Targeted Flora and Cockatoo Assessment, Turner Road Reserve

Report prepared for

Shire of Denmark

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[redacted]

southern ecology

FLORA | FAUNA | DIEBACK

Assessment for:

[redacted]

Prepared by:

[redacted]

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1 SUMMARY

The Shire of Denmark is investigating environmental constraints related to the development of a network of mountain bike trails within Turner Road Reserve (42 hectares (ha)), approximately 4.5 kilometres (km) north west of Denmark. A reconnaissance vegetation survey, targeted flora survey and a black cockatoo habitat assessment by Southern Ecology determined the following results:

- Turner Road Reserve is dominated by Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) Forest (29.5 ha) interspersed with areas of Karri (*Eucalyptus diversicolor*) (4.9 ha). Upper-slope sections of the reserve have previously been cleared for gravel extraction and have subsequently been revegetated with a combination of native and non-indigenous species (5.5 ha).
- Lower-slope and water gaining areas remain in Very Good to Excellent condition (25 ha). However, weed invasion, impacts of dieback (*Phytophthora cinnamomi*) and evidence of timber extraction are widely present in the reserve; subsequently 9.4 ha is in Degraded to Good condition. Approximately, 1.8 ha of the reserve is cleared for fire management and local fire brigade infrastructure.
- Several significant weeds occur in the reserve: **Vinca major* and **Watsonia meriana* var. *bulbillifera* are particularly widespread. Other locally significant weeds are present in scattered occurrences (**Rubus anglocandicans, *Acacia longifolia, *Allium triquetrum, *Polygala myrtifolia, *Oxalis purpurea* and **Rosa canina*).
- Two Priority-listed flora by the Department of Biodiversity, Conservation and Attractions (DBCA) occur in the reserve. *Bossiaea* sp. Mt Frankland (L. Graham 2174) (Priority 2) is an uncommon shrub only confirmed from three previous collections (Mt Frankland and Denmark River). *Netrostylis* sp. Blackwood River (A.R. Annels 3043) (Priority 3) is an inconspicuous sedge with a relatively broad distribution on the south coast. The targeted surveys have confirmed that multiple sub-populations of these taxa occur in the reserve, which have been avoided during trail design and planning.
- The reserve supports areas of mature woodland and forest dominated by either Marri, Jarrah or Karri, which represent potential habitat for three Threatened species of black cockatoo (Baudin's Cockatoo, Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo).
- In the survey area, 371 suitable DBH trees were recorded (comprised of 233 *Corymbia calophylla,* 120 *Eucalyptus marginata* and 18 *E. diversicolor*); 34 trees contained large hollows or chimneys. 18.6 ha of the native vegetation in the survey area (Marri, Jarrah and Karri forest) is high quality foraging habitat for black cockatoo species.

2 INTRODUCTION

2.1 Project Background

Southern Ecology was engaged to undertake biological assessments and to provide advice on environmental limitations for the development of mountain bike trails in Turner Road Reserve, 4.5 km north west of Denmark (Figure 1). The reserve includes a moderate to steeply inclined hillslope (relief of ~85 m) with a northern aspect and is approximately 42 hectares (ha). The reserve contains a combination of remnant Jarrah, Marri and Karri woodland or forest over heavily lateritic soil with underling areas of granite. Upper-slope areas have been extensively utilized for gravel extraction and have been variably rehabilitated with native and indigenous species. Historic extraction of timber, invasion of several weeds and *Phytophthora* dieback are evident.

Southern Ecology was engaged in 2023 and 2024 to broadly assess the 'reserve area' (42 ha) and also to undertake detailed assessments of the 'survey area' (26 ha) that encompassed a corridor (30 m wide) for several preliminary trail alignments and other areas for infrastructure (i.e. shuttle roads and carparks).

2.2 Scope and Objectives

The objective of the biological survey was to delineate vegetation flora and fauna values within the reserves and the survey area. The outcomes of the survey and biological survey report will be used to inform the project planning and environmental impact assessment. The scope of works included the following:

- Complete a desktop assessment of the survey area to identify:
    - Biological features and constraints within 5 km of the survey area (i.e., 'study area').
    - Significant flora, vegetation/ecological communities, soil/land system, groundwater and surface water values.
    - Likelihood of occurrence assessment for Threatened/Priority flora species identified from the study area.
- Complete a reconnaissance vegetation field assessment (phase 1) of the reserve area (42 ha):
    - Conduct a reconnaissance level assessment over the entire reserve to delineate broad vegetation type/condition and extent of weeds. (The outcomes of the assessment was provided during the concept trail design (undertaken by contractor Magic Dirt) so that preliminary environmental values could be considered).
- Complete detailed assessments (phase 2) of the survey area (26 ha) including:

- Complete targeted searches to record the presence of any Threatened and Priority flora, Weeds of National Significance (WoNS), Declared Pests and weeds of concern (in Shire of Denmark) and map the extent of populations encountered.
- Identify and map black cockatoo potential breeding trees and record visible hollows from ground level (suitable trees have DBH (diameter at breast height) is ≥ 500mm).

- Provide a combined vegetation, flora and black cockatoo assessment report.

2.3 Local and Regional Context

2.3.1 Location and Tenure

Turner Road Reserve (R13255) is a 'C' class reserve managed by the Shire of Denmark and is located within the 'Warren' Interim Biogeographic Regionalisation of Australia (IBRA) Region (DCCEEW 2025).

2.3.2 Environment

Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) that overlies the survey area indicates the native vegetation is composed of two associations that have >30% remaining (GoWA 2019) within the IBRA region:

- DENMARK 1- *Tall forest or Tall woodland. Mainly Karri (Eucalyptus diversicolor).* 78% remains in Warren Region, 35% in IUCN reserve system.
- DENMARK 969 - *Woodland / Low woodland / Low forest or Woodland (E. marginata, Corymbia calophylla).* 39% remains in the Warren IBRA Region, 3.1% in IUCN reserve system.

Two soil-landscape systems are mapped within the reserve area (Department of Primary Industries and Regional Development [DPIRD] (2023):

- Keystone yellow duplex Phase - "Gravelly yellow duplex soils; Jarrah-Marri forest."
- Keystone brown duplex Phase - "Brown gravelly duplex soils and red of yellow earths; much laterite. Marri-Karri-Red Tingle-Yellow Tingle forest."

No Nationally Important Wetlands, Ramsar sites or Environmentally Sensitive Areas (ESAs) occur within the study area (DPIRD 2025). The closest ESA occurs on Mt Lindesay, 9 km north of the survey area. The Balgamup and Teasedale Wetland Suites occur approximately 7 to 8 km from the survey area.

2.3.3 Phytophthora Dieback

Two soil and root samples from Turner Road Reserve have previously been assessed by Vegetation Health Service, DBCA and determined to be positive *for Phytophthora cinnamomi* (GAIA 2019, Appendix B, Map 1). Due to the topography and extensive history of soil disturbance in the Reserve, it is likely to be classified as Infested and Unprotectable (DBCA 2023).

2.4 State and Commonwealth Conservation and Pest Categories

Commonwealth and State regulatory authorities maintain lists of vegetation, flora and fauna that are assigned into categories of conservation significance or pest status. An overview of the codes and categories used for conservation and pest status in Western Australia that are relevant to this biological survey are provided in Appendix A.

Figure 1. Survey area location.

3 METHODS

3.1 Personnel

The assessment was conducted by Damien Rathbone (principal ecologist, BScHons Plant Science, Scientific License FB2000229). Damien has over 17 years of experience conducting biological surveys in southern Western Australia. Within the South Coast region, he has previously undertaken regional surveys for the Department of Biodiversity, Conservation and Attractions (DBCA) (Albany Regional Vegetation Survey, Fitzgerald River National Park Flora Survey, Ravensthorpe Range Flora Survey), threatened species survey and recovery implementation. Damien is also an accredited interpreter for dieback assessments on DBCA estate (Accreditation PDI-032).

3.2 Desktop Assessment

A desktop assessment of known or potential significant vegetation, flora and black cockatoo habitat within a 5 km radius of the survey area was undertaken using the following sources:

- Existing biological survey reports/planning documents for the area: Magic Dirt (2024), Southern Ecology (2024a), Southern Ecology (2024b) and Green Skills & Southcoast Bushcare Services [GS&SBS] (2024).
- Government of Western Australia [GoWA] (2025) Shared Location Information Platform (SLIP) environmental data (mapped in Appendix B)..
- Protected Matters Search Tool (Department of Climate Change, Energy, Environment and Water [DCCEEW] (2023).
- Threatened and Priority flora records from DBCA and/or the Western Australian Herbarium (mapped in Appendix B).
- Western Australian Herbarium [WAH] (1998–) *Florabase – the Western Australian Flora.* Department of Parks and Wildlife.

3.3 Likelihood of Occurrence Assessment

Pre-survey Likelihood of Occurrence

Prior to conducting the survey, the flora records returned from the database searches were assessed for their spatial accuracy. All valid species recorded were reviewed to determine key morphological characteristics, flowering times, habitat preferences and the likelihood and location of potentially suitable habitat within the survey area (Appendix C).

Post-survey Likelihood of Occurrence

Following the field survey, all conservation significant flora species identified in the database searches that were not detected during the survey were assessed to determine their likelihood of occurrence in the survey area (Appendix C).

Each flora species was assessed according to the general categories summarised in Table 1 to determine if the taxon may not have been adequately addressed during the survey. Habitat suitability was determined from information in herbarium voucher labels, published descriptions and knowledge from the authors. Survey effectiveness reflected the probability of detecting a particular species where suitable habitat was present, which could be dependent on thoroughness of the survey, flowering period or timing of emergence (i.e., annuals or disturbance responsive species).

Table 1. Indicative matrix of habitat suitability and effectiveness of field surveys to determine the likely presence of conservation significant flora post survey.

		Survey Effectiveness		
		No survey limitations present that would have prevented detection; all habitats were thoroughly surveyed	Moderate survey limitations present (i.e., inconspicuous or cryptic species; dense vegetation)	Major survey limitations present (i.e., species is a post fire ephemeral and habitat are long unburnt; habitat inaccessible)
Habitat and Proximity	Species reliably recorded within survey area/in close vicinity (<2 km) and suitable habitat present	Unlikely	Possible	Likely
	Species previously recorded within vicinity (2-10 km) and suitable habitat present	Unlikely	Possible	Possible
	No suitable habitat appears to be present	Unlikely	Unlikely	Unlikely

3.4 Field Assessment

3.4.1 Field Survey Schedule and Type

Field surveys for vegetation, flora and cockatoo habitat were undertaken over six days in 2023 and 2024.

Surveys were conducted in accordance with the Environmental Protection Authority (EPA) Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016) and Department of Agriculture, Water and the Environment [DAWE] Referral guideline for 3 WA threatened black cockatoo species (DAWE 2022). Overall, the survey effort included:

- Reconnaissance level flora and vegetation survey (42 ha).
- Targeted flora survey (26 ha).
- Black Cockatoo assessment (26 ha): recording potential breeding trees (Carnaby's Cockatoo (*Zanda latirostris*), Baudin's Cockatoo (*Zanda baudinii*) and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)). i.e., Native Eucalypt trees with diameter at breast heigh (DBH) ≥ 500mm; Foraging habitat quality assessment.

All field mapping was undertaken using a hand-held GPS unit (Garmin Oregon, datum GDA 2020 MGA Zone 50) and all features were mapped and extrapolated in an ARCGIS environment. Survey effort derived from GPS tracklogs is shown in Appendix B, Map 6. Dates and duration of the field assessments in the reserve and survey area are presented in Table 1.

Table 1. Field dates and survey type.

Date	Survey Type	Location
30th August 2023	Reconnaissance flora and vegetation. Preliminary results were provided to the Shire of Denmark (Southern Ecology 2024).	Turner Road Reserve (42 ha).
26th October and 16th November, 2023	Targeted flora survey and black cockatoo tree assessment.	The 'survey area'. Preliminary trail alignments (blue perimeter and black downhill) (7.6 ha).
21st and 22nd November 2024	Targeted flora survey and black cockatoo habitat assessment.	The 'survey area'. 30 m corridor for trail alignments and infrastructure areas.
10th December 2024	Black cockatoo habitat assessment.	The 'survey area'. 30 m corridor for trail alignments and infrastructure areas.

3.4.2 Weather

Daily weather observations recorded from the nearest weather stations available were used to describe local rainfall and temperatures preceding the survey (Figure 2).

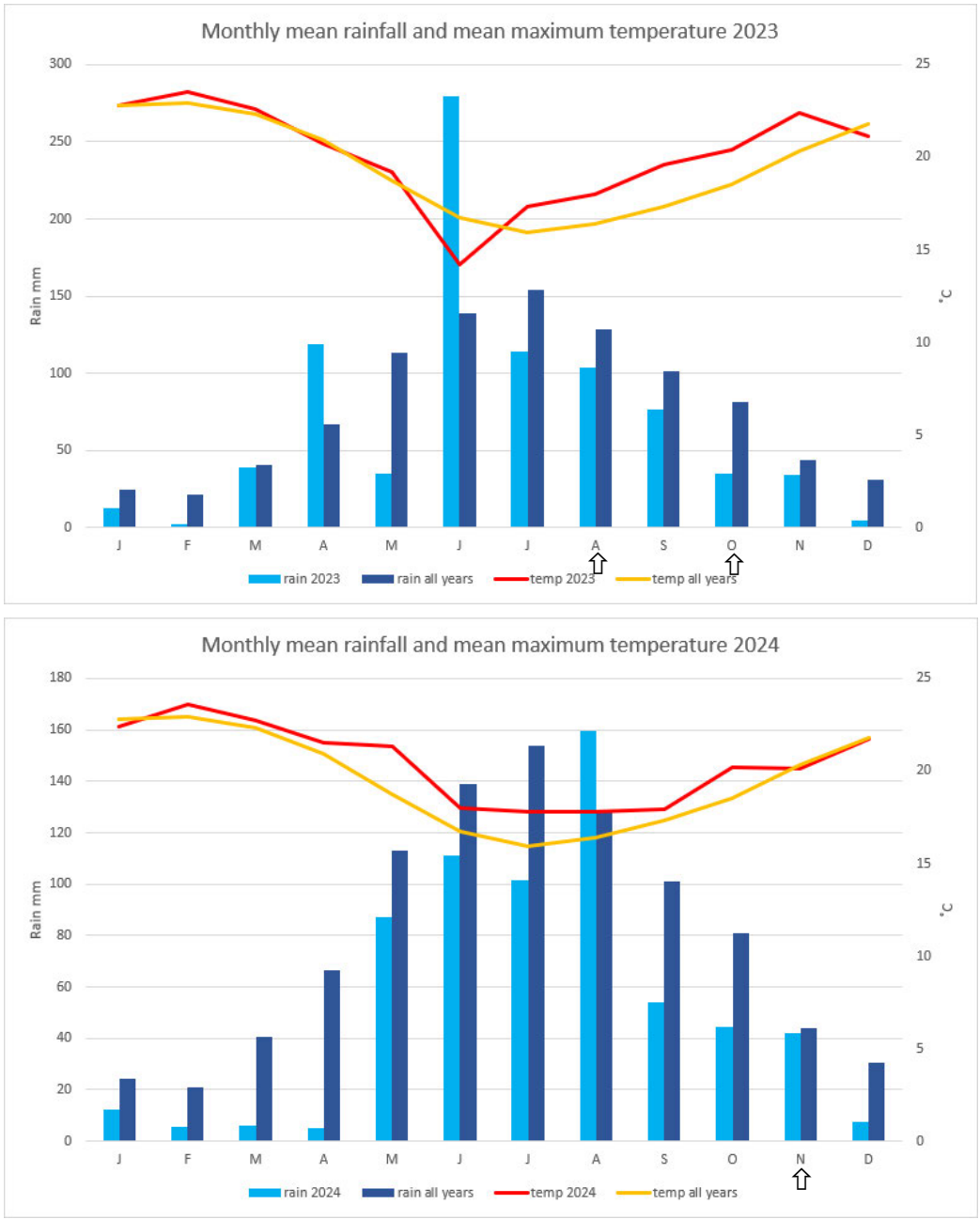

Figure 2. Rainfall and temperature statistics for 2023 and 2024 that encompassed the assessment period (⇧) compared with historical averages (all years available) from the nearest weather station (Rainfall = Youngs Siding 9609 , Temperature = Albany 9500) (BOM 2025).

3.5 Targeted Flora Search

Targeted searches for potential Threatened and Priority flora identified from the desktop assessment were conducted in the appropriate season to detect all of the Threatened or Priority species considered likely to occur. The survey area was initially assessed to identify vegetation types and condition. Vegetation and habitat types that were identified as potentially suitable for Threatened or Priority flora were surveyed by an intensive pattern of meandering transects. Where encountered, population census and site information of Threatened or Priority flora was recorded in accordance with the Threatened and Priority Flora Report Form Field Manual (Department of Environment and Conservation [DEC] 2010).

3.6 Weeds

All weeds considered to be significant (Declared pests (DPIRD 2022), Weeds of National Significance (WoNS) (Weeds Australia 2025) or locally significant (GS&SBS 2024)) or that were commonly encountered within remnant vegetation were recorded and/or mapped.

3.7 Targeted Black Cockatoo Assessment

Identification of breeding and foraging habitat for species of black cockatoo was undertaken within the survey area in accordance with guidance documents (DAWE 2022, Bamford 2020). All three species have the potential to occur in the survey area:

- Carnaby's Cockatoo (*Zanda latirostris*) (T-EN)
- Baudin's Cockatoo (*Zanda baudinii*) (T-EN)
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp*. naso*) (T-VU)

The assessment included traversing the survey area on foot and recording the location and species of known, suitable or potential breeding trees (live or dead) above or equal to a diameter at breast height (DBH) of 500 mm ('suitable DBH trees'). Trees with a DBH greater than 500 mm are large enough to potentially contain hollows suitable for nesting black cockatoos, or have the potential to develop suitable hollows over the next 50 years. Breeding habitat is also generally expected to be located within 6 km of food and water resources (DPaW 2013). The presence of hollow(s) potentially suitable for cockatoo breeding was assessed from ground level. The quality of habitat types considered suitable for cockatoo foraging was assessed using the methodology of Bamford (2020).

3.8 Survey Limitations

In accordance with the EPA documents *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) an assessment of potential survey limitations was undertaken (Table 2). No avoidable limitations were identified that can be expected to have affected the reliability of the results of the field survey.

Seasonal conditions preceding the field assessment have the potential to affect the emergence of annual species and the flowering of perennial species. The survey area occurs within a high rainfall zone and the assessment was conducted after close to average rainfall (Figure 2). Consequently, soil moisture conditions were not considered a major limitation for the emergence and flowering of Threatened or Priority flora species.

The information provided within this report is accurate and correct to the best of the author's knowledge. However, no liability is accepted for loss, damage or injury arising from its use. Plant populations can fluctuate over time, particularly after disturbance events such as fire and drought. Consequently, all mapping, vegetation descriptions and population estimates within this report should not be considered accurate indefinitely.

Table 2. Assessment of potential survey limitations for flora and fauna.

Potential for limitation	Assessment
Availability of contextual information	Regional vegetation extents (DBCA 2019) and flora records from the DBCA (WAH 1998–) were available to allow for an appropriate level of contextual information prior to the field survey. Cockatoo breeding and roosting datasets have not been updated since 2018 (GoWA 2025). Birdlife Australia does contain more updated information. However, the precise location of breeding trees are withheld. Anecdotally, there are multiple breeding locations for black cockatoo within the Denmark area.
Personnel experience	The principal ecologist conducting the assessments is competent with sufficient experience (>10 years) in surveying south coast biota.
Adequacy of survey scope	A targeted flora survey and cockatoo assessments over five days was sufficient to determine a baseline level of the biological information required for Environmental Impact Assessment (EIA). Other areas only subject to reconnaissance level survey are not surveyed at a suitable intensity for EIA.
Proportion and type of flora and fauna habitat recorded, identification issues or sampling biases	The survey effort focused on determining the presence of conservation significant vascular flora identified from the desktop assessment in a single-phase survey. A detailed flora and vegetation assessment using quadrats was not undertaken, therefore not all taxa within the survey area was recorded. Cockatoo roosting habitat was not specifically addressed during the survey as potential impacts to these components is considered negligible. All areas of intact mature Eucalypt forest are high quality foraging habitat and may potentially be used for roosting. However, no mature trees with DBH >100mm are to be cleared for the trail development. The location of suitable breeding trees were recorded and mapped to assist with planning and avoidance. The assessment of potential cockatoo hollows was basic only. i.e., an estimation was made from ground level therefore no internal dimensions could be assessed.
Extent of survey and site access	The reserve area and survey area was relatively large, contained some areas of high quality vegetation and was considerably dense in some areas. An effort was made to make a minimum of one meandering traverse of each potential trail corridor.
Timing, weather or season	Sufficient rainfall occurred prior to the surveys, such that the seasonal conditions were considered appropriate for recording the flora values present. The survey was conducted in spring therefore species that emerge or flower outside this period may not have been detected. There are no conservation significant flora considered likely to have been overlooked. Timing of surveys occurred within black cockatoo breeding season. Breeding was observed at Mt Hallowell (approx. 8 km away) during the assessment period.
Disturbances (e.g. fire, flood, slashing etc.)	Flora: The survey area is >10 years unburnt; therefore was unlikely to have affected the flora survey results.

4 RESULTS

4.1 Desktop Assessment

The desktop assessment determined that two Threatened Ecological Communities (TEC) may have the potential to occur in the study or survey area (DCCEEW 2025). The TECs identified are:

- *Empodisma* Peatlands of southwestern Australia TEC (Endangered).
- Subtropical and temperate saltmarsh TEC (Vulnerable).

The "*Empodisma Peatlands of southwestern Australia"* TEC was recently (September 2023) listed as Endangered under the EPBC Act and is unlikely to occur in the survey area given the absence of wetland vegetation (DCCEEW 2023).

The "*Subtropical and temperate saltmarsh"* TEC identified in the search is confined to the saline tidal margins of Wilson Inlet and is considered highly unlikely to occur within the survey area (DoTE 2013).

The desktop assessment identified that five conservation significant flora taxa have previously been recorded in the vicinity (<5 km) of the survey area (Appendix B, Map 1).

A pre-survey likelihood of occurrence assessment of conservation significant flora (Appendix C) determined the following conclusions:

- Three flora were considered likely or possible to occur within the survey area as they have been previously recorded within the reserve, or in close proximity.
- It was considered unlikely that the remaining two taxa occur within the survey area due to habitat preference or the records in the study area were geospatial errors.

4.2 Field Assessment

4.2.1 Vegetation

Turner Road Reserve is dominated by Marri and Jarrah Forest (29.5 ha) interspersed with areas of Karri (4.9 ha) (Appendix B, Map 3 and 4, Table 3, Plate 1-3). The condition is mostly Very Good, where the understory is intact, but widespread disturbance occurs from previous timber extraction and moderate impacts of *Phytophthora cinnamomi*. Some lower slope, water gaining areas are in Excellent condition. Approximately 5.5 ha of the reserve has previously been cleared for gravel extraction and has subsequently been revegetated. The quality of the revegetation is highly variable and contains a mix of local and non-indigenous species. The revegetated areas are largely devoid of mature remnant Eucalypts.

Table 3. Extent (ha) of remnant and non-native vegetation in Turner Road Reserve.

	Degraded	Good	Very Good	Very Good/Excellent	Total:
CcalEmarBlin (Marri Forest)	1.33	4.88	22.63	0.88	29.73
Ediv (Karri Forest)	2.40	0.85	0.37	1.35	4.96
Tlin (Wetland)				0.05	0.05
Rehabilitated Quarry					5.30
Cleared					1.86
Total:	3.73	5.73	23.00	2.28	41.90

Plate 1. Marri and Jarrah Forest in Very Good to Excellent condition.

Plate 2. Karri Forest in Good/Degraded condition.

Plate 3. Revegetation of previous gravel quarry. No condition score is applied to revegetation.

4.2.2 Conservation Significant Flora

Surveys have confirmed at least two DBCA Priority-listed flora occur in the reserve (mapped in Appendix B, Map 3).

Bossiaea sp. Mt Frankland (L. Graham 2174) (Priority 2) is medium shrub from the Fabaceae family known from the Mt Frankland area and one unconfirmed locality near “Denmark River” collected 1927 (Acc: PERTH 02718790). The targeted surveys have confirmed that two sub-populations (approx.. 250 individuals) occur in the reserve, which required alteration of trail alignment to avoid impacts.

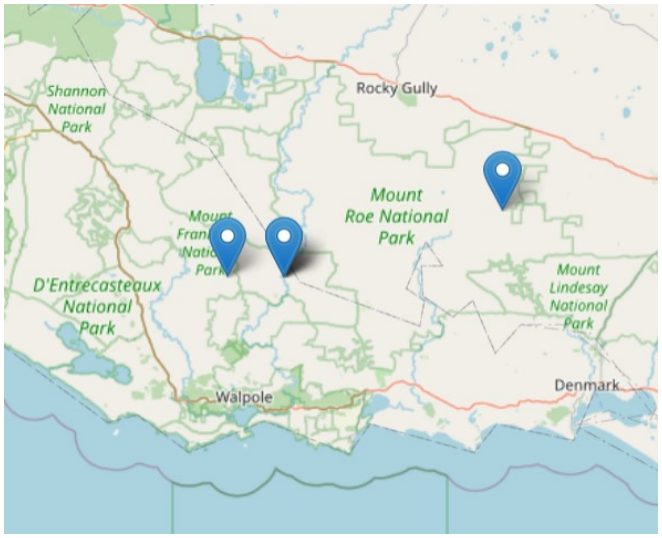

Plate 4. *Bossiaea* sp. Mt Frankland (L. Graham 2174) (Priority 2).

Netrostylis sp. Blackwood River (A.R. Annels 3043) (Priority 3) is an inconspicuous sedge from the Cyperaceae family that was previously collected from Turner Road Reserve (Acc: PERTH 04131053). The location of this population is confirmed to occur in the water gaining area in the north-east corner of the Reserve amongst Karri and *Eucalyptus patens*. An additional sub-population was recorded during the assessments, which required alteration of trail alignment to avoid impacts (total of approx.. 1050 individuals).

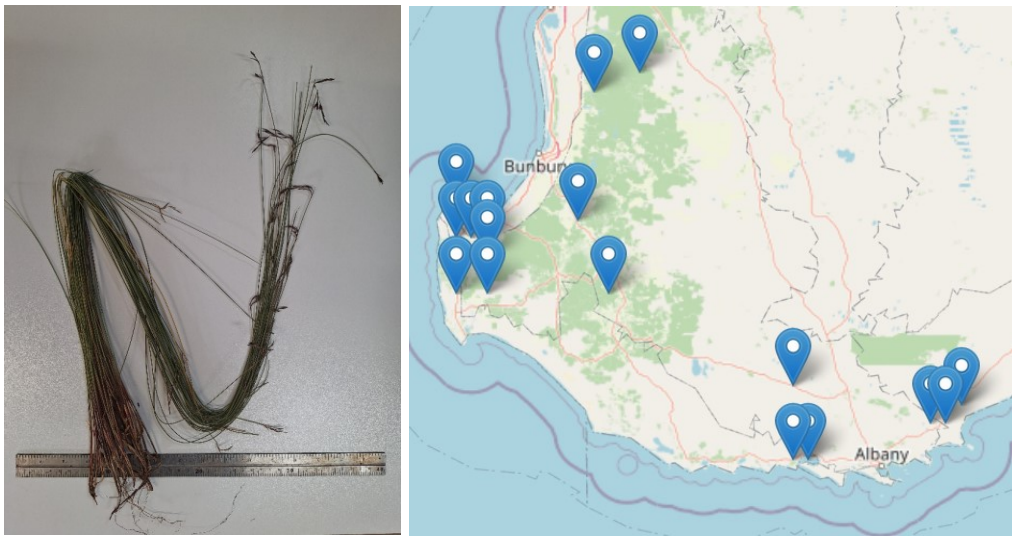

Plate 5. *Netrostylis* sp. Blackwood River (A.R. Annels 3043) (Priority 3)

4.2.3 Weeds

Several weed species have significant infestations within the Reserve (Appendix B, Map 4). Periwinkle (**Vinca major)* and Watsonia *(*Watsonia meriana var. bulbillifera)* are particularly widespread in the reserve (Plate 6 and 7). Blackberry (**Rubus anglocandicans*) occurs within one water gaining area. Other weeds are present in scattered occurrences (**Acacia longifolia, *Allium triquetrum, *Cirsium vulgare, *Phytolacca octandra, *Polygala myrtifolia, *Oxalis purpurea* and **Rosa canina*) or are within the revegetation (**Cupressus macrocarpa, *Eucalyptus globulus, *Melaleuca nesophila* and **Pinus radiata*).

Plate 6. * *Watsonia meriana* var. *bulbillifera*

Plate 7. **Vinca major*.

4.2.4 Post survey likelihood of occurrence

A post-survey likelihood of occurrence assessment of conservation significant flora (Appendix C) was undertaken following the field visits to determine the suitability of habitats encountered and the effectiveness of the survey effort and timing. The assessment determined the following conclusions:

- One conservation significant flora taxa identified in the desktop assessment was recorded in the survey area.
- One Priority-listed taxon was recorded in the survey area, but has not previously been recorded in the vicinity.
- At completion of the survey, all other conservation significant taxa identified in the desktop assessment were considered unlikely to occur in the survey area.

4.2.5 Black Cockatoo Habitat Assessment

The reserve supports areas of mature woodland and forest dominated by either Marri, Jarrah or Karri, which typically represent high quality foraging habitat for black cockatoo species. Many old growth trees are present with hollows that are potentially suitable for breeding. No confirmed breeding or roosting sites are recorded in the reserve (GoWA 2025), however there are multiple water sources and extensive contiguous forests with foraging and breeding potential. Sighting records of the three black cockatoo species are numerous within the study area. Several flocks of Baudin's Cockatoo and Forest Red-tailed Black Cockatoo were observed during the surveys and extensive evidence of feeding debris is present in the reserve. The reserve and survey area contain potential habitat for all three species of black cockatoo:

Baudin's Cockatoo (*Zanda baudinii*) (T-EN)

Baudin's Cockatoo occurs in high-rainfall areas, usually at sites that are heavily forested and dominated by Marri, Jarrah and Karri. It also occurs in woodlands of Wandoo (*E. wandoo*), Blackbutt (*E. patens*), Flooded Gum (*E. rudis*), and Yate (*E. cornuta*) (DSEWPaC, 2012). Baudin's cockatoo feeds mainly on the seeds of Marri, but may also feed on the seed of *Banksia* spp., *Hakea* spp. and *Erodium botrys*. Additionally, Baudin's Cockatoo feeds on invertebrate larvae and on apple, pear and persimmon in domestic and commercial fruit orchards (Chapman 2008). There is very little breeding information and the breeding biology of this species remains poorly known (Johnstone and Kirkby 2008). Known breeding trees include Karri, Marri, Wandoo and Tuart. Hollows suitable for Baudin's Cockatoo are likely to be in trees 500 mm or greater DBH and suitable hollows usually have a diameter of 300-400 mm (Johnstone & Storr 1998; Higgins 1999; Saunders 1974, 1979).

Carnaby's Cockatoo (*Zanda latirostris*) (T-EN)

Habitats considered suitable for this species are uncleared or remnant native Eucalypt woodlands or forests containing Marri, Jarrah or Karri and shrublands or Kwongkan heathland dominated by *Hakea, Dryandra, Banksia* and *Grevillea* (Johnston 2013, DSEWPaC 2012). On the south coast they feed on Jarrah and Marri seeds and a wide variety of mainly proteaceous species. Breeding hollows occur in Jarrah and Marri and generally have an entrance diameter >200 mm and occur in trees that are 120–150 years old. Trees approaching 680 mm DBH are close to developing suitable hollows (Pittman *et. al*. 2007, Whitford and Williams 2002, DPaW 2013).

Communal night roosting occurs at different sites throughout the year. Groups of birds will roost in a suitable tree or group of tall trees, usually close to a water source (known to drink at dams and farm troughs) and within an area of quality foraging habitat. The cockatoos fly to feeding areas each day before returning to the night roost, however, use of a particular night roost site may vary from daily to weekly. Night roosts are generally located in the tallest trees in an area; on the south coast potential roost trees include Marri, Karri, Blackbutt, *Taxandria juniperina*, Tuart (planted), introduced Eucalypts (for example Blue Gum) and introduced pines (DSEWPaC 2012).

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp*. naso*) (T-VU)

Forest Red-tailed Black Cockatoo commonly occur in Jarrah, Karri and Marri forests and also in a range of other forest and woodland types, including Blackbutt, Wandoo, Tuart, Albany Blackbutt, Yate and Flooded Gum (DSEWPaC, 2012). Ninety percent of the Forest Red-tailed Black Cockatoo total diet consists of Marri and Jarrah seeds (Johnstone & Kirkby 1999), and it depends on both feed trees during breeding periods (Johnstone *et al.* 2013). Other less important foods include *Allocasuarina* cones, fruits of Snottygobble (*Persoonia longifolia*) and *Hakea* spp, and the seed of a variety of Eucalypts (e.g *E. megacarpa*, *E. decipiens, E. lehmanni, E. diversicolor*) (DAWE 2022).

Breeding occurs almost exclusively in Marri. Johnson *et al.* (2013) found by measuring 128 breeding trees that mean DBH was 2790 mm, mean estimated age was 222 years, and mean hollow entrance size was 300 mm x 340 mm. However, Whitford *et al.* (2015) state a more realistic minimum age for trees bearing suitable hollows is approximately 120–150 years (tree diameters of 500–600 mm) and most nest hollows occurred in intermediate-sized trees.

Breeding Habitat Assessment

The survey area occurs within the known distribution and predicted breeding range of Baudin's Cockatoo and Carnaby's Cockatoo. Forest Red-tailed Black Cockatoo are also known to occur in the area and may breed in suitable trees anywhere within their range of occurrence (DSEWPaC 2012). There are no formally recorded breeding sites within the Turner Road Reserve (GoWA 2025). However, multiple unofficial black cockatoo breeding sites are known in the Denmark area.

In total, 371 suitable DBH trees (comprised of 233 *Corymbia calophylla,* 120 *Eucalyptus marginata* and 18 *E. diversicolor*) were recorded in the survey area (i.e., within 30 m corridor of alignments, additional trees may occur outside this area within the reserve). Of these trees, 34 within the survey area contained large hollows or chimneys (as observed from ground only) that may have suitable dimensions for black cockatoo breeding (mapped in Appendix B, Map 5).

Foraging Habitat Assessment

A basic foraging habitat quality assessment of the vegetation within the survey was undertaken (Table 4). All areas of native vegetation dominated by Eucalypt forest or woodland (i.e., Jarrah, Marri and Karri) score as high quality for each black cockatoo species (i.e., >6/10). In total, Turner Road Reserve contains approximately 34 ha of foraging habitat and the survey area intersects 18.6 ha.

Table 4. Foraging quality assessment of the survey area for black cockatoo species (Bamford 2020).

Taxon	Foraging quality categories			Overall Score (High = 5-10; Low = 0-4)
	Vegetation type and condition (6 points)	Site context / breeding habitat (3 points)	Stoking rate (1 point)	
Carnaby's Cockatoo	4/6 - Eucalypt Woodland/Forest with Marri 40-60% projected foliage cover.	2/3 – Closest know breeding site 62 km away.	0/1 – Not directly observed.	6
Baudin's Cockatoo	4/6 - Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths	3/3 – Known breeding within 12km.	1/1 – Birds and feeding evidence observed.	8
Forest Red-tailed Black-Cockatoo	4/6 - Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths	3/3 – Known breeding within 12km.	1/1 – Birds and feeding evidence observed.	8

Plate 8. Mature Karri with large chimney hollow.

Plate 9. Mature Jarrah with large chimney hollow.

5 DISCUSSION

The Shire of Denmark is investigating environmental constraints related to the development of a network of mountain bike trails within Turner Road Reserve. The trail concept plan (Magic Dirt 2024) proposes to establish a trail network including 10 km of bike trails and associated infrastructure throughout the Reserve. Southern Ecology was engaged to assess the reserve and trail corridors to identify environmental values. A reconnaissance vegetation survey, targeted flora survey and a black cockatoo habitat assessment was undertaken over six days in 2023 and 2024. Preliminary results were subsequently provided to the Shire of Denmark and used in the concept design and environmental planning.

Turner Road Reserve is dominated by Marri and Jarrah Forest and Woodland (29.5 ha) interspersed with areas of Karri (4.9 ha). These align with pre-European vegetation types where 39% and 78% remains within the IBRA Region, respectively. Upper-slope sections of the reserve have previously been cleared for gravel extraction and have subsequently been revegetated with a combination of native and non-indigenous species (5.5 ha). Weed invasion, impacts of dieback (*Phytophthora cinnamomi*) and evidence of timber extraction are widely present in the reserve; subsequently 9.4 ha is in Degraded to Good condition. Approximately, 1.8 ha of the reserve is cleared for fire management and local fire brigade infrastructure.

Two Priority-listed flora by the Department of Biodiversity, Conservation and Attractions (DBCA) occur in the reserve. (*Bossiaea* sp. Mt Frankland (L. Graham 2174) (Priority 2) and *Netrostylis* sp. Blackwood River (A.R. Annels 3043) (Priority 3)). The targeted surveys have confirmed that multiple sub-populations of these taxa occur in the reserve. Trail alignments were reviewed to avoid impacts to these populations.

The reserve supports areas of mature woodland and forest that represent habitat for three Threatened species of black cockatoo (Baudin's Cockatoo, Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo). Trail construction plans to avoid removal of any Eucalypt trees greater than 100mm DBH. Within the trail alignments (i.e., 30 m corridor), 371 suitable DBH trees were recorded of which 34 contained hollows or chimneys potentially suitable for breeding. Areas of Marri, Jarrah and Karri forest in the reserve (34 ha) and in the survey area (18 ha) are foraging habitat for black cockatoo species.

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APPENDIX A - Conservation Status Definitions

Table A1. Acts relevant to environmental impact assessment.

Environment Protection and Biodiversity Conservation [EPBC] *Act 1999*	https://www.legislation.gov.au/Details/C2016C00777
Environmental Protection [EP] *Act 1986*	https://www.slp.wa.gov.au/legislation/statutes.nsf/law_a252.html
Biodiversity Conservation [BC] *Act 2016*	https://www.slp.wa.gov.au/legislation/statutes.nsf/law_a147120.html

Table A2. The categories for flora and fauna listed as Threatened or specially protected. Taxa can be recognised as Threatened (T) or Conservation Dependent under Commonwealth (EPBC) and / or State (BC) Acts.

Threat category	Definition
Threatened - Critically Endangered (T-CR)	Considered to be facing an extremely high risk of extinction in the wild
Threatened – Endangered (T-EN)	Considered to be facing a very high risk of extinction in the wild
Threatened – Vulnerable (T-VN)	Considered to be facing a high risk of extinction in the wild
Threatened - Presumed extinct (T-EX)	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died.
Conservation dependant (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened
Migratory birds protected under international agreement (IA)	Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds
Other specially protected fauna (OS)	Fauna otherwise in need of special protection to ensure their conservation

Table A3. Flora or fauna that are potentially threatened but do not meet the survey criteria or are otherwise data deficient are listed under Priority categories with the Department of Biodiversity, Conservation and Attractions.

Category	Description
Priority One (P1)	Known from few locations (generally <5), small populations and/or occurring on land with insecure tenure
Priority Two (P2)	Known from few locations (generally <5), small populations with some occurring on land with secure tenure
Priority Three (P3)	Known from several locations with habitat not under imminent threat
Priority Four (P4)	(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy

Table A4. Categories for ecological communities listed as Threatened (TEC). Communities can be recognised as Threatened under Commonwealth (EPBC) and / or State (BC) Acts.

Category	Description
Presumed totally destroyed (PU)	Adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.
Critically Endangered (CR)	Adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
Endangered (EN)	Adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.

Vulnerable (VU)	Adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium (within approximately 50 years) to long-term future.

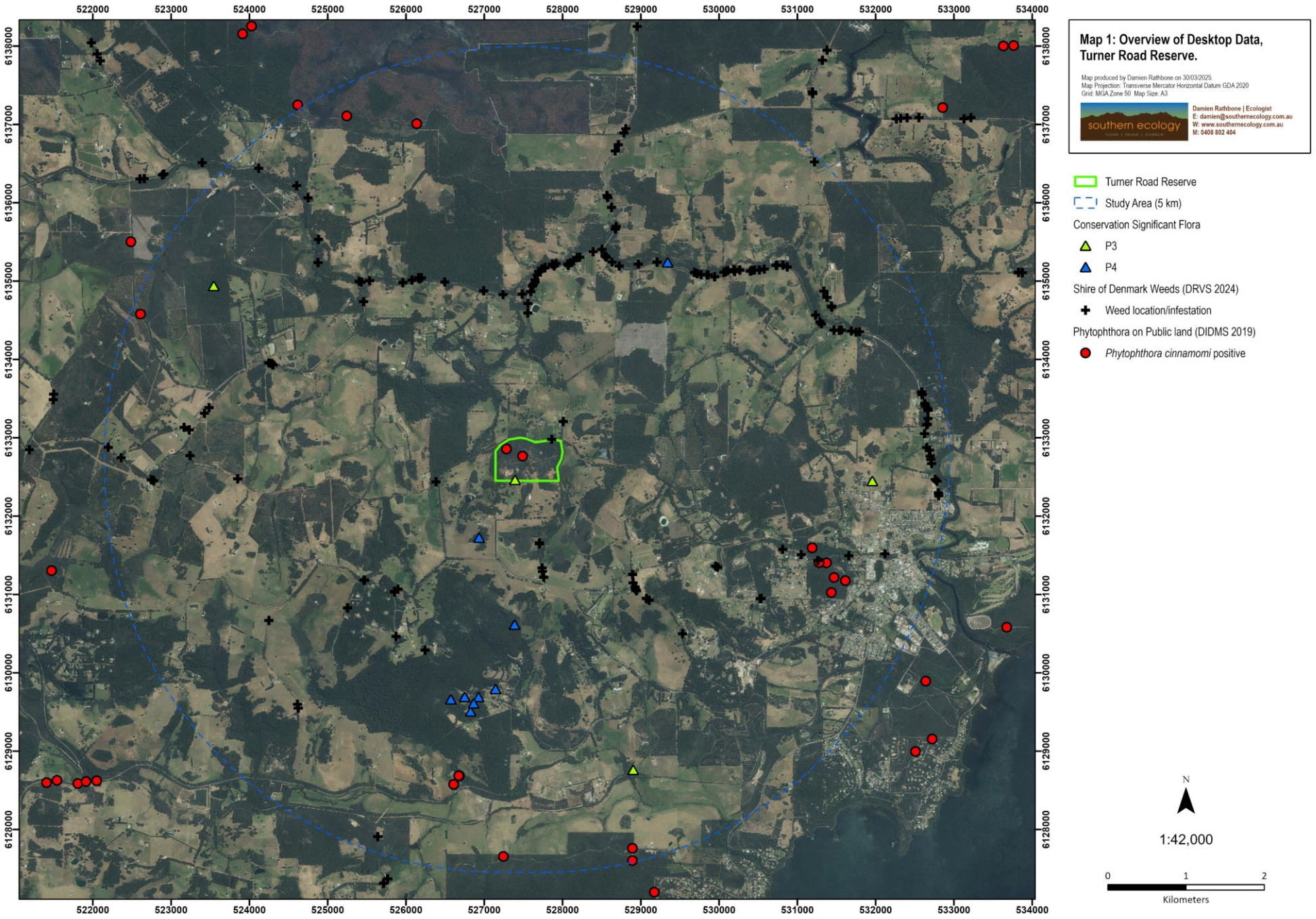
Table A5. The categories for ecological communities listed as Priority (PEC) with the Department of Biodiversity, Conservation and Attractions.

Category	Description
Priority One (P1)	Known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha) and are currently under threat
Priority Two (P2)	Known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years)
Priority Three (P3)	Known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or; (iii) made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc
Priority Four (P4)	Adequately known, rare but not threatened or meet criteria for Near Threatened or that have been recently removed from the threatened list. These communities require regular monitoring
Priority Five (P5)	Conservation dependant ecological communities. Not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years

Table A6. Species that are 'introduced' or 'weeds' can potentially be listed under the state Biosecurity Management Act (DPIRD 2019) or under the commonwealth Weeds of National Significance (WoNS) (DotEE 2019b).

Category	Description
Declared Pest, Prohibited - s12	Prohibited organism and may only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions
Permitted - s11	Permitted organisms must satisfy any applicable import requirements when imported. They may be subject to an import permit if they are potential carriers of high-risk organisms
Declared Pest - s22(2)	Declared pests must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia
Permitted, Requires Permit - r73	Regulation 73 permitted organisms may only be imported subject to an import permit. These organisms may be subject to restriction under legislation other than the Biosecurity and Agriculture Management Act 2007. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions
WoNS	Weeds of National Significance – this is nationally recognised list of weeds agreed by Australian governments based on an assessment process that prioritised weeds based on their invasiveness, potential for spread and environmental, social and economic impacts. Consideration was also given to their ability to be successfully managed.

APPENDIX B - Maps



Map 1: Overview of Desktop Data, Turner Road Reserve.

Map produced by Damien Rathbone on 30/03/2025.
Map Projection: Transverse Mercator Horizontal Datum GDA 2020
Grid: MGA Zone 50 Map Size: A3

southern ecology
FLORA | FAUNA | DIEBACK
Damien Rathbone | Ecologist
E: damien@southernecology.com.au
W: www.southernecology.com.au
M: 0408 802 404

- Turner Road Reserve
- Study Area (5 km)

Conservation Significant Flora

- P3
- P4

Shire of Denmark Weeds (DRVS 2024)

- Weed location/infestation

Phytophthora on Public land (DIDMS 2019)

- *Phytophthora cinnamomi* positive

N

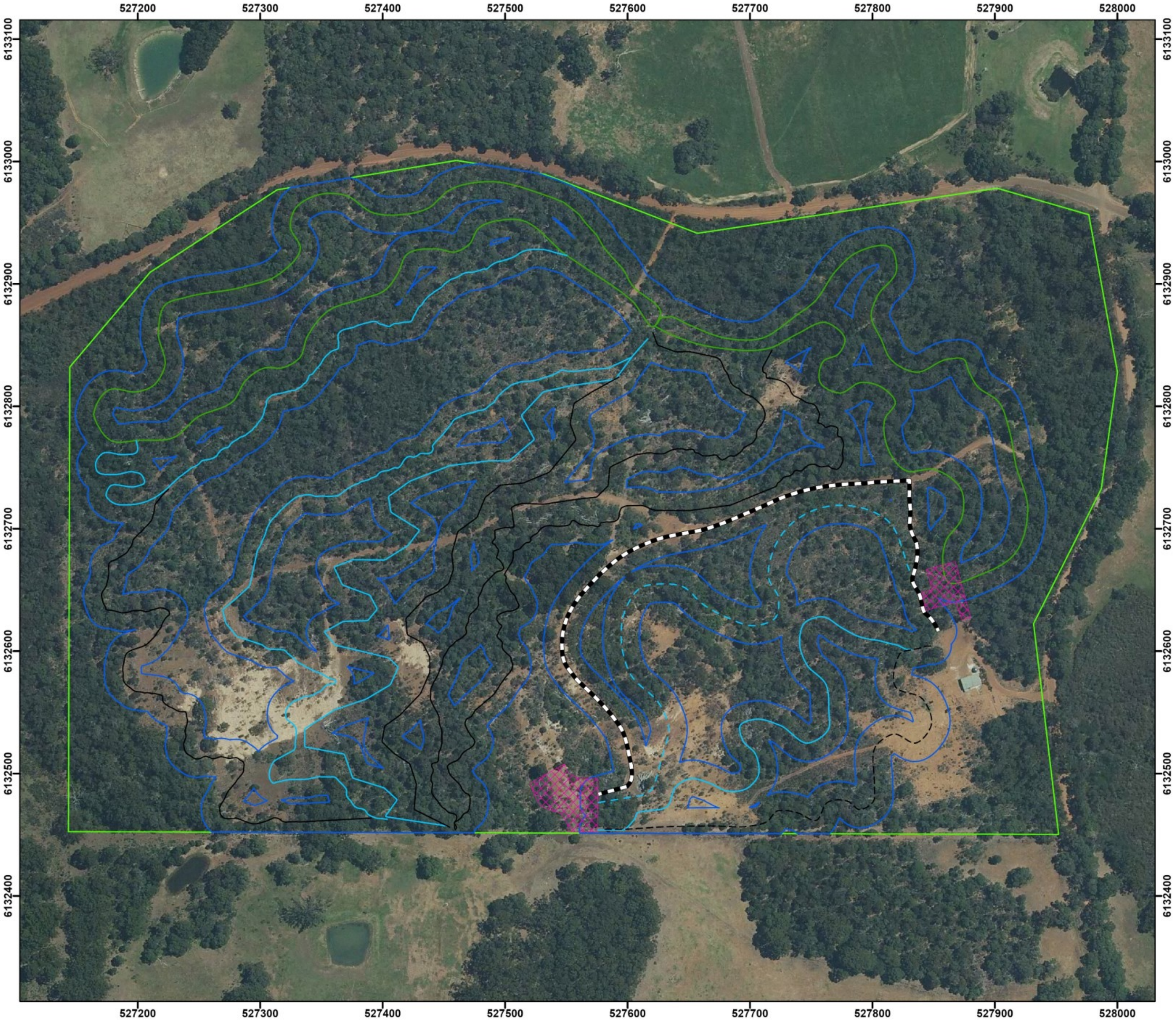
1:42,000

0 1 2
Kilometers

Map 2: Survey Area and Trail Alignments
Turner Road Reserve, Denmark

Map produced by Damien Rathbone on 30/03/2025.
Map Projection: Transverse Mercator Horizontal Datum GDA 2020
Grid: MGA Zone 50 Map Size: A3

southern ecology
FLORA | FAUNA | DIEBACK
Damien Rathbone | Ecologist
E: damien@southernecology.com.au
W: www.southernecology.com.au
M: 0408 802 404



Survey Area
- Reconnaissance Flora and Vegetation Assessment
- Targeted Flora and Cockatoo Habitat Assessment

Mountain Bike Trail Alignments
- Green Loop
- Blue 1-4
- Blue Climb
- Black 1-4
- Double Black
- Shuttle Road
- Carpark Locations

0 100
Metres

N

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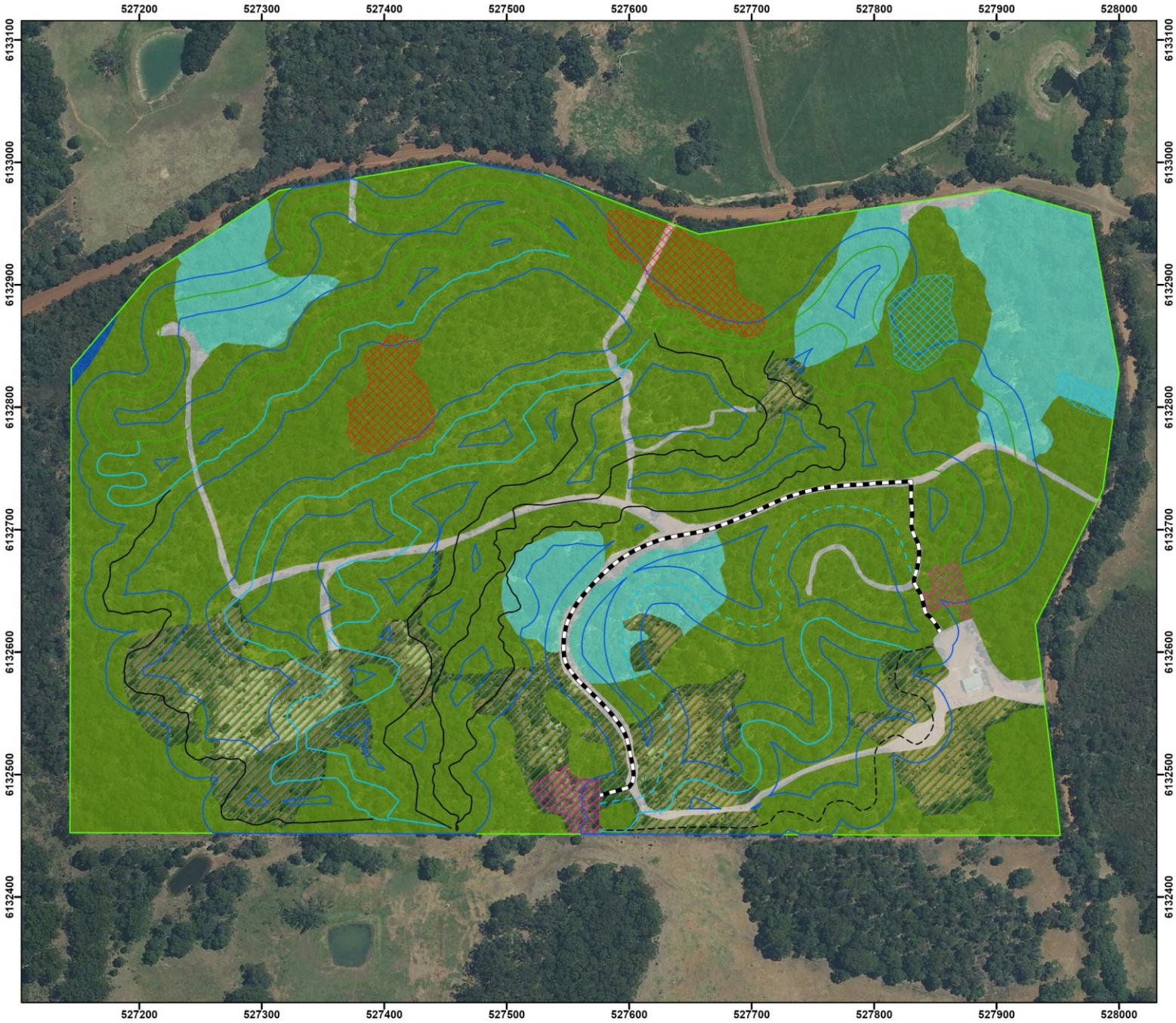


Map 3: Vegetation Type and Significant Flora, Turner Road Reserve, Denmark

Map produced by Damien Rathbone on 30/03/2025.
Map Projection: Transverse Mercator Horizontal Datum GDA 2020
Grid: MGA Zone 50 Map Size: A3

southern ecology
FLORA | FAUNA | DIVERSITY
Damien Rathbone | Ecologist
E: damien@southernecology.com.au
W: www.southernecology.com.au
M: 0408 802 404

Survey Area
- Reconnaissance Flora and Vegetation Assessment
- Targeted Flora and Cockatoo Habitat Assessment

Vegetation Type
- CcalEmarBlin (Marri Forest)
- Ediv (Karri Forest)
- Tlin (Taxandria Thicket)
- Rehabilitated Quarry
- Cleared

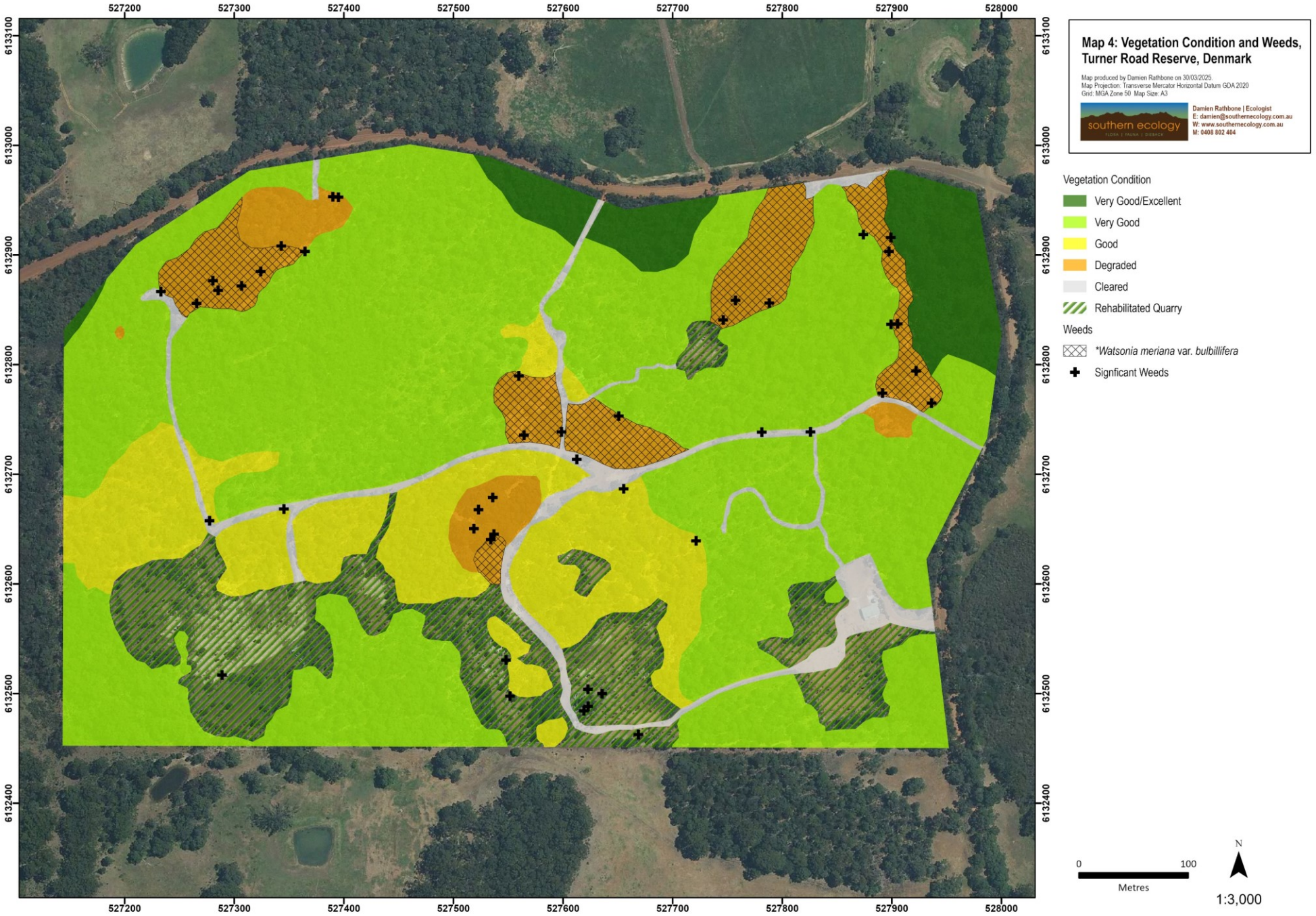
Conservation Significant Flora
- *Bossiaea* sp. Mt Frankland (L. Graham 2174) (P2)
- *Netrostylis* sp. Blackwood River (A.R. Annels 3043) (P3)

Mountain Bike Trail Alignments
- Green Loop
- Blue 1-4
- Blue Climb
- Black 1-4
- Double Black
- Shuttle Road
- Carpark Locations

0 100
Metres

N

1:3,000



Map 4: Vegetation Condition and Weeds, Turner Road Reserve, Denmark

Map produced by Damien Rathbone on 30/03/2025.
Map Projection: Transverse Mercator Horizontal Datum GDA 2020
Grid: MGA Zone 50 Map Size: A3

southern ecology
FLORA | FAUNA | OUTBACK
Damien Rathbone | Ecologist
E: damien@southernecology.com.au
W: www.southernecology.com.au
M: 0408 802 404

Vegetation Condition

- Very Good/Excellent
- Very Good
- Good
- Degraded
- Cleared
- Rehabilitated Quarry

Weeds

- **Watsonia meriana* var. *bulbillifera*
- Signficant Weeds

0 100
Metres

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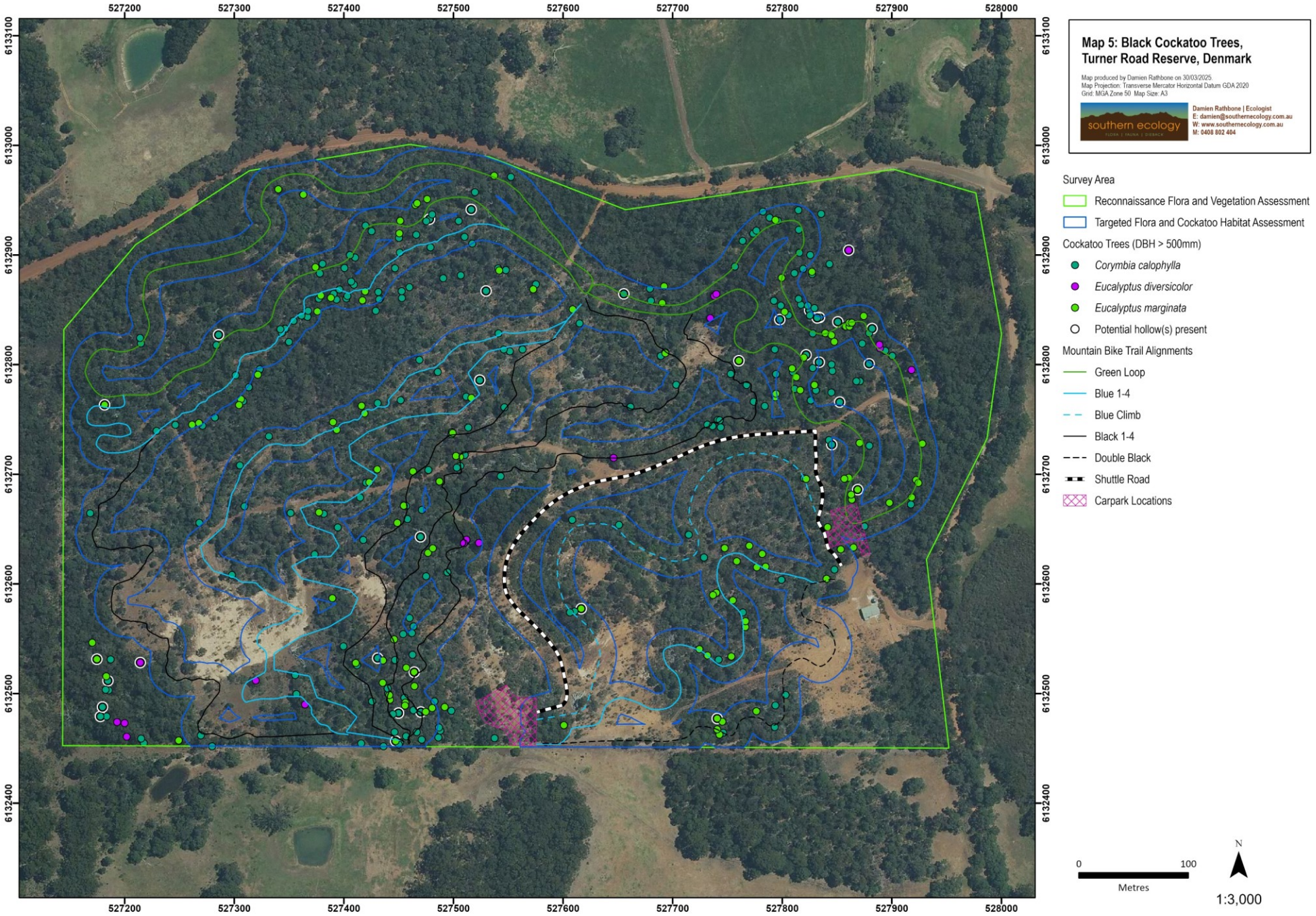


Map 5: Black Cockatoo Trees, Turner Road Reserve, Denmark

Map produced by Damien Rathbone on 30/03/2025.
Map Projection: Transverse Mercator Horizontal Datum GDA 2020
Grid: MGA Zone 50 Map Size: A3

Damien Rathbone | Ecologist
E: damien@southernecology.com.au
W: www.southernecology.com.au
M: 0408 802 404

Survey Area

- Reconnaissance Flora and Vegetation Assessment
- Targeted Flora and Cockatoo Habitat Assessment

Cockatoo Trees (DBH > 500mm)

- *Corymbia calophylla*
- *Eucalyptus diversicolor*
- *Eucalyptus marginata*
- Potential hollow(s) present

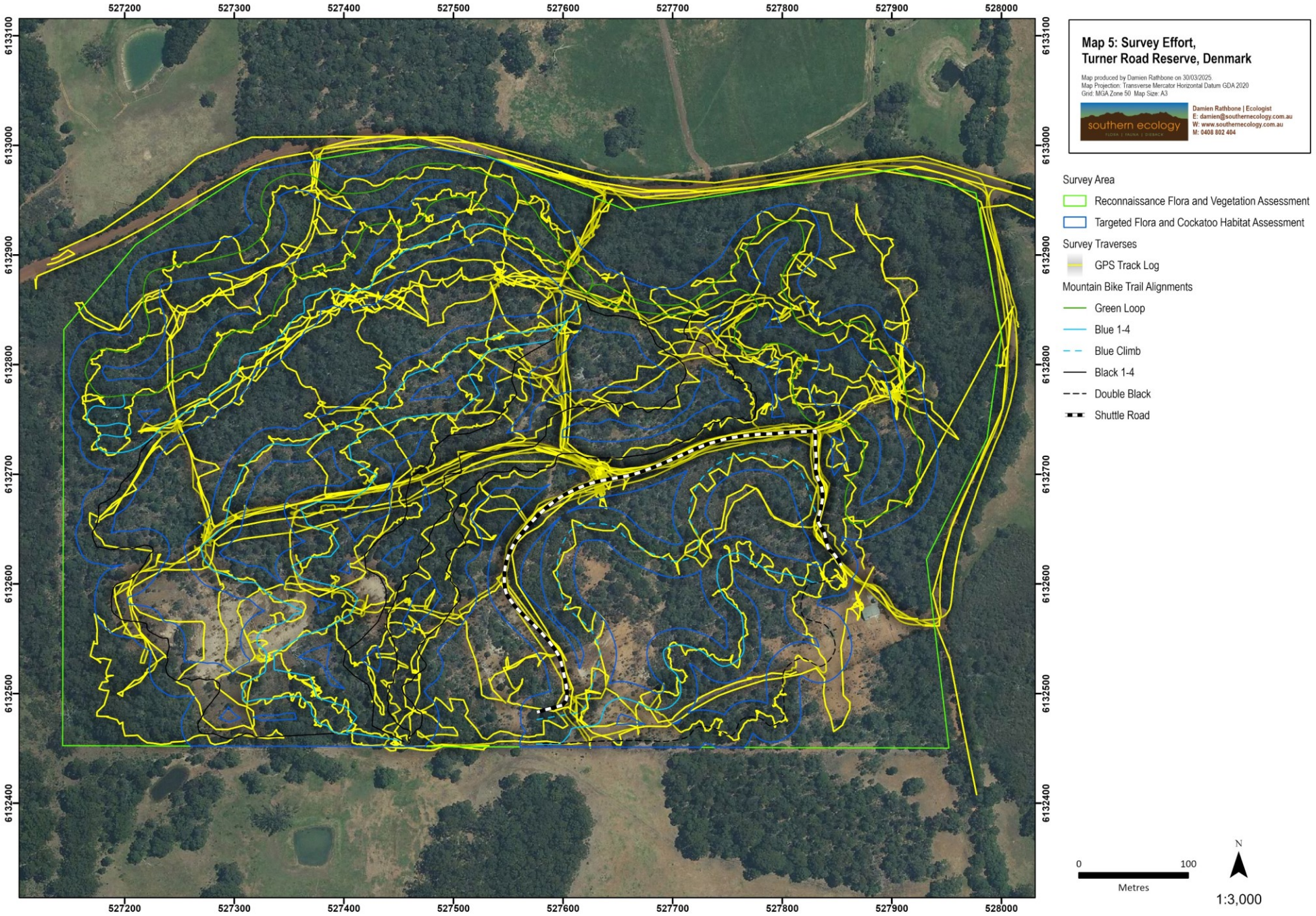
Mountain Bike Trail Alignments

- Green Loop
- Blue 1-4
- Blue Climb
- Black 1-4
- Double Black
- Shuttle Road
- Carpark Locations

0 100
Metres

N

1:3,000



Map 5: Survey Effort, Turner Road Reserve, Denmark

Map produced by Damien Rathbone on 30/03/2025.
Map Projection: Transverse Mercator Horizontal Datum GDA 2020
Grid: MGA Zone 50 Map Size: A3

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FLORA | FAUNA | DIVERSITY
Damien Rathbone | Ecologist
E: damien@southernecology.com.au
W: www.southernecology.com.au
M: 0408 802 404

Survey Area
- Reconnaissance Flora and Vegetation Assessment
- Targeted Flora and Cockatoo Habitat Assessment

Survey Traverses
- GPS Track Log

Mountain Bike Trail Alignments
- Green Loop
- Blue 1-4
- Blue Climb
- Black 1-4
- Double Black
- Shuttle Road

0 100
Metres

N

1:3,000

APPENDIX C - Likelihood of Occurrence Analysis

Pre and post-survey likelihood of occurrence of all conservation significant species flora identified in the desktop assessment was determined based on the presence of suitable habitat and survey effectiveness (see section 3.3).

Table C1. Likelihood of occurrence of conservation significant flora recorded in the vicinity of the survey area (<5 km).

Status, Taxon [FAMILY]	Description, Habitat & Distribution	Likelihood of Occurrence	
		Pre-survey	Post survey
P3 *Andersonia* sp. Virolens (G.J. Keighery 12000) [Ericaceae]	Low, spreading, cushion-like shrub, 0.05-0.12 m high. Fl. White/cream with red anthers, Sep. Grey/Brown/Yellow sand over laterite or granite. Often found in water gaining sites.	Unlikely. Record in survey area is a geospatial error from Mt Lindesay.	Unlikely.
P3 *Lasiopetalum* sp. Denmark (B.G. Hammersley 2012) [Malvaceae]	Open erect perennial shrub. Flowers cream/pink.	Possible. Widespread species and habitat is potentially suitable.	Unlikely. Suitable habitat occurs within the survey area. However, no limitations identified that would have prevented detection and all areas thoroughly surveyed.
P3 *Netrostylis* sp. Blackwood River (A.R. Annels 3043) [Cyperaceae]	Erect sedge to 0.5m high. Creekbeds, drainage lines, lake edges.	Likely. Widespread species and habitat is potentially suitable. Recorded	Recorded.
P4 *Banksia serra* [Proteaceae]	Erect, slender, non-lignotuberous shrub, 1-4(-7) m high. Flowers yellow/cream-green, Jul to Sep. Gravel, sand or clay loam over laterite. Hillslopes.	Possible. Widespread species and habitat is potentially suitable.	Unlikely. Suitable habitat occurs within the survey area. However, no limitations identified that would have prevented detection and all areas thoroughly surveyed.
P4 *Eucalyptus virginea* [Myrtaceae]	Tree, to 12 m high, bark smooth, powdery, white. Fl. white, Dec or Jan or Jul. Clay or sandy loam, shallow soil over granite, laterite loam over clay. Lower slopes near watercourses, edge of rock outcrops, gently sloping sites.	Unlikely. Conspicuous tree, known population in study area at Lapko Road.	Unlikely.