 82 from ecologists' observations. Not all detections were within the survey area – some were detected between sites while driving. Refer to the figures in **Appendix I** for locations. Representative photos of the detections are shown in **Figure 19** and **Figure 20**.

6.6.3.2 Habitats

The species is reported as occurring in lowland eucalypt forests and woodlands (Woinarski, 2006). Given that *Eucalyptus miniata*, *E. tetradonta* and *Corymbia nesophila* forests cover approximately 75% of the Tiwi Islands, and 84% (1,343 ha) of the survey area, and there are 180 previous records of the species on the Tiwi Islands, it was expected that it would regularly be observed.



Figure 19 Partridge Pigeon, camera site 45-3 (Map 4)



Figure 20 Partridge Pigeon nest and eggs (Map 1)

6.6.4 Masked Owl

6.6.4.1 Observations

Tiwi Island Masked Owls (*Tyto novaehollandiae melvillensis*) were observed on three occasions, noting that systematic surveys were not conducted for the species due to the high number of records (340) on the Tiwi Islands (second highest out of all threatened fauna on the Tiwi Islands) and the limited information that would be gained by detecting more individuals. Rather, it was considered more appropriate to assume the species to be present in apparently suitable habitat and conduct the impact assessment on that basis.

6.6.4.2 Habitats

The species is known to occur in tall open forests dominated by *Eucalyptus miniata*, *E. tetradonta* and *Corymbia nesophila* (Woinarski & Ward, 2012). Debus (2009) describes Masked Owl nests being in hollows 10-45 m high, with an entrance more than 20 cm wide. Based on these descriptions, it is expected that all *E. miniata*, *E. tetradonta* and *C. nesophila* forests in the survey area constitute either breeding or foraging habitat.

6.6.5 Brush-tailed Rabbit-rat

6.6.5.1 Observations

The Brush-tailed Rabbit-rat (*Conilurus penicillatus*) was detected on three cameras within the survey area nearest to Pirlangimpi (Map 1). Refer to the figures in **Appendix I** for locations. All detections were within 1.3 km of each other.

No other detections of the species were made, except for an unconfirmed sighting during *Typhonium* surveys at a site near Milikapiti. This sighting is not included as a confirmed record given the uncertainty in its identity.

6.6.5.2 Habitats

The species is mostly recorded in lowland eucalypt forests and woodlands dominated by *E. miniata* and *E. tetradonta* that are away from areas that are wet or exposed to recent severe fire (TSSC, 2016). They utilise tree hollows and hollow logs for sheltering (TSSC, 2016).

Vegetation in the area of detection (Map 1) predominantly comprises *Eucalyptus miniata* (Darwin Woollybutt), *E. tetradonta* (Darwin Stringybark), *Corymbia nesophila* (Melville Island Bloodwood) tall open forest over *Livistona humilis* (Sand Palm), *Grevillea heliosperma* (Rock Grevillea), *Terminalia ferdinandiana* (Billygoat Plum), *Planchonia careya* (Cocky Apple) tall shrubland over *Heteropogon triticeus*, *Sorghum intrans*, *Mnesithea rottboellioides* tall open tussock grassland (community E1).

Using the TSSC's definition for suitable habitat, it appears as though most of the eucalypt communities within the survey area could comprise suitable habitat for the species. However,

The species' home range has previously been estimated by Firth *et al.* (2006) as 0.79 to 0.97 ha.



Figure 21 Brush-tailed Rabbit-rat at Site 47-1 (Map 1)

6.6.6 Black-footed Tree-rat

6.6.6.1 Observations

The Black-footed Tree-rat (*Mesembriomys gouldii melvillensis*) was detected on 23 cameras and observed once while driving at night (see locations in **Appendix I**). It was detected in nine map areas, from 18 where cameras were deployed. Representative photos of several individuals are shown in **Figure 22** to **Figure 25**. Given the proximity of some cameras and the known foraging distance of the species, it is possible that an individual was captured on more than one camera. They were detected in six vegetation communities (**Table 20**).

6.6.6.2 Habitats

The species is reported to live predominantly in tall eucalypt forests and woodlands, though can occur across other tropical forests also (TSSC, 2015b). The distribution of detections during this survey supports this. As such, potential habitat quantification in **Section 10.3.1** shows a slightly larger area than for other species.