



The Extent and Condition of Natural Temperate Grassland of the South Eastern Highlands in the Ginninderry Project Area

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1 Introduction

Capital Ecology Pty Ltd (Capital Ecology) has been commissioned by The Riverview Group Pty Ltd ('Riverview') to assess and map the extent and condition of the grassland vegetation throughout the western portion (i.e. west of Parkwood Road) of the Ginninderry project area, which encompasses both the proposed urban development area and the Ginninderry Conservation Corridor (GCC) (formerly referred to as the West Belconnen Conservation Corridor (WBCC); the GCC was formally established in November 2019) (Figure 1.1-a).

Riverview Projects and the Commonwealth Government commenced a **Strategic Assessment**¹ under Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The focus of the Strategic Assessment was to assess the potential impacts from development of the Ginninderry project area on Matters of National Environmental Significance (MNES) protected under the EPBC Act. Following endorsement of the **Program Report**² Riverview received **EPBC Act Approval**³ to implement the staged development of the project. Attached to the approval are 20 conditions. Condition 11 of The EPBC Act Approval for the Strategic Assessment states –

11. Prior to the commencement of construction (in all areas other than the area marked as stage 1 in the Program Figure 4) and within 12 months before or within 12 months after endorsement of the Program by the Department, the approval holder must engage a suitably qualified expert to survey the West Belconnen site for Pink-tailed Worm Lizard and Natural Temperate Grassland of the South Eastern Highlands in accordance with the survey guidelines. The results of surveys must be submitted to the Department for acceptance within 6 months of completion of the survey. The accepted report must be made available to the public prior to the commencement of construction.

During spring 2017 Riverview commissioned two separate technical studies in accordance with Condition 11 (Robert Jessop Pty Ltd and SMEC 2017⁴, SMEC 2017b⁵). These studies were submitted to the Department of the Environment and Energy. The Department subsequently provided the following clarification (email from Ross Rowe dated 15 June 2018) regarding Condition 11.

The purpose of Condition 11 is to capture any areas of NTG that were not identified at the time original vegetation surveys were undertaken, reflecting changes in the definition of the listed ecological community. Noting that NTG supports PTWL, condition 11 also requires targeted surveys for PTWL to ensure any additional habitat is appropriately identified (both within the conservation corridor and development area) and if necessary, offset any development impacts according to the defined process strategy.

¹ Umwelt (2017). *West Belconnen Project Strategic Assessment. Strategic Assessment Report. Final*. Prepared by Umwelt (Australia) Pty Ltd on behalf of Riverview Projects Pty Ltd. Report No. 8062_R01_V8, March 2017.

² A T Adams Consulting (2017). *Urban Development at West Belconnen. Program Report*. Prepared for: Riverview Projects (ACT) Pty Ltd, 18 April 2017.

³ Australian Government (2017). *Urban Development at West Belconnen (Ginninderry) – SA.024 – Final approval decision for the taking of actions in accordance with an endorsed program under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. Signed K. Farrant on 1 September 2017.

⁴ Robert Jessop Pty Ltd and SMEC (2017). *West Belconnen Vegetation Survey Summary. 2017 Update*. Prepared for the Riverview Group, April 2017.

⁵ SMEC (2017b). *Assessment of mapped pink-tailed worm lizard habitat within Ginninderry for potential to meet criteria for classification as natural temperate grassland*. 27 September 2017.

Accordingly, the primary aim of this study is to map the extent and condition of EPBC Act listed Natural Temperate Grassland of the South Eastern Highlands (NTG-SEH) throughout the Ginninderry project area in order to:

- meet the conditions of existing planning and environmental approvals;
- inform future development of the urban development area and any associated offset requirements; and
- inform measures to protect and manage any NTG-SEH that occurs in the GCC.

1.1 Background

In April 2016, the Department of the Environment and Energy revised the listing classification and conservation status of the previously listed endangered ecological community 'Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory' (NTG). The revised 'Natural Temperate Grassland of the South Eastern Highlands' (NTG-SEH) was elevated to critically endangered and recognises a broader area of grasslands across the South Eastern Highlands bioregion (Commonwealth of Australia 2016a⁶). The revision also provided a 'minimum condition threshold' for use in determining whether a patch of grassland remains in a condition consistent with the listed community and is thus protected by the EPBC Act. In the ACT and surrounding region of NSW, the effect of the revised listing and associated minimum condition threshold has been that many patches which would not have been previously recognised as NTG are now recognised as NTG-SEH.

The Ginninderry project area is an example of the above described situation in that no NTG was identified in the development area by any of the original studies (e.g. Kevin Mills & Associates 2009a⁷, 2009b⁸, Nash and Hogg 2013⁹). However, advice from local grasslands expert Sarah Sharp in 2016 suggested that reassessment would be prudent in light of the revised listing. Indeed, Sharp (2016)¹⁰ concluded that *Kangaroo Grass - Purple Wire-grass - Wattle Mat-rush dry tussock grassland in the Southern Tablelands region of the South Eastern Highlands Bioregion* ('Rocky Natural Grassland') occurs in the Ginninderry project area on western facing steep slopes with very high levels of outcropping and loose rocks, co-occurring with high quality Pink-tailed Worm-lizard *Aprasia parapulchella* habitat.

To align with classifications presented by Sharp (2016) regarding NTG-SEH, Robert Jessop Pty Ltd and SMEC (2017) carried out a revision of previous work in the GCC and presented broad-scale mapping at the 'vegetation community scale' with no direct assessment of patches against the listing criteria for NTG-SEH. As a result, the areas identified in that report as potential NTG-SEH along the steep rocky slopes through the central part of the GCC should be taken as the maximum possible extent of this threatened ecological community.

⁶ Commonwealth of Australia (2016a). *Natural Temperate Grassland of the South Eastern Highlands: a nationally protected ecological community*. Department of Environment and Energy.

⁷ Kevin Mills & Associates (2009a). *West Belconnen Project. ACT and NSW Land. Flora and Fauna Studies*. Prepared for CB Richard Ellis Pty Limited, January 2009.

⁸ Kevin Mills & Associates (2009b). *Further Flora and Fauna Studies, Land at West Molonglo and Ginninderra Creek, New South Wales, Australian Capital Territory*. Report prepared for The Riverview Group, July 2009.

⁹ Nash and Hogg (2013). *West Belconnen Woodland Areas. Confirmatory Ecological Assessment*. Prepared for the Riverview Group, May 2013.

¹⁰ Sharp (2016). *West Belconnen Conservation Zone Vegetation Unit Descriptions, ACT*. March 2016.

SMEC (2017a)¹¹ and SMEC (2017b) surveys were restricted to the proposed urban development area and the assessment of vegetation in areas identified and mapped as Pink-tailed Worm-lizard habitat by Osborne and Wong (2013)¹². These studies found that patches of low-quality Pink-tailed Worm-lizard habitat did not meet the listing criteria for classification as NTG-SEH, but that moderate to high quality Pink-tailed Worm-lizard habitat was considered likely to unless there was evidence of historically having been a woodland (e.g. stumps, regenerating woodland, surrounding vegetation). Subsequent floristic assessment determined that four patches in the Ginninderry development area (3.34 ha in total) met the minimum criteria for consideration as NTG-SEH “*using a conservative assessment of the likelihood of the area originally supporting rocky natural grassland.*”

1.2 Scope

Capital Ecology has been commissioned to assess and map the extent and condition of NTG-SEH across the entire western portion (i.e. west of Parkwood Road) of the Ginninderry project area. Particular consideration has been given to the areas of potential Rocky Natural Grassland as defined by Armstrong *et al.* (2012)¹³ and mapped by Sharp (2016), Robert Jessop Pty Ltd and SMEC (2017), and SMEC (2017a,b).

This report is structured in the following manner.

- Section 2 – Methods. Section 2 provides a detailed description of the assessment and mapping methodology.
- Section 3 – Results. Section 3 provides the results of the mapping study, presented as text, tables, and GIS-prepared figures. A brief discussion is provided describing any interesting observations from the data, or otherwise observed.
- Section 4 – Discussion. Section 4 provides an overview of the study, comparison of the current mapping to previous mapping where available, and an outline of the key ‘project-scale’ conclusions and recommendations.
- References. A list of the studies, guidelines, and other documents reviewed and considered during the development of this report.
- Appendices. Appendix 1, Appendix 2, and Appendix 3 present the results of the floristic plot/transect surveys as summary tables.

¹¹ SMEC (2017a). *Assessment of mapped pink-tailed worm lizard habitat within Ginninderry for potential to meet criteria for classification as natural temperate grassland.* 18 January 2017.

¹² Osborne and Wong (2013). *The extent of habitat for the vulnerable Pink-tailed Worm Lizard (Aprasia parapulchella) in the West Belconnen – Ginninderra Creek investigation area – confirmatory distribution surveys and mapping.* Report commissioned by The Riverview Group Pty Ltd, 10 May 2013.

¹³ Armstrong R.C., Turner K. D., McDougall K.L., Rehwinkel R., Crooks J.I. (2012). *Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory.* Cunninghamiana 13 (1): 125 – 266.

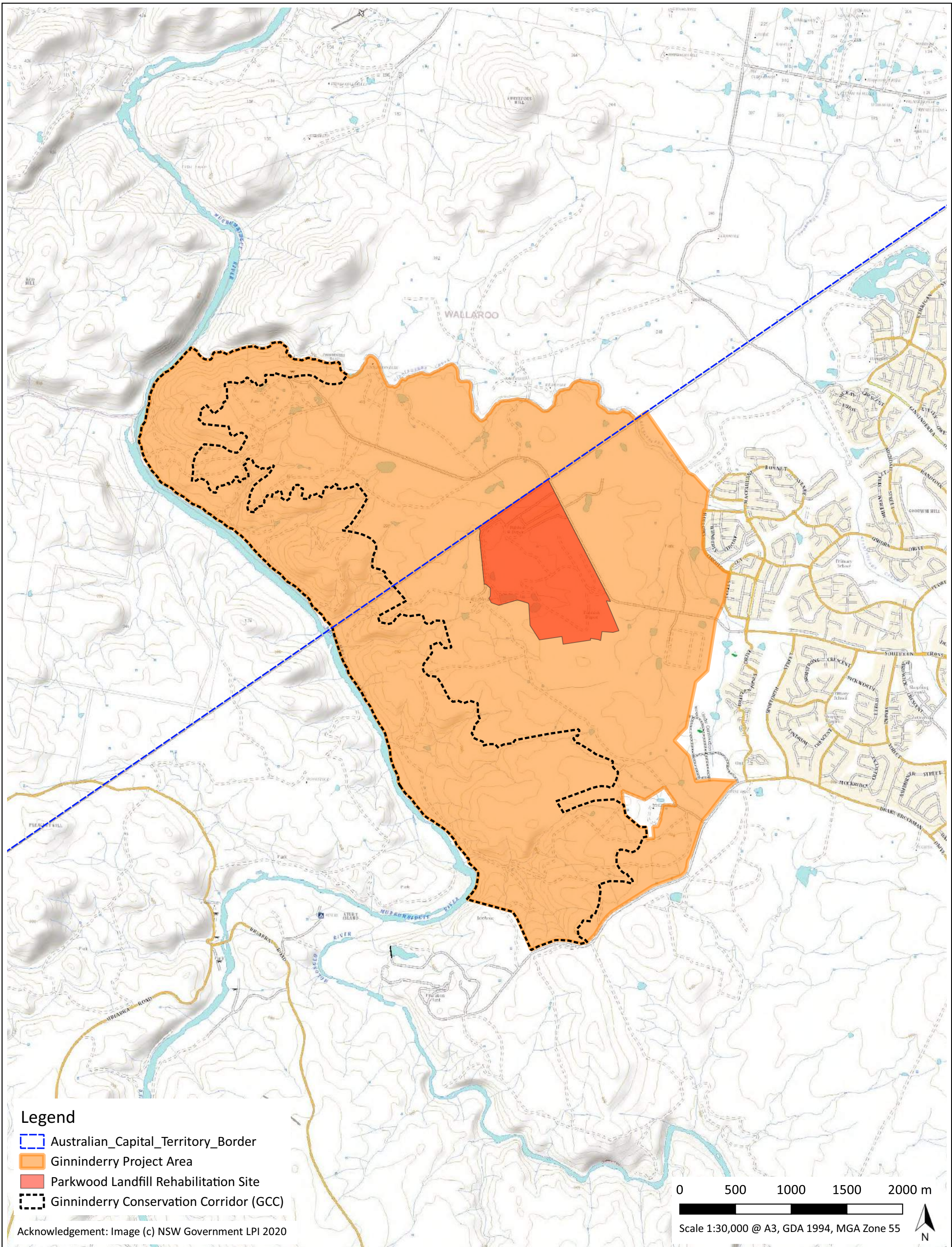


Figure 1.1-a. Locality Plan

2 Methods

2.1 Four-step temperate vegetation mapping method

The four-step method employed for this study was developed by Capital Ecology and has been trialled and improved during its subsequent application at numerous sites across the Southern Tablelands of NSW and the ACT. The method was employed to map the natural grassland at East Jerrabomberra and AMTECH offset reserves in spring 2016, together with the woodland and derived grassland at Mulangarri and Gungaderra offset reserves (Capital Ecology 2017¹⁴). More recently, this method was used in 2017 and 2018 to assess nine grassland sites (Capital Ecology 2018a¹⁵, Capital Ecology 2019b¹⁶) and twelve woodland sites (Capital Ecology 2018b¹⁷). The four-step method can be used to assess and map each of the Plant Community Types (PCTs) occurring in the lowland areas of the Southern Tablelands of NSW and the ACT. As detailed below, the four-step method draws upon elements of the relevant contemporary Commonwealth Government (Commonwealth of Australia 2016b¹⁸), ACT Government (ACT Government 2015a¹⁹), and NSW Government (NSW Government 2014²⁰, 2017²¹) vegetation mapping guidelines, together with other technical guidelines, notably Rehwinkel (2015²²). Each step of the four-step method has a specific purpose and must achieve a specific outcome which generally becomes the foundation for the subsequent step.

Repeatability is a key element of vegetation mapping methodologies when applied to sites which are periodically monitored, which will be the case for any areas of NTG-SEH in the GCC. Accordingly, the four-step method is described in full below.

2.1.1 Step 1. Plant Community Type (PCT) mapping

Purpose = to identify and delineate the boundaries of grassland PCTs within the Ginninderry project area.

Outcome = GIS mapping of grassland PCT boundaries.

The on-ground boundaries of grassland PCTs (as defined in ACT Government 2015d²³) present within the Ginninderry project area were accurately mapped using either hand-held GPS or by marking

¹⁴ Capital Ecology (2017). *ACT Environmental Offsets – 2016 Grassland Mapping Report*. Prepared for ACT Government Parks and Conservation Service.

¹⁵ Capital Ecology (2018a). *2017 Grassland Quality and Extent Mapping*. April 2018. Prepared for Environmental Offsets, ACT Parks and Conservation Service. Authors: S. Reid and R. Speirs. Project no. 2759.

¹⁶ Capital Ecology (2019b). *2018 Grassland Quality and Extent Mapping*. June 2019. Prepared for Environmental Offsets, ACT Parks and Conservation Service. Authors: S. Reid and R. Speirs. Project no. 2826.

¹⁷ Capital Ecology (2018b). *2017 Woodland Quality and Extent Mapping – ACT Government Environmental Offsets*. May 2018. Prepared for Environmental Offsets, ACT Parks and Conservation Service. Authors: S. Reid and R. Speirs. Project no. 2756.

¹⁸ Commonwealth of Australia (2016b). *Approved conservation advice for the Natural Temperate Grassland of the South Eastern Highlands (NTG–SEH) ecological community*.

¹⁹ ACT Government (2015a). *Monitoring Guidelines for Natural Temperate Grasslands*. Conservation Research, October 2015.

²⁰ NSW Government (2014). *BioBanking Assessment Methodology 2014*. NSW Government Office of Environment and Heritage.

²¹ NSW Government (2017). *Biodiversity Assessment Method*. Office of Environment and Heritage.

²² Rehwinkel (2015). *A Revised Floristic Value Scoring Method to assess grassland condition, an addendum to Friends of Grasslands Forum Proceedings* (30 October – 1 November 2014).

²³ ACT Government (2015d). *ACT Vegetation Types Database – Attachment to the ACT Environmental Offsets Calculator Assessment Methodology*. 18 May 2015.

boundaries directly onto high resolution orthorectified aerial photograph field maps (displaying the ACT Government's 2017 or 2018 aerial imagery available under CC.4.0) with one metre contours. PCT boundary delineation was undertaken by walking or driving (as deemed most suitable), carefully determining and recording the boundary alignment.

The vegetation within the Ginninderry project area has undergone various types and degrees of modification over the last 150 years. This modification often removes or disguises the elements which would have once clearly defined the PCT boundaries (noting that ecotones are usually gradual transitions between vegetation communities, often in excess of 50 m in width). As such, the PCT boundary delineation involved carefully reading the landscape, considering numerous less conspicuous landscape elements, such as the:

- presence, species, growth form and density of remnant canopy trees and/or stags or stumps of these (assisted by rigorous georeferencing and review of 1961 and 1968 aerial photographs);
- presence and species of midstorey shrubs and trees;
- floristic composition of the groundstorey; and
- the landscape position and other geographical features (elevation, aspect, soils, apparent hydrology etc.).

The exact grassland association/PCT often varies depending upon the landscape position and other geographical features. However, as is the case across the distribution of NTG-SEH in the broader South Eastern Highlands bioregion, the tendency of exotic pasture species and noxious weeds to proliferate in the poorly drained low-lying areas of the landscape means that most of the NTG-SEH persisting in moderate or better quality in the ACT is 'PCT-ACT01 – Tablelands Dry Tussock Grassland'. In this regard, whilst it is noted that small areas of the grassland occurring on the lowest slopes adjacent to the Murrumbidgee River may have once better aligned with the definition of a wetter grassland association (i.e. PCT-ACT03 Tablelands Moist Tussock Grassland or PCT-ACT04 Wet Tussock Grassland), the degree of vegetation modification in these areas now prevents accurate distinction between the historical grassland PCTs.

In light of the above, for this study the primary purpose of Step 1 was to identify and delineate the boundary between PCT-ACT01 and the adjoining PCTs (generally 'PCT-ACT25 – *Eucalyptus macrorhyncha* Tableland Grass / Shrub Forest' or 'PCT-ACT16 – *Eucalyptus melliodora* - *E. blakelyi* Tableland Grassy Woodland').

Step 1 is critical to the accurate mapping of temperate vegetation communities and was completed and mapped in GIS prior to moving on to Step 2.

2.1.2 Step 2. Vegetation zone definition and mapping

Purpose = to identify and delineate the boundaries of each grassland vegetation zone within the Ginninderry project area.

Outcome = GIS mapping of grassland vegetation zone boundaries.

The mapped PCT-ACT01 was further divided into vegetation zones based on the structure, floristic composition and overall quality ('intactness') of the vegetation²⁴. As described above for Step 1,

²⁴ While variation in seasonal conditions may influence data collection (Section 2.1.3) and Threatened Ecological Community determination (Section 2.1.4), it does not significantly influence vegetation zone

each patch of each discernible (generally homogenous) vegetation zone was accurately mapped using either hand-held GPS or by marking boundaries directly onto recent high resolution orthorectified aerial photograph field maps with one metre contours. There was no minimum patch size unless the total area for a zone was < 0.1 ha. Vegetation zone boundary delineation was undertaken by walking or driving (as deemed most suitable), carefully determining and recording the boundary alignment.

Table 2.1-a outlines the vegetation zones which were defined for 'PCT-ACT01 Tablelands Dry Tussock Grassland'. The defined zones are consistent with the grassland mapping presented in Capital Ecology (2018a, 2019). This permits direct comparison with other sites in the ACT and assists in determining the type and prioritisation of management activities.

Table 2.1-a. Vegetation zones for PCT-ACT01 Tablelands Dry Tussock Grassland

	Groundstorey Dominance Native or Exotic	Native Forb Diversity (Floristic Value Score) Low = FVS of < 5 Mod = FVS of ≥ 5 but < 6.5 High = FVS of ≥ 6.5	Vegetation Zone ID Colour as per mapping
PCT-ACT01 Tablelands Dry Tussock Grassland	Native	High	01.1 (NTG-SEH)
	Native	Mod <u>and/or</u> >50% cover foliage cover of <i>Carex bichenoviana</i> , <i>Themeda triandra</i> or <i>Poa labillardieri</i>	01.2 (NTG-SEH)
	Native	Low	01.3
	Exotic	N/A	01.4

As detailed in Table 2.1-b, an additional mapping layer was developed for the zone with exotic groundstorey dominance (i.e. PCT-ACT01 Zone 4) to differentiate areas by the key reason for the exotic dominance (i.e. Stock Camp, Noxious Weed Species, Pasture and Agricultural Weed Species). This additional mapping layer was developed to assist in management given that the required management measures differ depending upon the reason for the exotic dominance. For example, dense African Lovegrass *Eragrostis curvula* infestations may require intensive herbicide application to prevent the species' spread, however time since stocking is required to rehabilitate nutrient rich stock camps.

With regard to the above, it is important to note that the exotic dominance category mapping does not reflect the extent to which any exotic species (or group of exotic species) occurs within the Ginninderry project area. Many of the exotic species occur more broadly, including within native dominant vegetation zones.




With the exception of stock camps and areas subject to other forms of groundstorey modification, the presence of planted trees in grassland PCTs does not usually prevent recognition of the groundcover vegetation characteristics. Patches can retain the floristic composition and structure of

definition and mapping. This is because vegetation zone definition and mapping partly rely on an analysis of vegetation structure and overall 'intactness', which are less prone to disruption. In addition, even during below average seasonal conditions, a sufficient diversity of native forbs are generally present and can be used to infer vegetation condition.

NTG-SEH despite shading and other impacts of planted trees, and in many cases would be characteristically similar to the surrounding areas if the trees were removed. Accordingly, the definition of vegetation zones for this study was undertaken ignoring the presence of planted trees or other planted woody vegetation.

Step 2 was completed and mapped in draft form in GIS prior to moving on to Step 3. GIS mapping of vegetation zones allows for accurate calculations of the total area of each vegetation zone within the Ginninderry project area.

Table 2.1-b. Reason for exotic dominance

Reason for Exotic Dominance	
	Pasture and Agricultural Weed Species (cultivation or pasture improvement, such as Phalaris pasture)
	Noxious Weed Species (e.g. African Love Grass dominance)
	Stock camp (soil nutrification, annual weed dominance)

2.1.3 Step 3. Data collection (survey quadrats and transects)

Purpose = to record the floristic composition and structure of each grassland vegetation zone.

Outcome = recorded floristic composition and structure data.

Step 3 was based on ACT Government (2015a) and Rehwinkel (2015). Specifically, the following was completed.

1. As per Rehwinkel (2015), 20 m x 20 m (400 m²) quadrats (i.e. plots) were completed in locations deemed via observation during Steps 1 and 2 to support the highest floristic diversity within the vegetation zone.

The number of plots completed within each vegetation zone was determined by the area of the vegetation zone defined (using GIS) during Step 2 and the below.

- 1 plot per homogenous vegetation zone of 2 ha or less;
- 3 to 4 plots per homogenous vegetation zone between 2 and 50 ha; or
- 4 to 10 plots per homogenous vegetation zone between 51 and 250 ha.

The north-west corner point of the plot was recorded with a handheld GPS unit and marked with an orange cattle tag. The plot was then established using a compass, with the x axis running 90 degrees (due east), and the y axis running 180 degrees (due south). The plot was then marked using three measuring tapes (two tapes for side boundaries and one to define the diagonal). Note: plots were established as described as it is critical for future monitoring that plots can be replicated in a precise manner.

Modified Braun-Blanquet cover/abundance scores (Table 2.1-c) were assigned for each species recorded within the plot.

Table 2.1-c. Modified Braun-Blanquet cover/abundance scores

Cover/Abundance	Explanation
1	< 5% cover and solitary (<4 individuals)
2	< 5% cover and few (4-15 individuals)
3	< 5% cover and numerous/scattered (>15 individuals)
4	5% to < 25% cover
5	25% to < 50% cover
6	50% to < 75% cover
7	75% cover and greater

2. One 50 m step-point transect was completed to accompany each plot²⁵. The transects were placed in locations deemed via observation to support structural characteristics representative of the vegetation zone. At each 1 m point along the step-point transect the ground layer was allocated to one of the following options:

- Cryptogams (Moss/Lichen)
- Bare Earth
- Rocks
- Litter/Dead Vegetation
- Annual Exotic Grass
- Perennial Exotic Grass
- Exotic Broadleaf
- Perennial Native Grass
- Other native

3. Data was entered into excel spreadsheets²⁶ to calculate the floristic value scores (FVS), species richness, and other characterising features of the vegetation zones. Two different FVS 'Scenarios' were calculated.

'FVS – Scenario 1'. Several minor edits were made to the excel spreadsheets, notably to add species recorded in the plots but not provided in the spreadsheets. No other changes were made.

'FVS – Scenario 2'. Several minor edits were made to the excel spreadsheets, notably to add species recorded in the plots but not provided in the spreadsheets. In addition, the 'Significance Rating' developed to apply the Rehwinkel (2015) methodology for the nine

²⁵ Grassland sites are often heterogenous and contain patches of vegetation with dimensions smaller than 100 m. This is particularly true of higher quality areas (i.e. Zone 1 and Zone 2). Therefore, 50 m step-point transects were deemed appropriate. Given the heterogenous nature of grasslands, performing one step-point transect per plot was deemed necessary in order to accurately reflect zone composition.

²⁶ The excel spreadsheets were provided by ACT Government Parks and Conservation Service (PCS) for the study detailed in Capital Ecology (2019b).

native species listed in Table 2.1-d were reduced from either 'A' to 'B' or from 'B' to 'C'. This was deemed necessary as the Significance Rating for the species in Table 2.1-d were judged to be too high for grasslands in the ACT and were therefore resulting in FVS scores that were inappropriate for the observed condition of the grassland vegetation in the Ginninderry project area. The 'FVS – Scenario 2' scores are included in Table 3.1-a to Table 3.1-d and are subsequently used to determine whether or not a particular zone meets the EPBC Act listing criteria for NTG-SEH. Refer to Section 4.2 for a full outline and justification of this approach.

Table 2.1-d. Species Significance Ratings adjusted from Scenario 1 to Scenario 2

Species Significance Rating	Species	Recorded in Zone ²⁷
Adjusted from 'Level A' to 'Level B'	<i>Chrysocephalum apiculatum</i>	Zone 2
	<i>Desmodium varians</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Glycine tabacina</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Lomandra filiformis-coriacea</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Poa sieberiana</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Themeda triandra</i>	Zone 1, Zone 2, Zone 3
	<i>Tricoryne elatior</i>	Zone 1, Zone 2, Zone 3, Zone 4
Adjusted from 'Level B' to 'Level C'	<i>Cymbonotus lawsonianus</i>	Zone 3
	<i>Wahlenbergia communis</i>	Zone 1, Zone 2, Zone 3

Each plot and step-point transect was allocated a four-part identification code as per the below example. Note: only the plot identification code is displayed on vegetation zone mapping; the identification code for the accompanying step-point transect is not displayed to avoid congestion.

- i. Site = Ginninderry → Code Part 1 = **Gi**
- ii. PCT = ACT01 → Code Part 2 = **01**
- iii. Vegetation zone = 3 → Code Part 3 = **3**
- iv. Plot/transect number = 2 → Code Part 4 = **2**

↓

- Plot identification code = **Gi_01.3.2.P**
- Transect identification code = **Gi_01.3.2.T**

The north-west corner point of each plot and the start points of each step-point transect are provided in Appendix 1 and Appendix 3. As detailed above, the north-west corner point is required to navigate to the installed orange marker, and once located the marker can be used to accurately replicate the plot.

Table 2.1-e provides the survey dates and number of plots per vegetation zone (total = 16 plots). The timing of the 2020 surveys was determined in order to ensure that all plots and transects were completed during the best available seasonal conditions (i.e. when the majority of native forbs were in full flower).

Typically, surveys for grasslands are conducted in late spring/early summer. However prolonged below average rainfall in 2019 resulted in sub-optimal conditions during spring/early summer, with

²⁷ See Appendix B.

very little new native grass growth and few forbs flowering. In particular, the usual late spring/summer flush of the C4 summer growing grasses Kangaroo Grass *Themeda triandra* and Red-leg Grass *Bothriochloa macra* did not occur in 2019; these grasses are key elements for grassland vegetation zone mapping and plot scores. It was therefore decided that surveys should be delayed until after substantial rainfall, which occurred in mid-February and early March 2020. The surveys following these rainfall events confirmed that there was substantial new grass growth (particularly in the C4 summer growing grasses) and that a wide variety of native forbs were now flowering. As such, surveys occurred during the best available seasonal conditions for the 2019/20 survey period. This approach is consistent with Section 1.5.2 of Commonwealth of Australia (2016b) which defines favourable sampling times as *"in spring to early summer, and/or other time when native plant species are most evident (e.g. significant recent rainfall that has stimulated flowering of native plants)."*

Future monitoring should occur between October and December if possible, with the exact timing determined in order to ensure that all plots and transects are completed during optimal seasonal conditions (i.e. when the majority of native forbs are in full flower).

Table 2.1-e. Survey dates and plot numbers per vegetation zone

Survey Dates	Survey type	Number of Plots/ Transects Zone 1	Number of Plots/ Transects Zone 2	Number of Plots/ Transects Zone 3	Number of Plots/ Transects Zone 4	Total
27/02/2020	PCT mapping					
17/03/2020	Zone mapping					
24/03/2020	Plot-transect	4	4	4	4	16
25/03/2020	Plot-transect					

Any threatened/rare flora or fauna species observed during Steps 1 to 3 were recorded with a GPS waypoint.

2.1.4 Step 4. Threatened Ecological Community (TEC) determination

Purpose = to determine the areas of the Ginninderry project area which support EPBC Act NTG.

Outcome = data supported GIS mapping of the EPBC Act NTG-SEH within the Ginninderry project area.

The data recorded during Step 3 for each of the native dominant vegetation zones was analysed to determine whether the vegetation zone meets the listing criteria for the EPBC Act critically endangered ecological community NTG-SEH either as the 'high to very high' or 'moderate to high' condition threshold category. As mentioned previously, the 'FVS – Scenario 2' scores are used to determine whether or not a particular zone meets the EPBC Act listing criteria for NTG-SEH as they are more appropriate for grasslands in the ACT and better reflect the observed condition of the vegetation in the Ginninderry project area.

Table 2.1-f presents a flowchart of the key elements of the EPBC Act listing criteria for NTG-SEH, drawn from the text and tables in Section 1.5.2 of Commonwealth of Australia (2016b).

Table 2.1-f. Summary of condition thresholds for EPBC Act Natural Temperate Grassland of the South Eastern Highlands (NTG–SEH)

Condition Threshold Category	Scenarios		Vegetation Zone Colour as per mapping
High to Very High	1. The percentage cover of native vascular plants (including annual and perennial species) in the patch is greater than the percentage cover of perennial exotic species AND (in 0.04 ha sampling plots): 2. At any time of the year: <ul style="list-style-type: none"> a. At least 12 non-grass native species OR b. At least 3 indicator species OR c. A floristic value score (FVS) of at least 6.5 		ACT01 – Zone 1
Moderate to High	‘A’ scenarios	‘B’ scenarios	
	1. The patch is characterised by at least 50 % foliage cover of the ground of <i>Themeda triandra</i> . OR 2. The patch is characterised by at least 50 % foliage cover of the ground of <i>Poa labillardieri</i> . OR 3. The patch is characterised by at least 50 % foliage cover of the ground of <i>Carex bichenoviana</i> , or at least 50 tussocks for every 100 m ² .	1. The percentage cover of native vascular plants (including annual and perennial species) in the patch is greater than the percentage cover of perennial exotic species AND (in 0.04 ha sampling plots): 2. During favourable sampling times: <ul style="list-style-type: none"> a. At least 8 non-grass native species OR b. At least 2 indicator species OR c. A floristic value score (FVS) of at least 5 	ACT01 – Zone 2

3 Results

A summary of results for the Ginninderry project area is provided in Section 3.1, together with a table and representative photograph for each vegetation zone ('zone').

A number of weeds, such as St John's Wort *Hypericum perforatum*, are not listed as a category X species (i.e. significant weeds) in the excel spreadsheet developed to apply the Rehwinkel (2015) methodology. However, all weeds that were particularly widespread are highlighted in the following subsections.

PCT mapping (refer to Section 2.1.1) was used to determine the extent of natural grasslands and thus the area that was assessed in detail for this study. The extent and condition of woodland and forest PCTs were not assessed.

3.1 Grassland mapping results

Figure 3.1-a shows the extent of the grassland PCT and constituent vegetation zones in the Ginninderry project area, together with the location of the floristic plots and step-point transects. The location of the NW corner of each plot and the start of each transect are provided in Appendix 1 and Appendix 3, respectively.

As described in Section 2.1.1, the vegetation in the Ginninderry project area has undergone various types and degrees of modification over the last 150 years. This modification has removed many of the elements which would have once clearly defined the PCT boundaries. As such, the grassland PCT boundary was delineated by carefully reading the landscape, considering numerous less conspicuous landscape elements. In particular, as shown in Figure 3.1-a, the presence and species of canopy trees and stags/stumps combined with elevation, aspect, and slope were the main features that influenced this process.

The Ginninderry project area was found to support one grassland PCT: 'ACT01 Tablelands Dry Tussock Grassland', with the following zones.

- 15.36 ha of Zone 1: Native dominant – High to very high diversity (meeting the EPBC Act criteria for NTG-SEH in 'high to very high condition').
- 29.11 ha of Zone 2: Native dominant – Moderate to high diversity (meeting the EPBC Act criteria for NTG-SEH in 'moderate to high condition').
- 46.39 ha of Zone 3: Native dominant – Low diversity (not meeting the EPBC Act criteria for NTG-SEH).
- 40.48 ha Zone 4: Exotic dominant – Low diversity.

The 131.35 ha grassland PCT occurred in one large contiguous patch and was in general restricted to the steep, rocky slopes in the GCC (115.73 ha), with only a small portion occurring in the proposed urban development area (15.62 ha).

As described in Section 2.1.3, a second scenario adjusting the Significance Rating of nine common native grassland species was developed as it was deemed to be more appropriate for grasslands in the ACT and to better reflected the 'on ground' observed condition of the grassland vegetation in

the Ginninderry project area. This scenario is included in Table 3.1-a to Table 3.1-d as 'FVS – Scenario 2' and is used to determine whether or not a particular zone meets the EPBC Act listing criteria for NTG-SEH. Refer to Section 4.2 for a full outline and justification of this approach.

In total, 44.47 ha of grassland in the Ginninderry project area meets the EPBC Act listing criteria for NTG-SEH (Figure 3.1-b), all of which occurs in the GCC. As shown in Figure 3.1-d, the patches of NTG-SEH closely align with areas of moderate to high quality Pink-tailed Worm-lizard habitat (as presented in Osborne and Wong 2013 and Capital Ecology 2019a²⁸), with 38.56 ha (86.7%) in moderate to high quality Pink-tailed Worm-lizard habitat, 0.37 ha (0.8%) in low quality Pink-tailed Worm-lizard habitat, and the remaining 5.54 ha (12.5%) in non-Pink-tailed Worm-lizard habitat.

Prolonged impacts from agriculture and pest plants and animals have had a significant impact on the condition of the groundstorey and have resulted in the dominance of exotic species across extensive areas. As shown in Figure 3.1-c, the exotic areas were mainly classified as 'Pasture and Agricultural Weed Species' or 'Noxious Weed Species' (notably African Lovegrass), with one 'Stock Camp' identified on a small hill in the south.

Significant weeds were found throughout the Ginninderry project area, including African Lovegrass (all zones) and *Paspalum dilatatum* (Zones 3 and 4). All zones also contained Blackberry *Rubus fruticosus*, although following a recent substantial weed control program conducted by the land manager very few plants remain alive. Other pest plants that were widespread include Paterson's Curse *Echium plantagineum* (all zones), St John's Wort *Hypericum perforatum* (all zones), Skelton Weed *Chondrilla juncea* (all zones), Great Mullein *Verbascum thapsus* (all zones), and Saffron Thistle *Carthamus lanatus* (Zones 2, 3, and 4).

Tables 3.1a-3.1d provide summaries of the plot results for each zone and include calculated averages and \pm standard deviation. Detailed summaries of the floristics and step-point transects for each plot are provided in Appendices 1 to 3.

²⁸ Capital Ecology (2019a). *Ginninderry – Pink-tailed Worm-lizard survey and habitat mapping of NSW land*. Project no. 2866, 2 April 2019.

Table 3.1-a. Ginninderry ACT01 Zone 1 results summary

	ACT01 Zone 1
Description	NTG-SEH. Native-dominant, supporting a high to very high diversity of native grasses and forbs. In general, this zone is characterised by rocky outcrops on steep slopes with a north-west aspect and a groundstorey dominance of mixed Red-leg Grass, Rough Speargrass <i>Austrostipa scabra</i> , Snow Grass <i>Poa sieberiana</i> , and Kangaroo Grass.
Area	15.36 ha (4 plots and 4 transects).
Native % of Perennial Groundlayer	62% \pm 6% (range 55% - 68%)
Native Species Richness	22.75 \pm 2.87 (range 19 - 26) total native species, 14.75 \pm 2.06 (range 13 - 17) native non-grass species, 9.00 \pm 2.45 (range 6 - 11) 'FVS – Scenario 1' indicator species, 3.75 \pm 2.22 (range 1 - 6) 'FVS – Scenario 2' indicator species.
Exotic Species Richness	8.75 \pm 5.68 (range 3 - 15) species.
Significant Weeds	African Lovegrass with a low cover (less than 5%). Patterson's Curse, St John's Wort, Great Mullein, Skeleton Weed, Briar Rose, and Blackberry also present.
Weed Value Score (WVS)	5.44 \pm 3.68 (range 1.13 - 9.18).
FVS – Scenario 1	28.76 \pm 4.20 (range 25.14 - 34.79).
FVS – Scenario 2	17.23 \pm 2.22 (range 14.69 - 20.11).



Table 3.1-b. Ginninderry ACT01 Zone 2 results summary

	ACT01 Zone 2
Description	NTG-SEH. Native-dominant, supporting a moderate to high diversity of native grasses and forbs. In general, this zone is characterised by rocky outcrops on steep slopes with a north-west aspect and a groundstorey dominance of mixed Red-leg Grass, Rough Speargrass, Snow Grass, Weeping Grass <i>Microlaena stipoides</i> , and Kangaroo Grass. Gi_01.2.1 recorded a cover of Kangaroo Grass of over 75%.
Area	29.11 ha (4 plots and 4 transects).
Native % of Perennial Groundlayer	55% \pm 15% (range 32% - 70%).
Native Species Richness	14.25 \pm 3.77 (range 9 - 17) total native species, 7.75 \pm 1.26 (range 6 - 9) native non-grass species, 4.50 \pm 1.29 (range 3 - 6) 'FVS – Scenario 1' indicator species, 0.75 \pm 0.50 (range 0 - 1) 'FVS – Scenario 2' indicator species.
Exotic Species Richness	9.50 \pm 3.87 (range 5 - 14) species.
Significant Weeds	African Lovegrass with a low cover (less than 5%). Patterson's Curse, St John's Wort, Great Mullein, Skeleton Weed, Briar Rose, and Saffron Thistle also present.
WVS	8.19 \pm 3.81 (range 3.03 - 12.15).
FVS – Scenario 1	12.57 \pm 2.96 (range 9.51 - 15.41).
FVS – Scenario 2	6.35 \pm 0.91 (range 5.19 - 7.26).

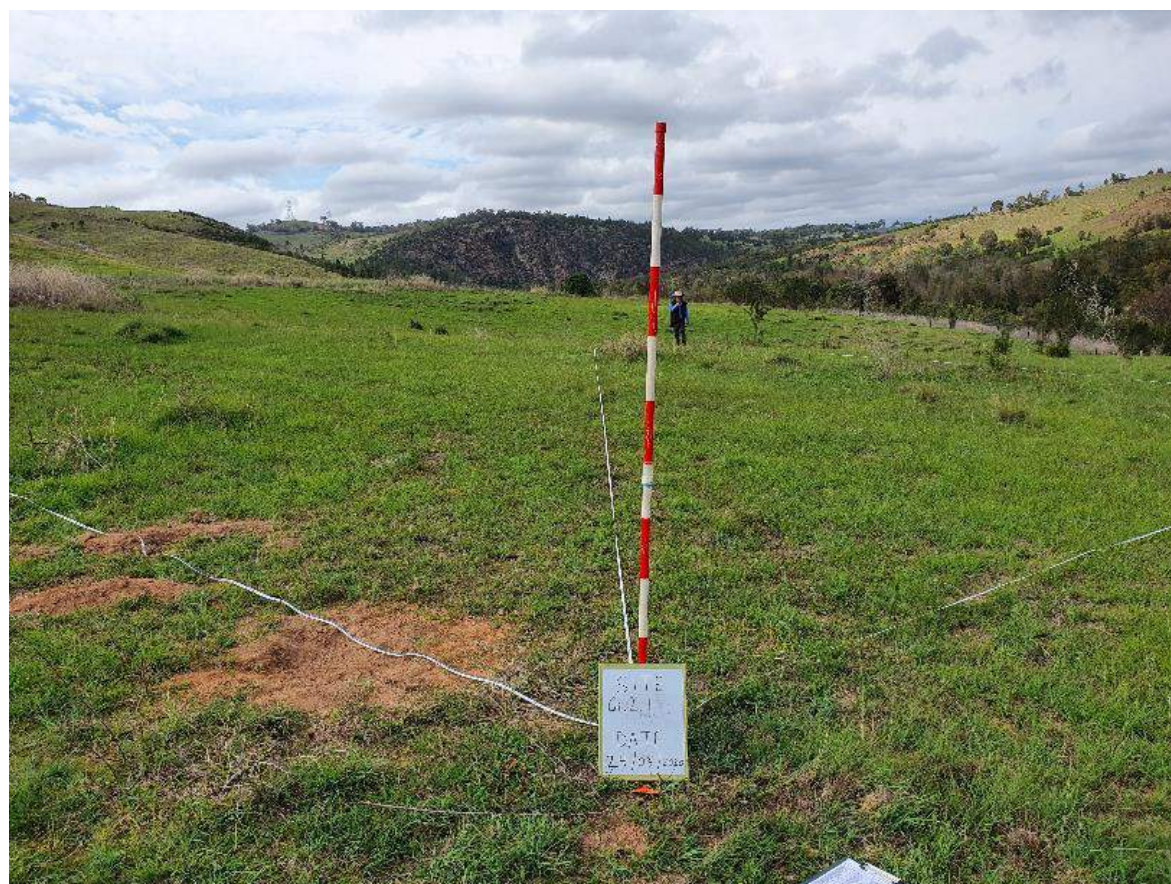


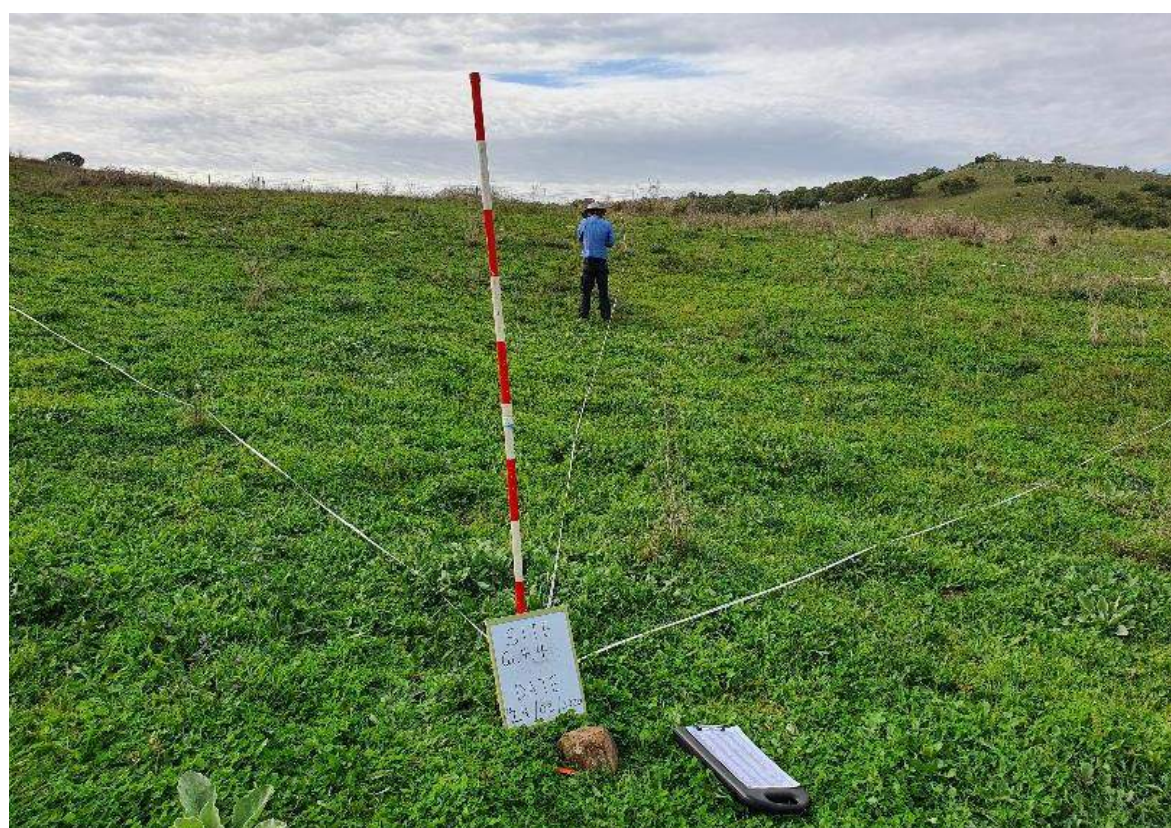
Table 3.1-c. Ginninderry ACT01 Zone 3 results summary

	ACT01 Zone 3
Description	Native pasture. Historically cultivated and/or pasture improved in places. Native-dominant, with some forbs present. In general, this zone has a marginal dominance of disturbance tolerant native grasses, particularly Red-leg Grass. A high cover and diversity of exotic grasses and herbaceous weeds are present.
Area	46.39 ha (4 plots and 4 transects).
Native % of Perennial Groundlayer	44% \pm 11% (range 35% - 63%).
Native Species Richness	12.00 \pm 1.63 (range 10 - 14) total native species, 6.50 \pm 2.08 (range 4 - 9) native non-grass species, 3.50 \pm 1.00 (range 3 - 5) 'FVS – Scenario 1' indicator species, 0 \pm 0.00 'FVS – Scenario 2' indicator species.
Exotic Species Richness	12.25 \pm 0.96 (range 11 - 13) species.
Significant Weeds	Paspalum and African Lovegrass with a low combined cover (less than 5%). Patterson's Curse, St John's Wort, Skeleton Weed, Briar Rose, Blackberry, Saffron Thistle, and Great Mullein also present.
WVS	9.20 \pm 1.45 (range 7.33 - 10.66).
FVS – Scenario 1	8.75 \pm 1.57 (range 7.65 - 10.99).
FVS – Scenario 2	4.29 \pm 0.88 (range 3.63 - 5.55).



Table 3.1-d. Ginninderry ACT01 Zone 4 results summary

	ACT01 Zone 4
Description	Exotic pasture. Historically cultivated and/or pasture improved in places. This zone is highly disturbed and dominated by exotic vegetation that primarily consists of common exotic pasture species and a diversity of exotic herbaceous weed, particularly Bromes <i>Bromus spp.</i> , Wild Oats <i>Avena sp.</i> , Clovers <i>Trifolium spp.</i> , and Goosegrass <i>Eleusine tristachya</i> . The native Small Crumbweed <i>Dysphania pumilio</i> is also particularly widespread throughout this zone.
Area	40.48 ha (4 plots and 4 transects).
Native % of Perennial Groundlayer	11% \pm 4% (range 5% - 15%).
Native Species Richness	8.25 \pm 3.69 (range 4 - 13) total native species, 4.50 \pm 1.91 (range 3 - 7) native non-grass species, 1.75 \pm 0.96 (range 1 - 3) 'FVS – Scenario 1' indicator species, 0 \pm 0 'FVS – Scenario 2' indicator species.
Exotic Species Richness	14.00 \pm 3.16 (range 11 - 18) species.
Significant Weeds	African Lovegrass and Paspalum with a low to high combined cover (less than 5% up to 75%). St John's Wort, Saffron Thistle, Skeleton Weed, Paterson's Curse, Spear Thistle, Scotch Thistle, Briar Rose, Blackberry, and Great Mullein also present. Blackberry has largely been controlled.
WVS	10.91 \pm 2.09 (range 8.23 – 13.21).
FVS – Scenario 1	4.16 \pm 2.06 (range 1.81 – 5.93).
FVS – Scenario 2	2.37 \pm 1.08 (range 1.03 – 3.60).



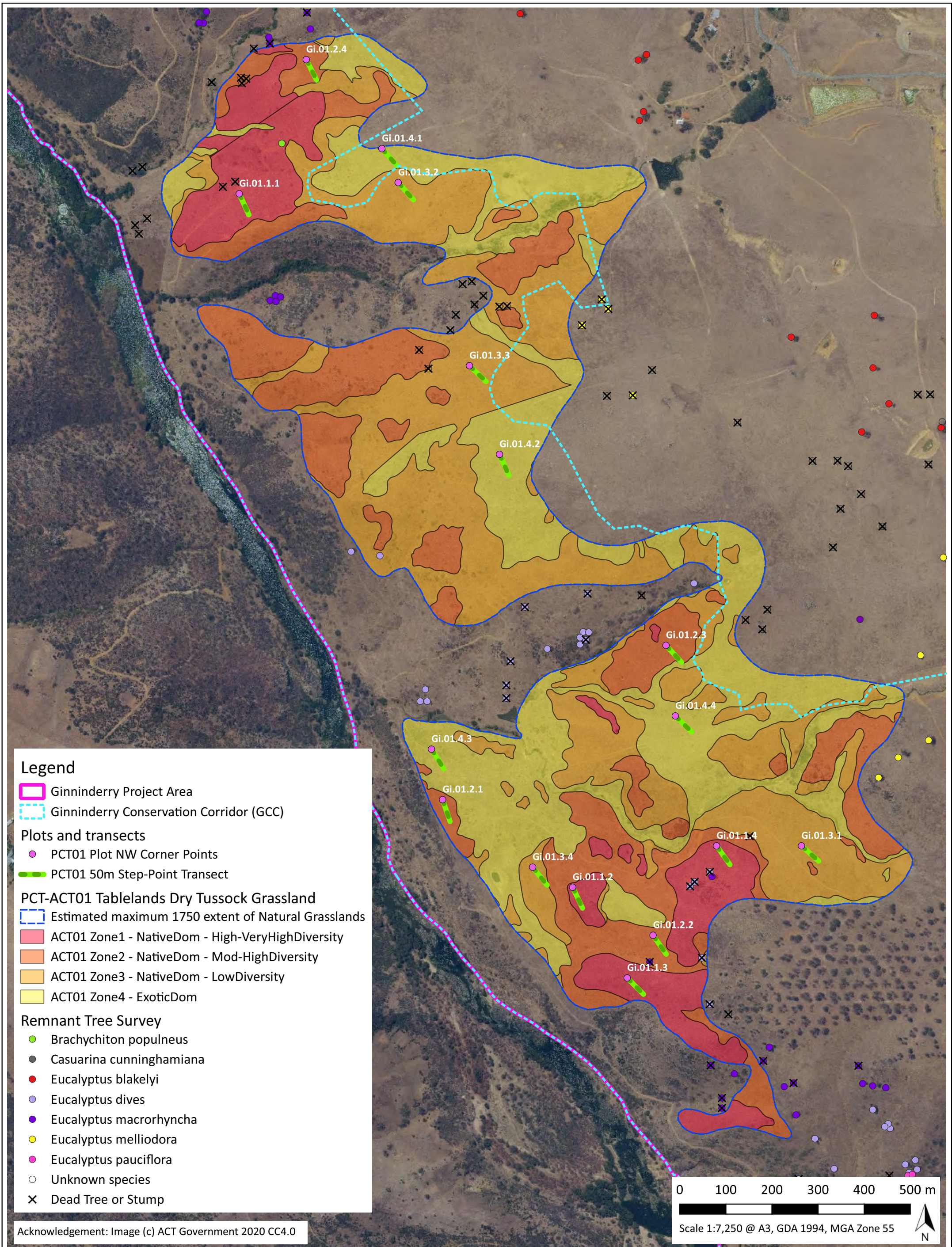


Figure 3.1-a. Grassland Vegetation Mapping Results

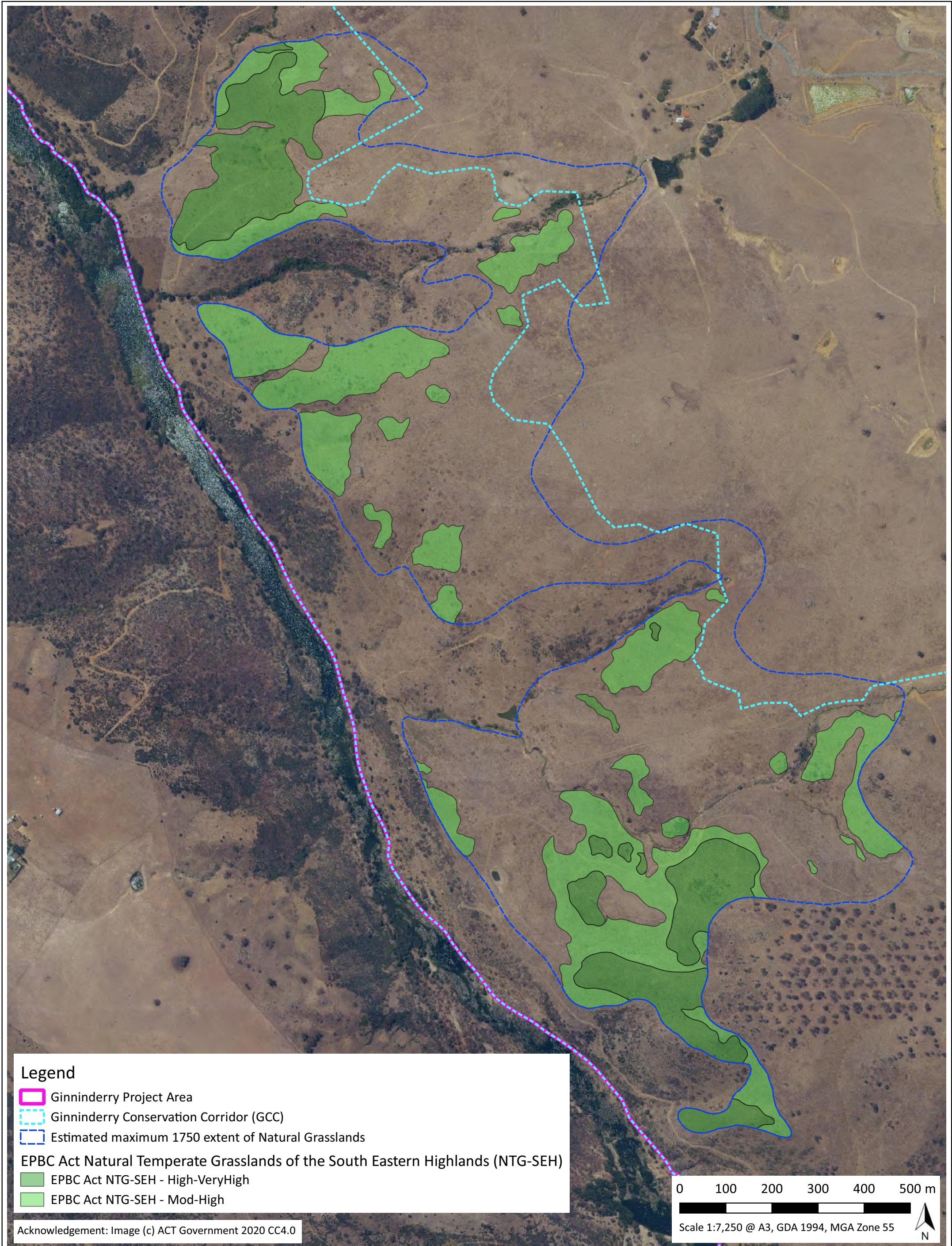


Figure 3.1-b. EPBC Act NTG-SEH

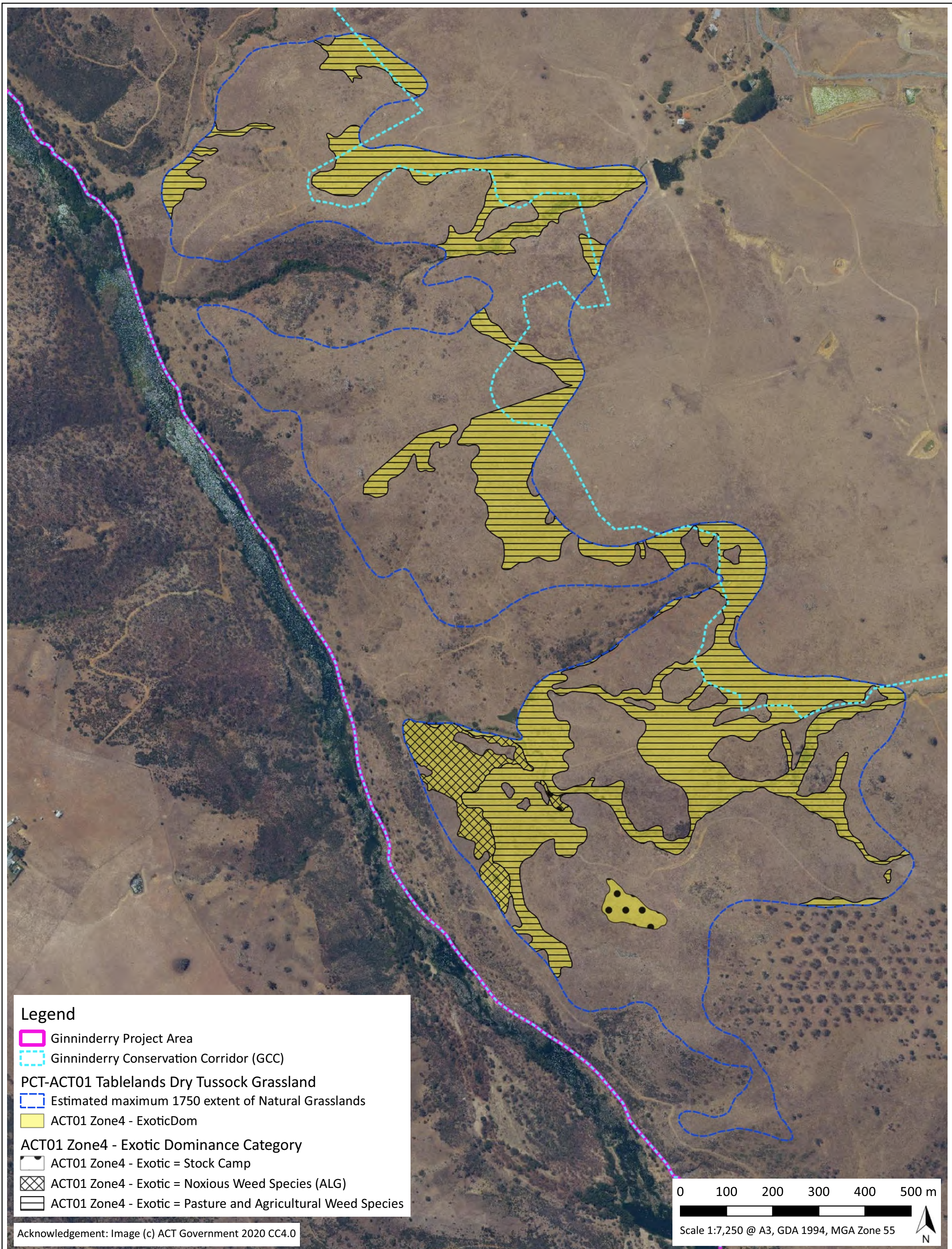


Figure 3.1-c. Exotic Vegetation Classification

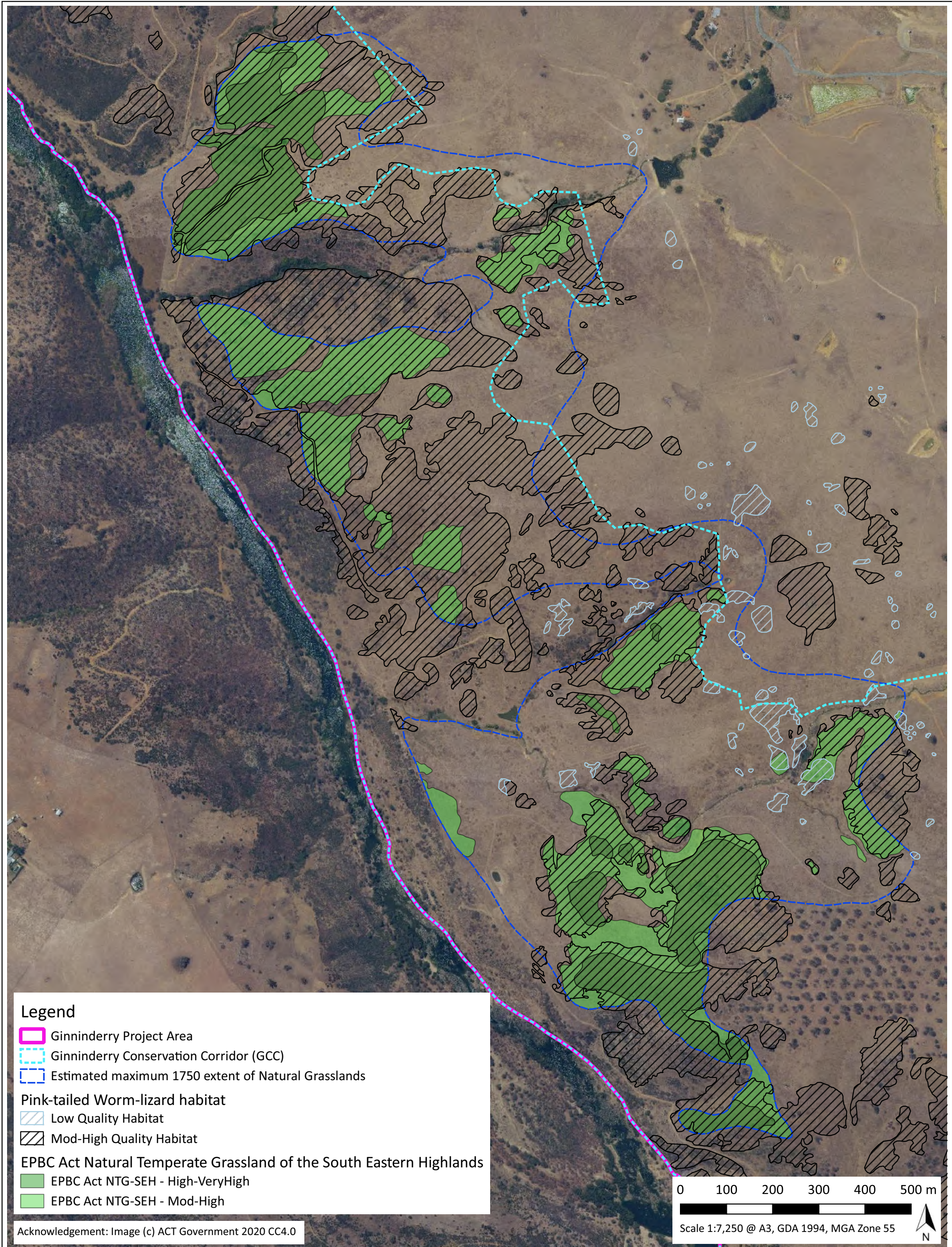


Figure 3.1-d. EPBC Act and Pink-tailed Worm-lizard habitat

4 Discussion

Capital Ecology was commissioned to assess and map the extent and condition of the grassland vegetation throughout the western portion (i.e. west of Parkwood Road) of the Ginninderry project area, which encompasses both the proposed urban development area and the GCC. The primary aim of this study was to identify areas of EPBC Act listed Natural Temperate Grassland of the South Eastern Highlands (NTG-SEH) in order to meet the conditions of existing planning and environmental approvals, inform future development of the urban development area and any associated offset requirements, and inform measures to protect and manage any NTG-SEH that occurs in the GCC.

4.1 Overview

As detailed in Section 3, the Ginninderry project area supports one grassland PCT, being 'ACT01 Tablelands Dry Tussock Grassland'. As the Ginninderry project area has been subject to various types and degrees of modification over the last 150 years, the quality of grassland vegetation varies widely, from patches dominated entirely by exotic weeds and grasses to the fragmented but floristically diverse patches of NTG-SEH located on rocky slopes and hill-tops. The highest quality patches (PCT-ACT01 Zone 1) all occur on steep north-west facing slopes where impacts from historic land-uses have been the least intensive. With its generally thin nutrient-poor soils, such sloping land tends to also have a natural propensity to resist the establishment and proliferation of exotic pasture species and weeds. Moderate quality patches (PCT-ACT01 Zone 2) have a similar composition to Zone 1 but have experienced greater disturbance, and as such, support a lower floristic diversity. The remainder of the grassland areas have experienced substantial disturbance from historic land-uses combined with more recent and ongoing impacts from a variety of pest plants and animals. As a result, these areas support either a low diversity native pasture (PCT-ACT01 Zone 3) or low diversity exotic pasture (PCT-ACT01 Zone 4).

In total, 44.47 ha of the grassland in the Ginninderry project area meets the EPBC Act criteria for NTG-SEH. All 44.47 ha occurs on rocky slopes or knolls in the GCC and the majority (86.7%) closely aligns with areas of moderate to high quality Pink-tailed Worm-lizard habitat. It is therefore not surprising that all of the NTG-SEH is confined to the GCC as the boundary of the corridor was designed to protect the known significant ecological values of the area, particularly with respect to Pink-tailed Worm-lizard habitat where 167.5 ha (95.4%) of the 188.3 ha of habitat in the Ginninderry project area is protected in the GCC. As such, the proposed development of future stages of Ginninderry will not directly impact any NTG-SEH.

As shown in Figure 3.1-c, the grasslands contain substantial exotic areas dominated by 'Pasture and Agricultural Species' or 'Noxious Weed Species'. African Lovegrass, occurring in the low-lying area along the Murrumbidgee River and scattered as small patches or as individual tussocks across the remainder of the Ginninderry project area, represents the foremost threat to the grassland values of the GCC. This noxious weed is highly invasive, colonises all parts of the landscape including those which generally favour native species (i.e. nutrient poor soils), and forms dense monocultures when left unmanaged. Current management efforts are insufficient to appropriately control this species. Accordingly, diligent and systematic control of this species is required to conserve and enhance the values of the GCC. Other pest plants, such as St John's Wort, Paterson's Curse, and Briar Rose, are also of concern as they are widespread and occur at moderate densities. These prolific weeds are also likely to be having a detrimental impact on the grassland values of the GCC.

4.2 Adjusting Species Significance Values

Rehwinkel (2015) defines the Significance Rating criteria for native grassland species in the following manner.

A = ‘indicator species, level A’: *species that are uncommon in the region, and where they occur, generally indicate grassland sites of high to very high value; such species occur very rarely or in very low numbers in grasslands that have been subject to intense, frequent, long-term or sometimes even one-off disturbances (e.g. ploughing, heavy stock grazing pressures or application of fertilisers); some of these species are also inherently rare; this category includes all threatened flora species that are listed under the NSW and Australian Government acts.*

B = ‘indicator species, level B’: *species that are more common in grassland sites, relative to level 2 species; they generally occur less frequently in highly disturbed sites, though some persist with intermediate levels of disturbance.*

C = ‘common or increaser species, level C’: *species that are thought to be ‘disturbance-tolerant’, ‘disturbance responding’ or ‘increaser’ species; increasers respond positively to various disturbances and are thus most commonly recorded in disturbed or degraded sites.*

Using the Significance Ratings developed to apply the Rehwinkel (2015) methodology, PCT-ACT01 Zones 1, 2, and 3 (total area = 90.86 ha) would possess the floristic diversity and/or FVS required to meet the minimum EPBC Act listing criteria for the NTG-SEH threatened ecological community. However, this finding would greatly overestimate the actual extent of NTG-SEH in the Ginninderry project area. For example, PCT-ACT01 Zone 3 is best described as moderately to highly disturbed native pasture that has been subject to prolonged intensive land uses including cultivation (in some areas), pasture improvement, and set stocking. The groundstorey is characterised by a marginal dominance of disturbance tolerant native grasses (particularly Red-leg Grass), a low diversity of native forbs, and a moderate to high cover and diversity of exotic grasses and weeds. The structure, condition, and multiple signs of prolonged disturbance clearly indicate that PCT-ACT01 Zone 3 is not consistent with the description of NTG-SEH in Commonwealth of Australia (2016a,b) and therefore should not be classified as this threatened ecological community.

The above described finding is largely being driven by the Significance Rating assigned to certain species. These Significance Ratings were developed and based on the NSW region ‘South Eastern Highlands excluding the Monaro’ (Rehwinkel 2015). As a result, some species have a Significance Rating which is inappropriately high for the ACT. By reducing the Significance Rating of such species, the accumulated FVS better reflects the ‘on ground’ observed condition and quality of grasslands in the Ginninderry project area.

Accordingly, this study has developed a secondary scenario that adjusts the Significance Rating for nine of the native grassland species that were encountered in floristic plots (Table 4.2-a)²⁹.

²⁹ Please note that Capital Ecology only reconsidered the Significance Rating for species recorded in plots for this study. A reconsideration of the Significance Rating for all species is recommended for future studies.

Table 4.2-a. Species Significance Ratings adjusted from Scenario 1 to Scenario 2

Species Significance Rating	Species	Recorded in Zone ³⁰
Adjusted from 'Level A' to 'Level B'	<i>Chrysocephalum apiculatum</i>	Zone 2
	<i>Desmodium varians</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Glycine tabacina</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Lomandra filiformis-coriacea</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Poa sieberiana</i>	Zone 1, Zone 2, Zone 3, Zone 4
	<i>Themeda triandra</i>	Zone 1, Zone 2, Zone 3
	<i>Tricoryne elatior</i>	Zone 1, Zone 2, Zone 3, Zone 4
Adjusted from 'Level B' to 'Level C'	<i>Cymbonotus lawsonianus</i>	Zone 3
	<i>Wahlenbergia communis</i>	Zone 1, Zone 2, Zone 3

The majority of the species included in Table 4.2-a were recorded in most (if not all) vegetation zones, including moderately to highly disturbed native pasture (PCT-ACT01 Zone 3) and highly disturbed exotic pasture (PCT-ACT01 Zone 4). This finding in itself indicates that the original Significance Rating assigned to these species is inappropriate for grasslands in the Ginninderry project area and, based on Capital Ecology's experience, across the wider ACT.

The species adjusted from Level A to Level B are all relatively common in grasslands in the ACT, can be indicators of moderate to high value sites but not necessarily high to very high value sites, and are often recorded in low to moderate abundance in areas that have been substantially disturbed. As such, these species are more accurately defined by the description associated with Level B species. The exception to this is Kangaroo Grass *Themeda triandra*, which is often an indicator of high to very high value grasslands. However, this is only true when the cover of Kangaroo Grass is high; this is accounted for in Rehwinkel (2015) and Section 1.5.2 of Commonwealth of Australia (2016b), where a cover of greater than 50% of Kangaroo Grass is classified as moderate to high condition NTG-SEH and where a cover of greater than 75% of Kangaroo Grass increases the FVS by 1 point.

The species adjusted from Level B to Level C are found frequently in highly disturbed sites and can respond positively to disturbance. As such, these species are more accurately defined by the description associated with Level C species.

Accordingly, two different 'FVS Scenarios' for the current study were calculated (Table 4.2-b).

'FVS – Scenario 1'. Several minor edits were made to the FVS excel spreadsheets, notably to add species recorded in the plots but not provided in the spreadsheets. No other changes were made.

'FVS – Scenario 2'. Several minor edits were made to the FVS excel spreadsheets, notably to add species recorded in the plots but not provided in the spreadsheets. In addition, the 'Significance Rating' developed to apply the Rehwinkel (2015) methodology for the nine native species listed in Table 4.2-a were reduced from either 'A' to 'B' or from 'B' to 'C'.

³⁰ See Appendix B.

Table 4.2-b. The average number of indicator species and average Floristic Values Scores (FVS) by vegetation zone for Scenario 1 and Scenario 2

Species Significance Ratings	Average no. of Indicator Species				Average FVS			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
Scenario 1	9.00	4.50	3.50	1.75	28.76	12.57	8.75	4.16
Scenario 2	3.75	0.75	0	0	17.23	6.35	4.29	2.37

As discussed above and shown in Table 4.2-b, 'FVS – Scenario 2' scores were deemed more appropriate for grasslands in the Ginninderry project area and the wider ACT, and as such, are used to determine whether or not a particular zone meets the EPBC Act listing criteria for NTG-SEH.

4.3 Comparison to Previous Mapping

The results presented in this report largely agree with previous studies that investigated the extent of NTG-SEH in the Ginninderry project area. For example, Robert Jessop Pty Ltd and SMEC (2017) estimated that NTG-SEH occurs along the steep rocky slopes through the central part of the GCC and Sharp (2016) concluded that Rocky Natural Grassland occurs in the Ginninderry project area on western facing steep slopes with very high levels of outcropping and loose rocks, co-occurring with high quality Pink-tailed Worm-lizard habitat.

The exception to this are the findings of SMEC (2017a,b). SMEC (2017a,b) surveys were restricted to the proposed urban development area and the assessment of vegetation in areas identified as Pink-tailed Worm-lizard habitat in earlier studies. These studies found that patches of low-quality Pink-tailed Worm-lizard habitat did not meet the listing criteria for classification as NTG-SEH, but that moderate to high quality Pink-tailed Worm-lizard habitat was considered likely to unless there was evidence of historically having been a woodland (e.g. stumps, regenerating woodland, surrounding vegetation). Subsequent floristic assessment determined that four areas in the Ginninderry development area (3.34 ha in total) met the minimum criteria for consideration as NTG-SHE (refer to Figure 4.3-a).

However, SMEC (2017a,b) did not survey outside of Pink-tailed Worm-lizard habitat or within the GCC and employed a *“conservative assessment of the likelihood of the area originally supporting rocky natural grassland.”* Importantly, Sharp (2016) classified Rocky Natural Grassland as 'possible' or 'probable' and noted *“even where there are no trees it cannot be defined absolutely whether these areas are derived or naturally treeless, even when there is no evidence that trees once occurred there (e.g. the presence of stumps or hollows where tree roots may have rotted away or removed)”*.

The surveys performed for the current study considered the wider landscape. This included an assessment of the entire western portion of the Ginninderry project area upslope of the Murrumbidgee River and encompassed all of the areas identified by SMEC (2017a,b) as NTG-SEH. The boundary of the grassland PCT was carefully delineated by considering numerous less conspicuous landscape elements, particularly the presence and species of canopy trees and stags/stumps combined with elevation, aspect, and slope. As a result, 2.43 ha (73%) of the areas assessed by SMEC (2017a,b) as NTG-SEH were found to occur higher in the landscape than the upper elevation limit of the historic grassland PCT (Figure 4.3-a). These areas are therefore considered to have originally been a woodland/forest PCT, and as such occurred outside of the current study's detailed grassland assessment and mapping area.

The remaining areas mapped by SMEC (2017a,b) as NTG-SEH were found to be either dominated by exotic species (0.56 ha, classified as PCT-ACT01 Zone 4 in this study) or lacked the required floristic diversity to meet the criteria of NTG-SEH³¹ (0.35 ha, classified as PCT-ACT01 Zone 3 in this study)(Figure 4.3-a).

4.4 Conclusion and Recommendations

The Ginninderry project area was found to support one grassland PCT: 'ACT01 Tablelands Dry Tussock Grassland', with the following vegetation zones.

- 15.36 ha of Zone 1: Native dominant – High to very high diversity (meeting the EPBC Act criteria for NTG-SEH in 'high to very high condition').
- 29.11 ha of Zone 2: Native dominant – Moderate to high diversity (meeting the EPBC Act criteria for NTG-SEH in 'moderate to high condition').
- 46.39 ha of Zone 3: Native dominant – Low diversity (not meeting the EPBC Act criteria for NTG-SEH).
- 40.48 ha Zone 4: Exotic dominant – Low diversity.

The 131.35 ha grassland PCT occurs as one large patch and was in general restricted to the sloping land in the GCC (115.73 ha), with only a small portion occurring in the proposed urban development area (15.62 ha).

In total, 44.47 ha of the grassland in the Ginninderry project area meets the EPBC Act criteria for NTG-SEH (Figure 3.1-b). All of the 44.47 ha occurs in the GCC and aligns closely with areas of moderate to high quality Pink-tailed Worm-lizard habitat. As such, the proposed development of future stages of the Ginninderry urban development area will not directly impact any NTG-SEH. However, works in the GCC and indirect impacts from urban development do have the potential to impact NTG-SEH. As such, the areas of NTG-SEH in the GCC should be included in the **Ginninderry Conservation Corridor Management Plan**³² and associated **Ginninderry Development Offset Management Plan**³³ and managed accordingly. To that end, the mapping and floristic survey results presented in this report establish an accurate and reliable baseline upon which ongoing management and monitoring of the NTG-SEH in the GCC can be developed. This report also outlines a reliable and repeatable four-step methodology which can be used to determine future changes in grassland quality and extent, and which will further aid management decisions by differentiating areas of exotic dominance based on the category of exotic species that this dominance is attributed to.

³¹ Using 'FVS – Scenario 2' scores to determine whether or not a particular zone meets the EPBC Act listing criteria for NTG-SEH

³² Ginninderry (2018). *Ginninderry Conservation Corridor 2018 – 2023 Management Plan*. September 2018.

³³ SMEC (2018). *Ginninderry Development Offset Management Plan*. Prepared for Riverview Projects (ACT) Pty Ltd, 5 October 2018. Reference No: 3002638.

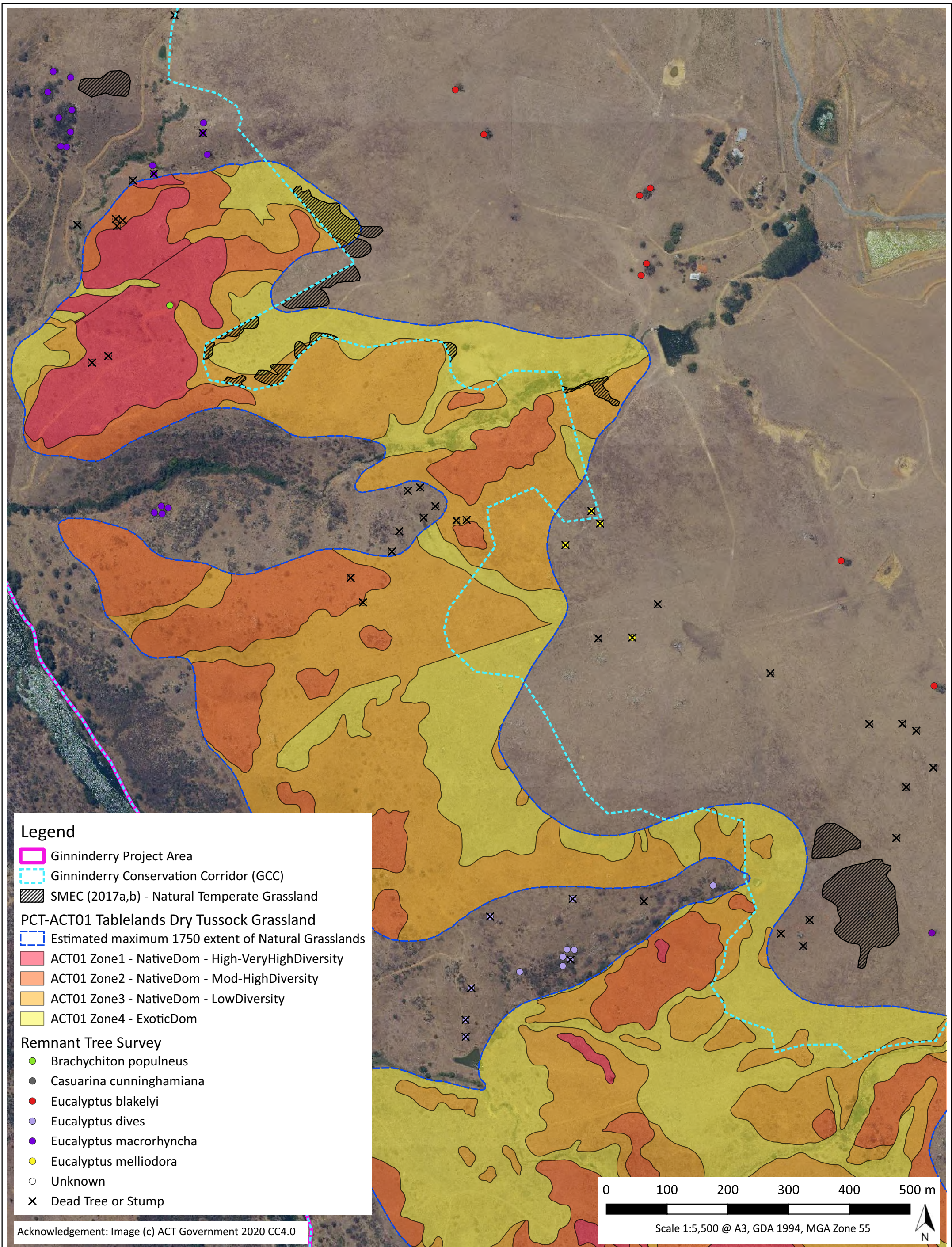


Figure 4.3 a. Comparison to Previous Mapping (SMEC 2017a,b)

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Appendices

Appendix 1. Grassland Floristic Plot Data Summary Table

PCT	Zone	Plot ID	Easting	Northing	Native spp.	Indicator spp.	Native non-grass spp.	Threatened spp.	Exotic spp.	Significant weeds	Sig weed cover % (level 'X' weeds only)	Significant weed spp. (level 'X' weeds in bold)	Floristic Value Score	Weed Value Score	Zone FVS Average
ACT01	1	Gi_01.1.1	678838	6101044	23	'FVS Scenario 1' = 6 'FVS Scenario 2' = 1	13	0	15	1	< 5	Eragrostis curvula <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 27.04 'FVS Scenario 2' = 14.69	9.18	'FVS Scenario 1' = 28.76 'FVS Scenario 2' = 17.23
		Gi_01.1.2	679561	6099538	26	'FVS Scenario 1' = 11 'FVS Scenario 2' = 5	17	0	12	1	< 5	Eragrostis curvula <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i> <i>Rubus fruticosus</i>	'FVS Scenario 1' = 34.79 'FVS Scenario 2' = 20.11	7.70	
		Gi_01.1.3	679680	6099342	23	'FVS Scenario 1' = 11 'FVS Scenario 2' = 6	16	0	3	0	0	<i>Chondrilla juncea</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 25.14 'FVS Scenario 2' = 16.99	1.13	
		Gi_01.1.4	679873	6099628	19	'FVS Scenario 1' = 8 'FVS Scenario 2' = 3	13	0	5	1	< 5	Eragrostis curvula <i>Echium plantagineum</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 28.07 'FVS Scenario 2' = 17.12	3.74	
	2	Gi_01.2.1	679279	6099729	9	'FVS Scenario 1' = 5 'FVS Scenario 2' = 1	6	0	8	1	< 5	Eragrostis curvula <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i>	'FVS Scenario 1' = 14.78 'FVS Scenario 2' = 6.86	8.30	'FVS Scenario 1' = 12.57 'FVS Scenario 2' = 6.35
		Gi_01.2.2	679736	6099434	17	'FVS Scenario 1' = 6 'FVS Scenario 2' = 1	9	0	5	0	0	<i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i>	'FVS Scenario 1' = 15.41 'FVS Scenario 2' = 7.26	3.03	
		Gi_01.2.3	679764	6100064	17	'FVS Scenario 1' = 4 'FVS Scenario 2' = 1	8	0	11	1	< 5	Eragrostis curvula <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i>	'FVS Scenario 1' = 10.56 'FVS Scenario 2' = 6.09	9.26	
		Gi_01.2.4	678983	6101336	14	'FVS Scenario 1' = 3 'FVS Scenario 2' = 0	8	0	14	1	< 5	Eragrostis curvula <i>Carthamus lanatus</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 9.51 'FVS Scenario 2' = 5.19	12.15	
	3	Gi_01.3.1	680058	6099628	12	'FVS Scenario 1' = 5 'FVS Scenario 2' = 0	7	0	12	0	0	<i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 7.67 'FVS Scenario 2' = 3.63	7.33	'FVS Scenario 1' = 8.75 'FVS Scenario 2' = 4.29

PCT	Zone	Plot ID	Easting	Northing	Native spp.	Indicator spp.	Native non-grass spp.	Threatened spp.	Exotic spp.	Significant weeds	Sig weed cover % (level 'X' weeds only)	Significant weed spp. (level 'X' weeds in bold)	Floristic Value Score	Weed Value Score	Zone FVS Average
		Gi_01.3.2	679183	6101068	14	'FVS Scenario 1' = 3 'FVS Scenario 2' = 0	6	0	11	1	< 5	Paspalum dilatatum <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rubus fruticosus</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 10.99 'FVS Scenario 2' = 5.55	9.96	
		Gi_01.3.3	679337	6100671	10	'FVS Scenario 1' = 3 'FVS Scenario 2' = 0	4	0	13	1	< 5	Eragrostis curvula <i>Carthamus lanatus</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 7.65 'FVS Scenario 2' = 3.77	8.84	
		Gi_01.3.4	679474	6099582	12	'FVS Scenario 1' = 3 'FVS Scenario 2' = 0	9	0	13	1	< 5	Eragrostis curvula <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 8.69 'FVS Scenario 2' = 4.19	10.66	
	4	Gi_01.4.1	679147	6101142	13	'FVS Scenario 1' = 3 'FVS Scenario 2' = 0	7	0	11	0	0	<i>Carthamus lanatus</i> <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 5.93 'FVS Scenario 2' = 3.60	8.23	'FVS Scenario 1' = 4.16 'FVS Scenario 2' = 2.37
		Gi_01.4.2	679402	6100478	4	'FVS Scenario 1' = 1 'FVS Scenario 2' = 0	3	0	18	1	< 5	Paspalum dilatatum <i>Carthamus lanatus</i> <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Onopodium acanthium</i> <i>Rosa rubiginosa</i> <i>Rubus fruticosus</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 1.81 'FVS Scenario 2' = 1.03	11.63	
		Gi_01.4.3	679255	6099838	8	'FVS Scenario 1' = 2 'FVS Scenario 2' = 0	5	0	12	2	50-75	Eragrostis curvula Paspalum dilatatum <i>Carthamus lanatus</i> <i>Cirsium vulgare</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rubus fruticosus</i> <i>Verbascum thapsus</i>	'FVS Scenario 1' = 5.84 'FVS Scenario 2' = 2.73	13.21	

PCT	Zone	Plot ID	Easting	Northing	Native spp.	Indicator spp.	Native non-grass spp.	Threatened spp.	Exotic spp.	Significant weeds	Sig weed cover % (level 'X' weeds only)	Significant weed spp. (level 'X' weeds in bold)	Floristic Value Score	Weed Value Score	Zone FVS Average
		Gi_01.4.4	679784	6099911	8	'FVS Scenario 1' = 1 'FVS Scenario 2' = 0	3	0	15	1	< 5	<i>Eragrostis curvula</i> <i>Carthamus lanatus</i> <i>Chondrilla juncea</i> <i>Echium plantagineum</i> <i>Hypericum perforatum</i> <i>Rosa rubiginosa</i>	'FVS Scenario 1' = 3.05 'FVS Scenario 2' = 2.12	10.56	

Appendix 2. Grassland Floristic Plot Species and Cover

Species Name	Gi_01.1.1	Gi_01.1.2	Gi_01.1.3	Gi_01.1.4	Gi_01.2.1	Gi_01.2.2	Gi_01.2.3	Gi_01.2.4	Gi_01.3.1	Gi_01.3.2	Gi_01.3.3	Gi_01.3.4	Gi_01.4.1	Gi_01.4.2	Gi_01.4.3	Gi_01.4.4
Exotic																
<i>Avena sp.</i>	4						3				3	3	4	3		3
<i>Acetosella vulgaris</i>		3			3		3									
<i>Bromus sp.</i>	3								3				4	3		4
<i>Capsella bursa-pastoris</i>								3								
<i>Carthamus lanatus</i>								3			4		3	4	2	4
<i>Chondrilla juncea</i>	3	3	2			2	3		2	3		2	3	3		3
<i>Cirsium vulgare</i>															3	
<i>Citrullus lanatus</i>														1		
<i>Cyperus eragrostis</i>														1		
<i>Digitaria sp. (exotic species)</i>	2						3			3						2
<i>Echium plantagineum</i>	2	2		4	3	3	3	3	4	3	3	3	3	4	3	4
<i>Eleusine tristachya</i>											3			3		3
<i>Epilobium sp.</i>			2													
<i>Eragrostis cilianensis</i>							3	3	3	3	3			2		3
<i>Eragrostis curvula</i>	2	2		1	3		2	3			1	2			6	2
<i>Erodium sp. (exotic species)</i>	2							2			1				2	
<i>Hirschfeldia incana</i>								3						3		3
<i>Hypericum perforatum</i>	3	3			3	3	3	3		3	4	3	3	3	3	3
<i>Hypochaeris glabra</i>	3	3														
<i>Hypochaeris radicata</i>	3	3			3			3		3		3			3	
<i>Malva sp.</i>								2				3		1		
<i>Modiola caroliniana</i>					1			3	3		3	3			3	
<i>Onopordum acanthium</i>														1		
<i>Paspalum dilatatum</i>										2				3	3	
<i>Petrorhagia nanteuilii</i>		3														
<i>Plantago lanceolata</i>													3			3
<i>Rosa rubiginosa</i>	1	1	1	1	1	1	1		1		1	1	1	1		1
<i>Rubus fruticosus</i>		1								1				1	1	
<i>Salvia verbenaca</i>	3						3		3		3	3				
<i>Silybum marianum</i>									1							
<i>Taraxacum sp.</i>	3							3	3	3		3	3			3
<i>Trifolium sp. (exotic)</i>	3	3		3	4	4	3	3	3	3	4	3	3	4	4	4
<i>Verbascum thapsus</i>	2	2	2	3				2	1	3	2	3	3	2	2	
<i>Xanthium spinosum</i>									1							
Native																
<i>Acaena ovina</i>	3	2					2	2								
<i>Aristida ramosa</i>	3	3	3			2										
<i>Austrostipa bigeniculata</i>	3			3			3	3		3			3			3
<i>Austrostipa scabra</i>	4	3	3	3		4	3	3								
<i>Bothriochloa macra</i>	4	4	5	5		5	4	4	6	4	5	4	3		3	3
<i>Brachyloma daphnoides</i>			1													
<i>Calotis lappulacea</i>				3												
<i>Carex inversa</i>									3	3	3					
<i>Cheilanthes sieberi</i>	3	3	3	3												
<i>Chloris truncata</i>	3							3					1		3	2
<i>Chrysocephalum apiculatum</i>						2										
<i>Convolvulus angustissimus</i>	1	1		2			1									

Species Name	Gi_01.1.1	Gi_01.1.2	Gi_01.1.3	Gi_01.1.4	Gi_01.2.1	Gi_01.2.2	Gi_01.2.3	Gi_01.2.4	Gi_01.3.1	Gi_01.3.2	Gi_01.3.3	Gi_01.3.4	Gi_01.4.1	Gi_01.4.2	Gi_01.4.3	Gi_01.4.4
<i>Cryptandra amara</i>		1	1													
<i>Cymbonotus lawsonianus</i>												1				
<i>Cymbopogon refractus</i>		2	1			1										
<i>Cynoglossum suaveolens</i>	2	3	3	3		1		3		1		3	2			
<i>Daucus glochidiatus</i>		3														
<i>Desmodium varians</i>	3	3	2	2		2	2		1	1	1	1	1			
<i>Dichanthium sericeum</i>							2									
<i>Dysphania pumilio</i>	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
<i>Elymus scaber</i>							2			2						
<i>Enneapogon nigricans</i>	3	2	3	3		3	2	2								
<i>Epilobium billardierianum</i>										1			2			
<i>Geranium solanderi</i>												1				
<i>Glycine clandestina</i>		1														
<i>Glycine tabacina</i>	3	3	3	3	3		3	2	1							2
<i>Hibbertia obtusifolia</i>			2													
<i>Hypericum gramineum</i>		2														
<i>Lomandra filiformis</i>			2	1												
<i>Lomandra filiformis-coriacea</i>	3	3	2	3	2	2		1	1		3		1	1	1	
<i>Lomandra longifolia</i>					1											
<i>Microlaena stipoides</i>	3	3				4	3		3	3	3		3	3		3
<i>Oxalis perennans</i>	3	3	3	3	3	3		3	3	3		2	1		1	
<i>Panicum effusum</i>	3				3	3			3	3	3		3		3	3
<i>Poa labillardierei</i>												1				
<i>Poa sieberiana</i>	3	3	4	3		3			1	4			1			
<i>Portulaca oleracea</i>								3								
<i>Rubus parvifolius</i>							1									
<i>Rumex brownii</i>		3	2	2	2	1			1		3	1	1	1	1	1
<i>Rytidosperma sp.</i>	3	3					3				3					
<i>Stackhousia monogyna</i>			2													
<i>Themeda australis</i>		6			7			4		3	1	4				
<i>Tricoryne elatior</i>	3	3	2	3	3	3	2		2			2			3	
<i>Tripogon loliiformis</i>							2									
<i>Vittadinia muelleri</i>	3	3	2													
<i>Wahlenbergia communis</i>	3	3	3	3		3	2	2				1				
<i>Wahlenbergia luteola</i>	2			3						1						
<i>Carex bichenoviana</i> or <i>Themeda triandra</i> cover >75%	-	-	-	-	Yes	-	-	-	-	-	-	-	-	-	-	-
Cryptogam cover on soil's surface (%)	<2	<2	<2	<2	<2	-	<2	-	-	-	-	-	-	-	-	-

Appendix 3. Step-Point Transect Data Summary Table

PCT	Zone	Transect ID	Datum and Zone	Start Easting	Start Northing	Length (m)	Crypt	Bare	Rock	Litter	Ann Ex Grass	Per Ex Grass	Ex Broadleaf	Per Native Grass	Other Native	Percent Perennial Native
01	1	Gi_01.1.1	MGA Zone 55	678838	6101044	50	0	4	0	3	0	0	14	25	4	67.44
		Gi_01.1.2	MGA Zone 55	679561	6099538	50	0	0	5	0	1	3	11	26	4	68.18
		Gi_01.1.3	MGA Zone 55	679680	6099342	50	2	0	5	4	0	1	15	18	5	58.97
		Gi_01.1.4	MGA Zone 55	679873	6099628	50	0	2	4	0	0	4	16	14	10	54.55
	2	Gi_01.2.1	MGA Zone 55	679279	6099729	50	1	2	0	1	0	9	7	29	1	65.22
		Gi_01.2.2	MGA Zone 55	679736	6099434	50	0	0	0	0	0	2	22	16	10	52.00
		Gi_01.2.3	MGA Zone 55	679764	6100064	50	1	0	2	0	3	6	24	12	2	31.82
		Gi_01.2.4	MGA Zone 55	678983	6101336	50	0	1	0	0	9	3	9	27	1	70.00
	3	Gi_01.3.1	MGA Zone 55	680058	6099628	50	0	0	0	1	0	2	30	11	6	34.69
		Gi_01.3.2	MGA Zone 55	679183	6101068	50	0	0	0	3	1	0	17	29	0	63.04
		Gi_01.3.3	MGA Zone 55	679337	6100671	50	0	2	0	0	0	1	27	20	0	41.67
		Gi_01.3.4	MGA Zone 55	679474	6099582	50	0	0	0	2	0	8	22	13	5	37.50
	4	Gi_01.4.1	MGA Zone 55	679147	6101142	50	0	1	1	0	22	6	17	2	1	11.54
		Gi_01.4.2	MGA Zone 55	679402	6100478	50	0	0	0	1	1	0	41	7	0	14.58
		Gi_01.4.3	MGA Zone 55	679255	6099838	50	0	1	0	7	0	29	11	1	1	4.76
		Gi_01.4.4	MGA Zone 55	678838	6101044	50	0	1	0	1	3	2	29	4	0	11.43