



# Silverton Wind Farm

## Porcupine Grass Sparse Woodland Recovery Plan

FINAL REPORT

Prepared for GE Renewable Energy

20 December 2018

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<b>Report to:</b>	GE Renewable Energy
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<b>Biosis project no.:</b>	26380
<b>File name:</b>	<b>26380.SilvertonWF.PGSW_RP.FNL02.20181220.docx</b>
<b>Citation:</b>	Biosis 2018. Silverton Wind Farm: Porcupine Grass Sparse Woodland Recovery Plan. Draft Report for GE Capital. Author: Woodward R. Biosis Pty Ltd, Albury. Project Number 26380.

## Document control

Version	Internal reviewer	Date issued
Draft version 01	Matt Looby	21/12/2017
Draft version 02	Sera Cutler	30/04/2018
Final Version 01	Renae Baker	14/12/2018
Final Version 02	Renée Woodward	20/12/2018

## Acknowledgements

Biosis acknowledges the contribution of the following people and organisations in undertaking this study:

- GE Renewable Energy: Catherine Powers & Davorin Jelaca
- Catcon: Paul Busolin & Clare Patterson
- Jacobs: Damien Wagner
- AGL: Bree Lacey
- Leaseholder Blore
- Ian Sluiter from Ogyris Ecological Research for external technical review
- NSW Department of Planning and Environment: Stephen Shoesmith
- NSW Office of Environment and Heritage: Peter Ewin, Miranda Kerr, Helen Knight & Mark Irvin, and access to the BioNet Atlas of NSW Wildlife.

Biosis staff involved in this project were:

- Steve Mueck & Sarah Hilliar (Field survey)
- Julian Turner, Gareth Davies, Andrew Longmire, Sarah Hilliar & James Shepherd (Mapping)
- Sarah Hilliar, Clare McCutcheon and Ian Smales (Reporting)

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# 1 Overview

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## 1.1 Background

The Silverton Wind Farm study area is located approximately 5 kilometres north of Silverton and 25 kilometres northwest of Broken Hill in the far west of NSW (Figure 1).

In May 2009, the Silverton Wind Farm project was granted approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) by the then NSW Minister for Planning. Approval was granted for the construction of 282 wind turbines and associated infrastructure. This included Concept Approval for the construction, operation and decommissioning of up to 598 wind turbines and associated infrastructure. The wind farm was declared to be a critical infrastructure project under the EP&A Act, as an energy generating development with the capacity to generate at least 250MW.

Approvals were received to extend the commencement date of construction under Modification 1 (11 April 2011) and Modification 2 (3 June 2016). Further modification (Modification 3) was then approved by the NSW Planning and Assessment Commission (PAC) on 22 December 2016 in accordance with Clause 8J(8) of the *Environmental Planning and Assessment Regulation 2000* and the transitional arrangements of the EP&A Act. Modification 3 sought to decrease the maximum number of turbines to 167, while increasing the dimensions and capacity of each turbine. The current project involves the development of 58 of these turbines.

Approval was granted for the modifications to the project approval (08\_022 MOD 3) and concept approval (08\_0022MOD2) subject to the conditions set out in the instrument of approval. The detailed project history and compliance with conditions of consent is outlined in the Biodiversity Adaptive Management Plan (BAMP) (Biosis 2018b).

Condition 18(c) of the Project Approval requires that prior to the commencement of construction, the Proponent must prepare a Biodiversity Management Plan for the project, which includes a Recovery Plan for the Critically Endangered Ecological Community (CEEC) Porcupine Grass – Red Mallee – Gum Coolibah hummock grassland/low sparse woodland in the Broken Hill Complex Bioregion, hereafter referred to as Porcupine Grass Sparse Woodland (PGSW). This plan has been developed to satisfy that specific condition of the Project Approval. In December 2017, it was identified that clearing of 6.81 hectares of PGSW was required for construction of the revised footprint of the Silverton Wind Farm.

The Silverton Wind Farm project is being undertaken by the Powering Australian Renewables Fund (PARF). The PARF is a partnership between AGL, QIC and Future Fund. PARF have engaged GE-CATCON under an Engineer, Procure and Construct (EPC) Contract to deliver the Silverton Wind Farm works; TransGrid (Network Service Provider – NSW) has been engaged under their Project Agreement to deliver the connection works.

This plan has been developed in consultation with:

- NSW Government Department of Planning and Environment (DPE)
- NSW Government Office of Environment and Heritage (OEH).

### 1.1.1 Specific conditions related to Porcupine Grass Sparse Woodland

Specific conditions relating to the clearance of PGSW are discussed below and summarised in Table 1.

#### MOD 3 project approval

Condition 17(a) of the third modification (08\_022 MOD 3) specifies that no more than 0.81 hectares of PGSW can be cleared, unless the Secretary of the DPE agrees otherwise. Condition 18(c) of this approval requires the

development of a Recovery Plan for the PGSW in conjunction with the Biodiversity Adaptive Management Plan (Biosis 2018a). These reports must outline:

- The baseline data on the vegetation and fauna habitat within the community
- The detailed performance and completion criteria for evaluating the performance of the enhancement activities.

### **Revised approval November 2017**

Following approval from the Secretary of the DPE, further site inspections in September 2017 (EHP 2017) determined that the extent of PGSW was more extensive than initially mapped by NGH ENVIRONMENTAL (2008a). In consultation with OEH, the DPE approved the clearing of 7 hectares of PGSW (Correspondence from DPE, Mike Young 2/11/2017, Appendix 1.1) subject to the following:

At a minimum, in addition to addressing the requirements of the project approval, the plans must:

- Be prepared by a suitably qualified expert (preferably with experience in the preparation of relevant plans) endorsed by OEH.
- Include figures and tables detailing the final clearing footprint, infrastructure layout, environmental constraints and areas of PGSW.
- Identify clear objectives, targets and performance indicators.
- Detail baseline conditions, including pre-construction feral goat numbers and the results of the updated baseline mapping and analysis of the PGSW across the site.
- Describe how the objectives, targets and performance measures will be achieved (including timeframes).
- Describe the management measures proposed to control feral goats and address the increased clearing impacts on the PGSW.
- Describe the proposed quantitative monitoring that will be used to measure whether the proposed actions are achieving the objectives, targets and performance indicators.
- Include a contingency plan (including timeframes, triggers and actions) that describes the measures (both proactive and reactive) that would be undertaken if the proposed actions are not achieving the objectives, targets and performance indicators.

The Recovery Plan should also clearly identify the final clearing footprint including how much PGSW is proposed to be avoided through micro-siting of the access tracks (i.e. a table comparing the original Environmental Assessment, approved and amended layout calculations).

### **Revised approval December 2017**

Approval was sought on the 19 and 22 November 2017 to commence construction in Area 7. After consideration of information submitted to the DPE,, construction approval was granted on 22 December 2017 (correspondence from DPE, Mike Young 22/12/2017, Appendix 1.2).

The departmental approval noted:

- Total clearing of PGSW for the wind farm is 6.81 hectares.
- Significant improvement had been made in the development of the PGSW Recovery Plan and Goat Management Plan.

- Construction activities must occur in accordance with the approved Construction Biodiversity Management Plan.
- Construction activities are to be supervised by an ecologist from Biosis with full demarcation of the disturbance footprint.

**Table 1 Condition compliance in relation to clearance of PGSW**

Condition of Consent		Addressed in	Page
<b>The Recovery Plan (and associated BAMP) must</b>			
1	Be prepared by a suitably qualified expert (preferably with experience in the preparation of relevant plans) endorsed by OEH	Appendix 2	64
2	Include figures and tables detailing the final clearing footprint, infrastructure layout, environmental constraints and areas of PGSW	Section 4.2.5 Table 7 Figure 10	27 27 35
3	The Recovery Plan should also clearly identify the final clearing footprint including how much EEC is proposed to be avoided through micro-siting of the access tracks (i.e. a table comparing the original EA, approved and amended layout calculations)	Section 4.2	25
4	Identify clear objectives, targets, performance and completion criteria for evaluating the performance of the enhancement activities	Section 5 The methods, actions, monitoring and reporting required to implement this plan are detailed within the BAMP (Biosis 2018b).	42
5	Detail baseline conditions: <ul style="list-style-type: none"> <li>• including pre-construction goat numbers</li> <li>• and the results of updated mapping and analysis of PGSW across the site</li> </ul>	Section 2 Section 5.2.4 Section 3.5	10 43 23
6	Describe how the objectives, targets and performance measures are to be achieved (including timeframes)	Section 5.2 and Section 5.4:Table 8 BAMP (Biosis 2018b)	42
7	Describe the management measures proposed to control goats and address the increased clearing impacts on PGSW	Section 5.2.4 Goat Management Plan (GMP) (Biosis 2018c) BAMP (Biosis 2018b)	42
8	Describe the proposed quantitative monitoring that will be used to measure whether the proposed actions are achieving the objectives, targets and performance indicators	Section 5.2 BAMP (Biosis 2018b)	42
9	Include a contingency plan (both proactive and reactive) that would be undertaken if the proposed actions are not achieving the objectives, targets and performance indicators	An annual monitoring report to OEH on the response of PGSW to improved goat management. After three years, a comprehensive review of the response data will determine whether	BAMP and 50



Condition of Consent		Addressed in	Page
		further refinement of management of PGSW is required to ensure there is a net gain in the conservation value of this community . Any updated Recovery Plan and associated BAMP will be submitted to OEH. Refer to BAMP (Biosis 2018b) for details of the monitoring and reporting framework.	
10	Total clearing of PGSW for the wind farm is 6.81 hectares	Total clearing for PGSW is 6.39 hectares.	27
11	Construction activities must occur in accordance with the approved Construction Biodiversity Management Plan	Monthly compliance reports prepared by Ecology and Heritage Partners (EHP) and submitted to Catcon and GE Renewable Energy.	N/A
12	Construction activities are to be supervised by an ecologist from Biosis with full demarcation of the disturbance footprint.	Construction has been monitored by a Biosis ecologist using a field tablet outlining the updated mapping of the PGSW extent.	N/A

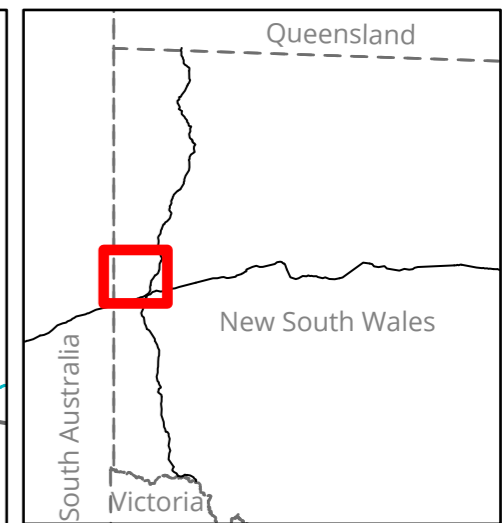
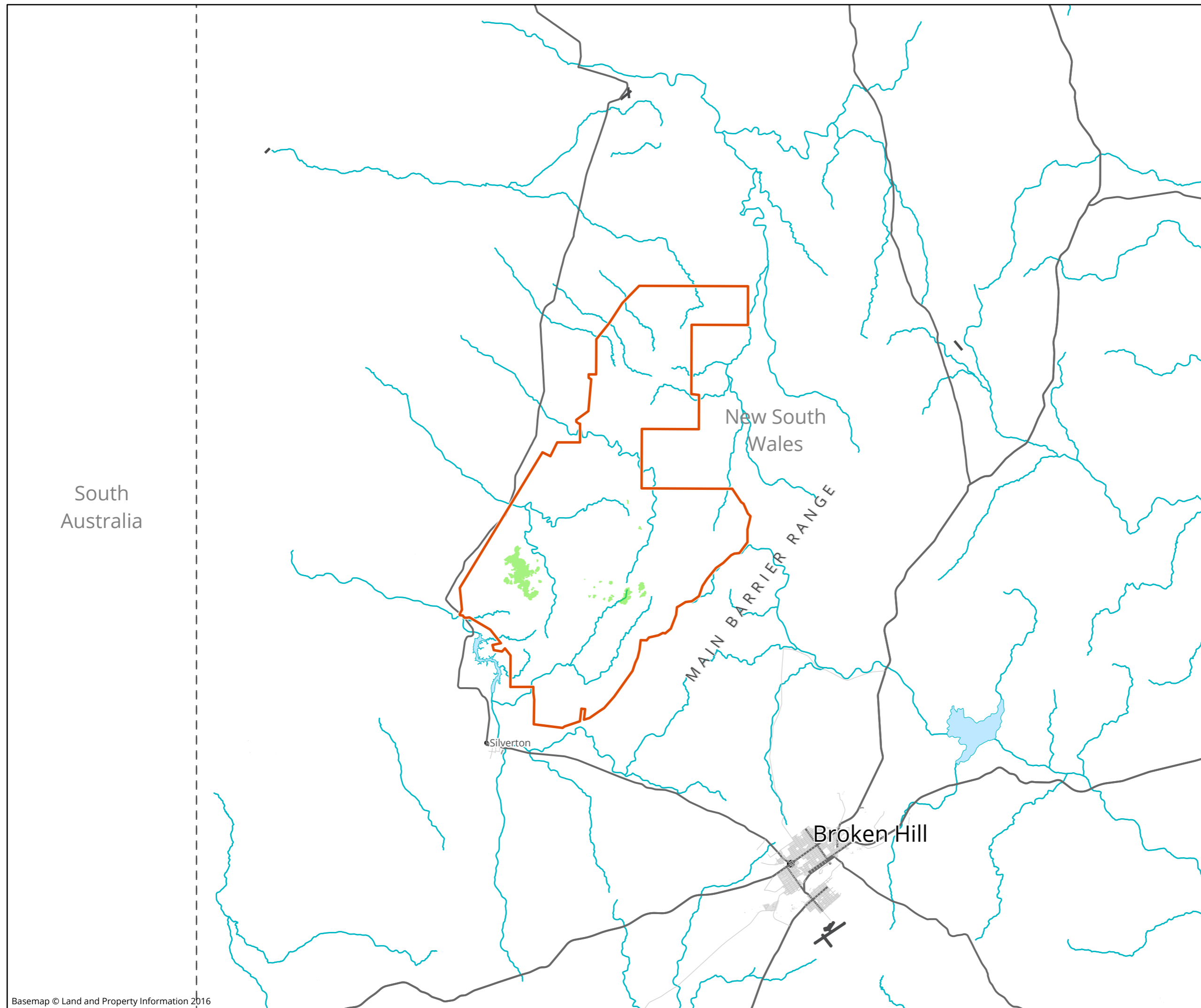
## 1.2 Purpose

This document provides an overview of PGSW across the Silverton Wind Farm and was prepared by a suitably qualified expert (Renée Woodward, Senior Botanist, Biosis). It describes the baseline condition of the vegetation and fauna habitat within PGSW and discusses the actions to address ongoing impacts and threats to the community, with an aim to achieve a net gain in condition of PGSW over the lifetime of the wind farm.

Specific management measures to be undertaken during construction and operation of the wind farm to protect and enhance the PGSW community are provided. This forms the basis for future monitoring in accordance with the BAMP (Biosis 2018a). Annual monitoring and reporting will be followed by a review of the management approach to continually improve on-ground management and ecological outcomes, evaluate performance of management actions and to inform potential adaptive management responses. A comprehensive review of monitoring and management will be undertaken after three years, being after surveys in spring 2021 to ensure there is a net gain in the conservation value of this community.

## 1.3 Relationship to other plans

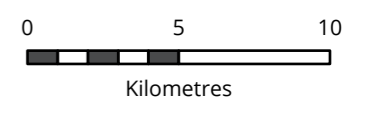
The specific management actions, monitoring and adaptive management responses in relation to PGSW management are described in the implementation section of the BAMP (Biosis 2018b). The overarching BAMP provides a cohesive document that details the methods, actions, monitoring and reporting identified for the Goat Management Plan (Biosis 2018bc), PGSW Recovery Plan (this document), Barrier Range Dragon Management Plan (Biosis 2018a) and Vegetation Management Plan (Biosis 2018d), into one cohesive implementation document. This allows for a unified approach to on-ground monitoring and management of biodiversity at the Silverton Wind Farm site. The PGSW Recovery Plan is to be read in conjunction with the GMP, VMP and BAMP.



**Legend**

- Study area
- Porcupine Grass Sparse Woodland

Figure 1 - Location of the study area



Scale: 1:1:250,000@ A3  
Coordinate System: GDA 1994 MGA Zone 54



Matter: 26380  
Checked by RW, drawn by: ARL  
Last edited by: alongmire on 04 September 2018  
Location: P:\26300s\26380\Mapping\26380\_PGSW\_GMP

## 2 Overview of Porcupine Grass Sparse Woodland

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### 2.1 Description

Porcupine Grass Sparse Woodland is a distinctive and naturally restricted community. Usually characterised by a ground layer dominated by Porcupine Grass *Triodia scariosa*, the overstorey small tree and shrub canopy comprises Red Mallee *Eucalyptus socialis* and Gum Coolabah *Eucalyptus intertexta* (Plate 1). Shrubs include very sparse wattles with low-growing species between the hummocks, typically dominated by hardy chenopods. The community occurs on steep rocky terrain with a skeletal layer of aeolian red sandy loam (Benson & Sass 2008). This substrate is unusual habitat for both the eucalypts and Porcupine Grass, which are normally associated with sandplains and dunes in NSW (OEH 2017a).

Porcupine Grass Sparse Woodland supports a diverse assemblage of birds and reptiles, particularly in areas such as the intact rocky ridges, areas dominated by Porcupine Grass, and areas adjacent to drainage lines. In particular, PGSW provides habitat for a number of reptile species that are listed as endangered under the *Biodiversity Conservation Act 2016* (BC Act). Further detail regarding fauna and associated habitat within the community are discussed in Section 2.1.4.

The community was first identified by NGH Environmental (2008b) following baseline surveys for the Silverton Wind Farm Project. Given the highly restricted distribution of the community, it was subsequently listed as a critically endangered community (NSW Scientific Committee 2010) under the NSW *Threatened Species Conservation Act 1995* (replaced by the BC Act). This community has been formally assigned to the Plant Community Type (PCT) PCT359: Porcupine Grass - Red Mallee - Gum Coolabah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion (OEH 2017b).

#### 2.1.1 Flora

##### Native flora

As described in Section 2.1, PGSW is characterised by a ground layer dominated by a hummock grass known as Porcupine Grass with a sparse or absent low canopy of Red Mallee and Gum Coolabah. Mid-storey shrubs are very occasional and are typically wattles such as Mulga *Acacia aneura*, Dead Finish *Acacia tetragonophylla* or Prickly Wattle *Acacia victoriae*, and occasionally Silver Cassia *Senna artemisioides*.

Across most of the distribution of the community, the ground layer is dominated by the characteristic Porcupine Grass. Hardy chenopod plant taxa such as Mallee Saltbush *Atriplex stipitata*, Angular Saltbush *Atriplex angulata*, Black Bluebush *Maireana pyramidata*, Pearl Bluebush *Maireana sedifolia*, Frosted Goosefoot *Chenopodium desertorum*, and Limestone Copperburr *Sclerolaena obliquicuspis* form a low shrub layer between the tussocks or may dominate the ground layer in areas where Porcupine Grass is absent. Smoke Bush *Ptilotus obovatus* and Thargomindah Nightshade *Solanum sturtianum* are also common low shrubs in the community.

Softer, more palatable species have been observed growing within the sharp foliage of Porcupine Grass where they escape browsing by feral goats and other herbivores. These species include Lemon Grass *Cymbopogon ambiguous*, Jointed Nineawn *Enneapogon cylindricus*, Rock Fern *Cheilanthes sieberi* subsp. *sieberi* Twining Glycine *Glycine clandestina*, Hill Hibiscus *Hibiscus sturtii* var. *sturtii* and Native Carrot *Daucus glochidiatus* among others.

The community occurs within the arid zone where the climate is noted for very low average rainfall (mean of 210 millimetres per annum), but also high variability in rainfall between years. Large infrequent rainfall events

stimulate the growth of ephemeral and perennial plant taxa from dormant seedbanks. Therefore, the species composition at any given time is expected to be influenced by recent rainfall or drought conditions and any occurrence of fire (NSW Scientific Committee 2010).

A comprehensive baseline survey of the community occurred in spring 2018, to be followed by three years of annual monitoring (Biosis 2018a). Further survey may align with a favourable growing season allowing the observation of additional species. It predicted that a reduction in goat herbivory may allow the growth and recruitment of palatable species that are likely to be suppressed under the current management.

A current species list for PGSW compiled from all known sources is provided in Appendix 3.



**Plate 1 Porcupine Grass Sparse Woodland (S Hilliar, December 2017)**

### Exotic species

The remote location and harsh conditions of the study area have resulted in a low incidence of weeds within the community to date. The invasive perennial weed Rosy Dock *Acetosa vesicaria* was recorded by John Benson (NSW Scientific Committee 2010), and field survey by NGH Environmental (2008b) documented Winged Sea Lavender *Limonium lobatum*, Common Sow-thistle *Sonchus oleraceus* and Wards Weed *Carrichtera annua* within the community.

Potentially significant weeds that occur within the local area include African Boxthorn *Lycium ferocissimum*, Saffron Thistle *Carthamus lanatus*, Patterson's Curse *Echium plantagineum* and the introduced annual grasses Roughtail *Rostraria pumila* and Arabian Grass *Schismus barbatus* (Appendix 3).

These species are likely to be present in greater numbers following high autumn-winter rainfall. All these exotic species have potential to disperse into PGSW, particularly within areas of soil disturbance during construction.

### 2.1.2 Associated Plant Community Types (PCTs)

As identified in the Vegetation Management Plan (VMP) (Biosis 2018c), PGSW may be ecotonal with the widespread Dead Finish - Mulga Shrubland (PCT123 of Benson 2008). On lower slopes and in gravelly creeks or rocky gorges, PGSW may also be ecotonal with PCT136 Prickly Wattle Shrubland and on deeper gullies it adjoins PCT234 River Red Gum on Creeks.

The NSW Scientific Committee (2010) note that PGSW may also grade into PCT169 Curly Mallee *Eucalyptus gillii* open woodland, which has a ground layer not dominated by Porcupine Grass, but this community does not occur within the study area.

### 2.1.3 Structural variants

Variations in species and structural diversity of PGSW is common in its limited geographic range. As discussed by Jacobs (in litt, 2017), the PCTs with which PGSW intergrades do not include the characteristic Red Mallee, Gum Coolabah or Porcupine Grass (OEH 2017b). Therefore, PGSW occurs as

- Porcupine Grass hummock grassland with key eucalypt species present
- Porcupine Grass hummock grassland without key eucalypt species present
- Eucalypt species present without/with minimal Porcupine Grass.

Some areas of the community may contain little or no Porcupine Grass. This may be due to natural variation within the community resulting from small scale variation in conditions such as soil depth, slope and aspect (Jacobs in litt 2017). Jacobs also note that Porcupine Grass may also have been lost in some areas of the community as a result of environmental conditions such as drought and grazing by goats. The fire history for the study area is unknown, but it is possible that a long inter-fire interval has seen the decline of above ground Porcupine Grass. Porcupine Grass has been observed to increase rapidly post-fire to a maximum at around 20-30 years followed by a plateau or slow decline in abundance and cover (Haslem et al. 2011).

Given these land-use histories, Porcupine Grass may still be present as propagules in the soil seed bank, however studies indicate that the majority of soil-stored seed may lose viability after two years (Wright & Fensham 2017). Therefore, although the community determination (NSW Scientific Committee 2010) identifies Porcupine Grass as a typical community dominant, this assessment considers areas with a canopy layer dominated by Red Mallee and/or Gum Coolabah located on rocky hills containing (or able to be identified as previously having contained) Porcupine Grass, to be part of the listed threatened community, even if these areas currently do not contain Porcupine Grass.

### 2.1.4 Fauna

Porcupine Grass Sparse Woodland supports a diverse assemblage of fauna, particularly birds and reptiles. Fauna surveys undertaken at the Silverton Wind Farm by NGH Environmental (2008b) found that high species diversity in these faunal groups was typically associated with intact rocky ridges, Porcupine Grass grassland and areas adjacent to drainage lines. Porcupine Grass Sparse Woodland provides habitat for a number of reptile species that are listed as endangered under the BC Act. These include Mallee Slender Blue-tongue Lizard *Cyclodomorphus melanops elongatus*, Marble-faced Delma *Delma australis* and Barrier Range Dragon *Ctenophorus mirrityana* (OEH 2009). The Barrier Range Dragon was recently described as a separate species from the Tawny Crevice Dragon *Ctenophorus decresii* (McLean et al. 2013) and is currently known from four sites in western New South Wales, including the study area. It is also noted that PGSW, via the presence of Porcupine Grass dominated vegetation on rocky substrates, provides an extended range for the Mallee Slender Blue-tongue Lizard, Marble-faced Delma and Unbanded Delma *Delma butleri*, which were previously only known from habitats with sandy substrates (Sass et al. 2011).

In addition to the three threatened reptiles described above, one vulnerable mammal species (Little Pied Bat *Chalinolobus picatus*) was recorded during preliminary fauna surveys of the Silverton Wind Farm (NGH Environmental 2008b). Four BC Act threatened birds were also recorded. These included Pied Honeyeater *Certhionyx variegatus*, Painted Honeyeater *Grantiella picta*, Redthroat *Pyrrholaemus brunneus* and Major Mitchell's Cockatoo *Lophochroa leadbeateri*. Of these, Painted Honeyeater is also listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These species are all likely to utilise habitat features within and adjacent to areas of PGSW at Silverton Wind Farm. The region in which the PGSW ecological community occurs is also known or potential habitat for a number of additional listed threatened mammal and bird species (NGH Environmental 2008b), but their utilisation of this specific community is not yet documented.

Introduced fauna present within areas of PGSW include foxes, feral cats, rabbits and goats. In 2008, foxes and rabbits were recorded in low abundance, likely due to drought and lack of ground cover due to grazing pressure (NGH Environmental 2008b). Goats were found to be abundant and widespread, and evidence of their grazing was found within areas of PGSW and the broader area (NGH Environmental 2008b). The NSW Scientific Committee has listed 'Competition and habitat degradation by feral goats' as a Key Threatening Process. 'Competition and land degradation by unmanaged goats' is also listed as a Key Threatening Process under the EPBC Act. Grazing pressure and habitat degradation by goats is a key threat to PGSW and the threatened reptile species present. Further detail regarding the impacts of feral goats is provided in Section 4.1.1 and management of impacts to PGSW and threatened reptile habitat is addressed in the GMP (Biosis 2018c).

## 2.2 Distribution

Distributed on the southern Barrier Range (Walker 1991), PGSW is limited to an area north of the township of Silverton on the rocky hills of the Umberumberka Range (Figure 1). Situated within the Barrier Range Complex Bioregion (NSW Scientific Committee 2010), the landscape in which the community is found is characterised by rocky hills to 200 metres above sea level with skeletal aeolian red sandy loam soils. These abiotic features of PGSW appear to limit the geographic range of the community.

The full extent of the community was estimated by Benson (2008) to occupy about 400 hectares.

## 2.3 Land tenure and grazing

The tenure of the land at the Silverton Wind Farm is Crown Land offered as leasehold under the authority of the *Western Lands Act 1901*. The Silverton Wind Farm is situated across four lease holdings, including the Blore lease holding. The PGSW community is primarily restricted to a large patch within the Blore lease holding, however there are small patches located on two other lease holdings. The land is currently used for grazing purposes, including feral goats.

As outlined in the GMP, harvesting feral goats by pastoralists has led to a reduction in goat numbers generally. The focus on goat management, however, has now moved to maintaining goats at a level where they remain economically viable for harvest. This change in management focus now presents a new set of challenges, as the approach often conflicts with conservation management where eradication or suppression at very low numbers is the goal (Russell et al. 2011). The maintenance of commercial numbers of feral goats within the landscape may also be at odds with the key threatening processes outlined above.

Leaseholders at Silverton Wind Farm are currently taking this approach to goat management, where goats have become a commodity and are being managed at levels that may be detrimental to the landscape, particularly to the PGSW and endangered Barrier Range Dragon located within Area 7 of the Wind Farm.

A goat fence was erected around the majority of PGSW by the Blore lease holding in May 2014 (Figure 2) as part of the Mundi Mundi Conservation Project funded by the Total Grazing Pressure Program, Western Local Land Services (LLS). The fence was erected to temporarily exclude and manage goats for the purposes of protecting PGSW and the endangered Barrier Range Dragon. The fence also stops goats from seeking refuge in the steep, rocky terrain during mustering events and acts as a wing to guide goats to the 4 kilometre long wing off the Umberumberka Reservoir.

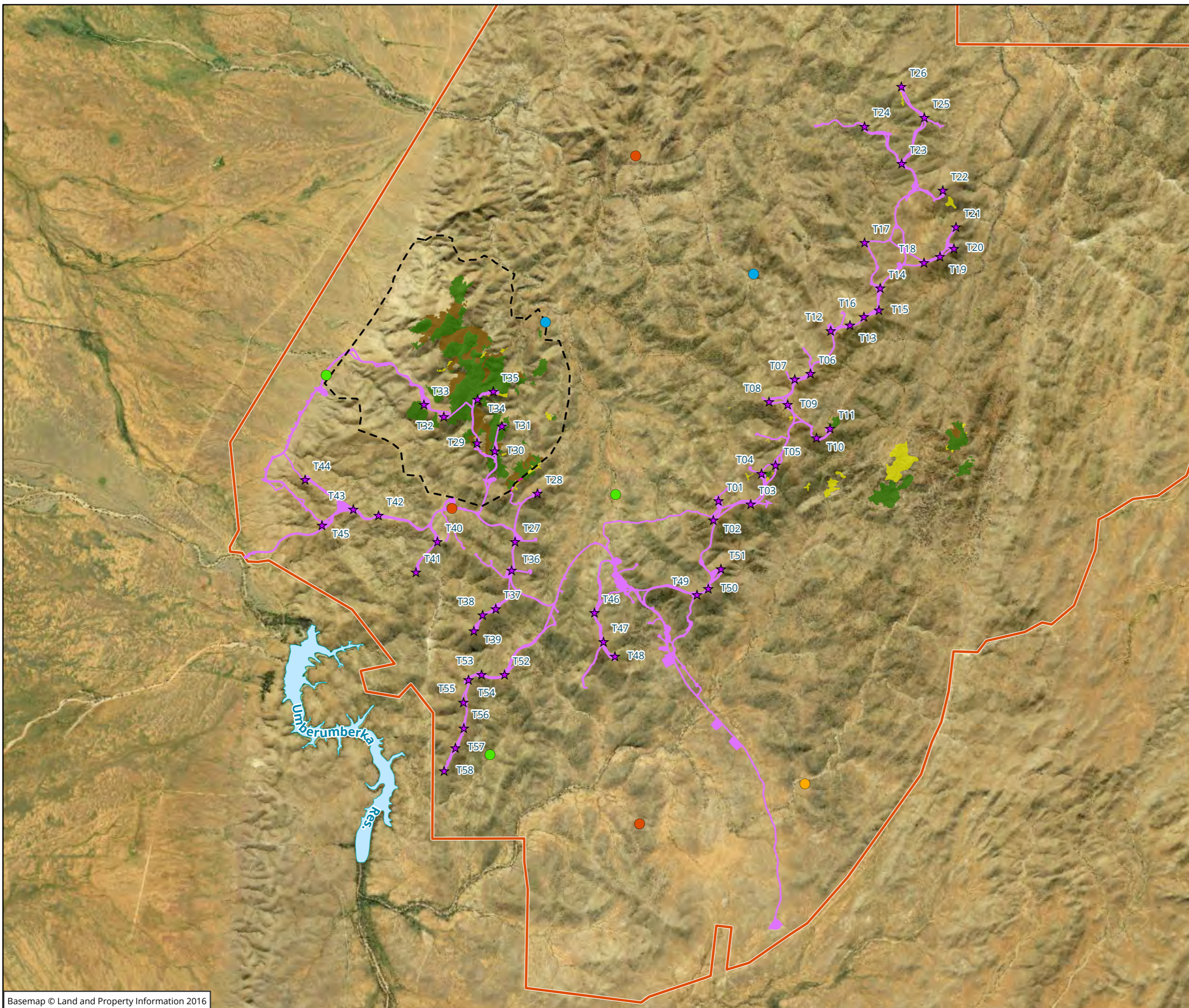
## **2.4 Ability to recover**

The main conservation concern for PGSW is ongoing dieback and a general absence of regeneration across the majority of its distribution. It is likely that the community has undergone a long period of decline resulting from past land use, particularly grazing by feral goats and rabbits, and timber cutting. Continued grazing and browsing by feral goats is likely to be the major reason for the lack of apparent recruitment of tree and shrub species (NSW Scientific Committee 2010).

Field survey by Biosis in 2017 noted that many species of the community are restricted to within the protection of spiny Porcupine Grass tussocks, and shrub species are in an 'arrested' state as described by AREA (2017), where they are in a hedged or topiarised form due to intense browsing. The vegetation is being impacted by browsing and browsing is expected to have eliminated many flora species from this community (NGH Environmental 2008b).

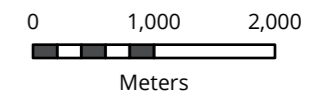
The impact of feral goats is exacerbated by drought events such as the Millennium Drought when significant die-off of Porcupine Grass and canopy species was observed (NGH Environmental 2008b and NSW Scientific Committee 2010). What is unknown, is whether feral goats may impact the recovery of Porcupine Grass after fire when vegetative recovery can occur. In a landscape dominated by feral goats as the primary herbivore, this recovery could conceivably be severely interrupted.

Improved management of feral goats in an adaptive management approach as outlined in the BAMP (Biosis 2018b ) and GMP (Biosis 2018c) aims to minimise feral goat browsing and provide opportunities for recruitment, and hence initiate recovery of PGSW following this long term decline. If a significant reduction in goat abundance and associated improvement in vegetation condition is not observed within the first three years of monitoring, further goat management measures will be required (Biosis 2018 b & c).



- Legend**
- Study area
  - Goat fence
  - Infrastructure
  - Pre-existing road
  - ★ Turbine
- PGSW structural variants**
- Porcupine grass with eucalypts
  - Porcupine grass only
  - Eucalypts only
- Watering point**
- Ground tank
  - Trapped dam
  - Trapped trough
  - Trapping yard

Figure 2 – Infrastructure for goat management



Scale: 1:62,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54



Matter: 26380  
Checked by RW, drawn by: ARL  
Last edited by: jturner on 03 October 2018  
Location: P:\26300s\26380\mapping\26380\_PGSW\_GMP



## 3 Mapping

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Mapping of the PGSW has been prepared by a number of organisations over the past ten years. However, other than preliminary field survey to prepare the EIS in 2008, there had been no opportunity for field validation of remotely derived mapping products until ground-truthing by Biosis in December 2017. Additionally, each iteration of the mapping used higher resolution imagery, allowing more accurate delineation of the community boundary. A targeted mapping program, including field survey, for the full extent of the community outside of the Silverton Wind Farm has not been undertaken.

### 3.1 NGH Environmental 2008

Porcupine Grass Sparse Woodland was initially identified by NGH Environmental while preparing the EIS for the Silverton Wind Farm (NGH Environmental 2008b, Map 4.6, page 34).

The fieldwork for the EIS was preliminary and sought to describe and measure key biodiversity attributes across the entire development site. NGH Environmental noted that while the range of environmental variation was assessed within each vegetation community, not every part of each community was inspected in fine detail. Rather, a subset of surveys was undertaken within each vegetation community that enabled a broad scale assessment of each community type. It was also discussed that due to the large area of the proposed development site, not all vegetation boundaries were assessed in detail. Rather, the mapping provided an indicative estimate of the extent of vegetation communities across the study area, including the extent of PGSW.

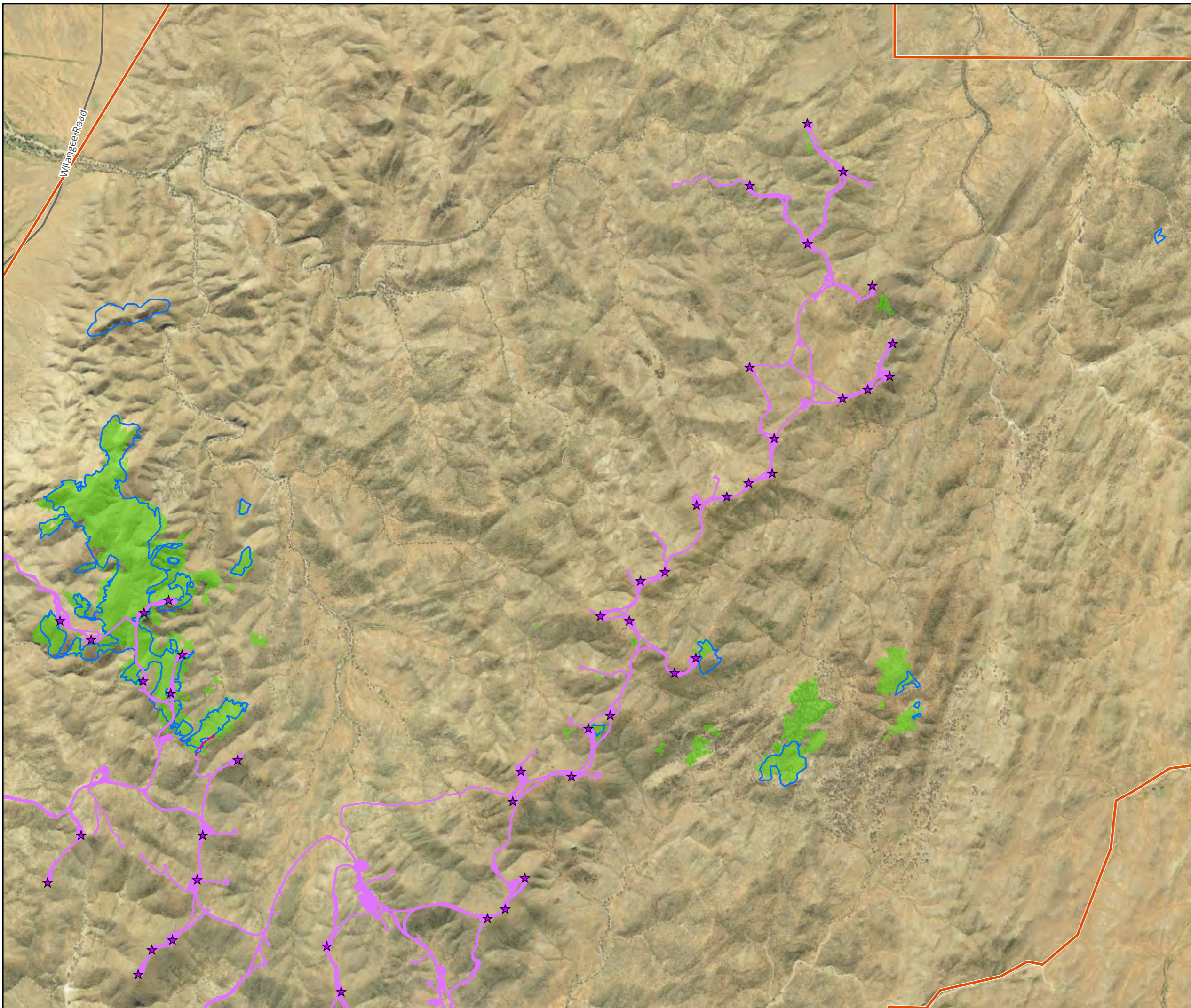
This preliminary mapping of the community identified 316.31 hectares of PSGW (Figure 3).

### 3.2 OEH 2016

Office of Environment and Heritage undertook draft mapping of the community in 2016 (OEH in litt. 2017). Guided by the extent of the PGSW identified by NGH Environmental, systematic Aerial Photograph Interpretation (API) was completed (Figure 4) using ADS 50 centimetre image that was captured on 26/7/2013. A scale of 1:1,250 metres was used to identify areas of the community. This mapping predominantly focussed on the extent of Porcupine Grass, which has a distinctive photo pattern.

A grid was used to define systematic search areas that were inspected from west to east, then east to west with overlap until the entire cell was checked. The boundaries of the NGH Environmental (2008b) mapping was refined and extended where necessary based on the higher resolution imagery. Where the mapper was not entirely confident of the Porcupine Grass photo pattern it was mapped and identified in the attribute table as 'needing field verification'.

Another area of Porcupine Grass was identified approximately 39 kilometres east of the known extent of PGSW, also in the Barrier Land System. The areas immediately surrounding the spinifex mapped to see if there were any more outliers. This resulted in an additional 38.6 hectares of the community to be verified. As a result, OEH mapped 358.8 hectares of PGSW, comprising 263.4 hectares where the mapper was confident in the signature of the community and a further 95.4 hectares requiring field validation.



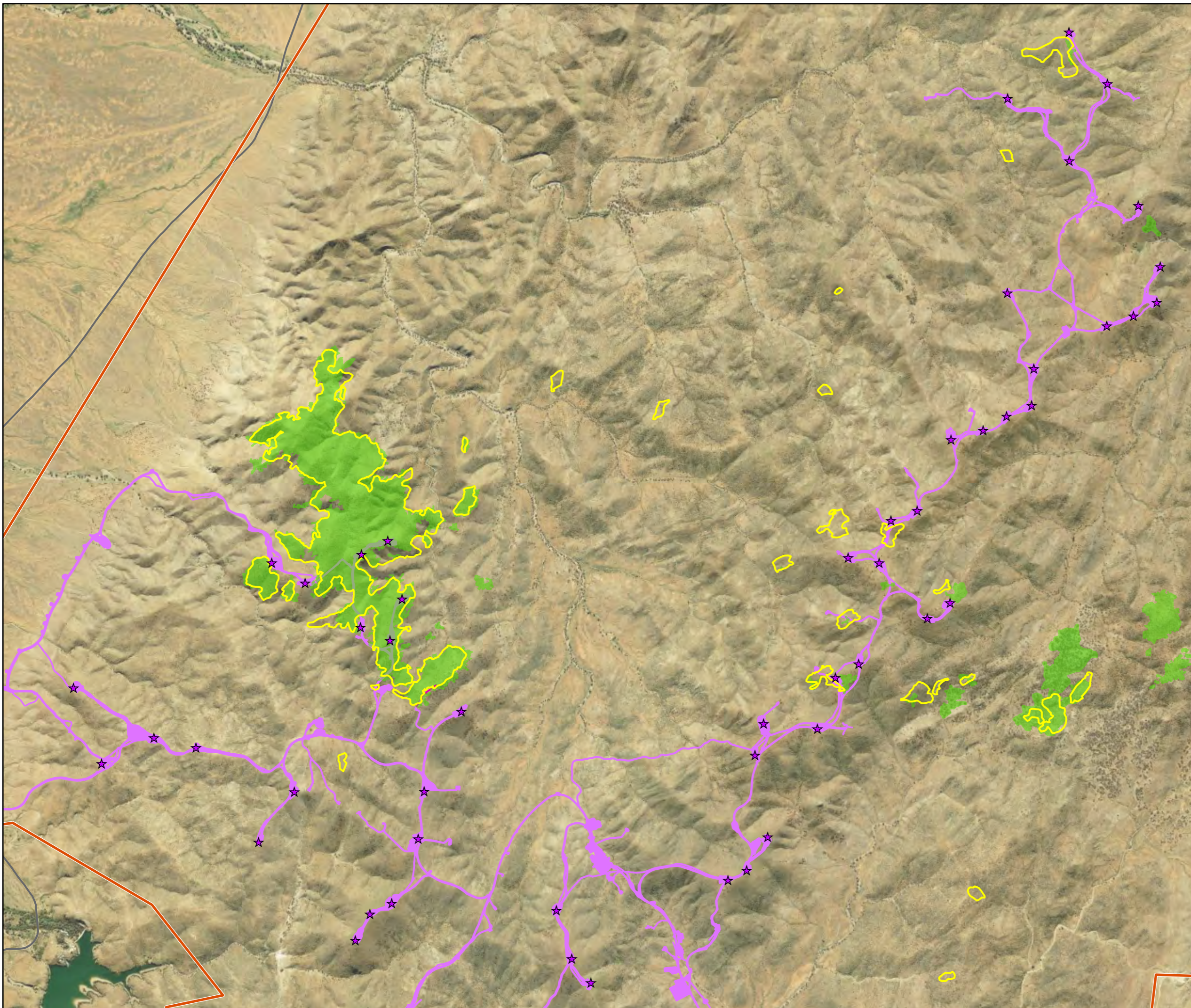
**Legend**

- ▭ Study area
- ▭ PGSW (NGH 2008 for EIS)
- ▭ PGSW (Biosis 2017)
- ▬ Infrastructure
- ▬ Pre-existing road
- ★ Turbine

Figure 3 – PGSW (NGH 2008b)

0 1,000 2,000  
 Metres  
 Scale 1:40,000 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54





**Legend**

- Study area
- PGSW (OEH 2016)
- PGSW (Biosis 2017)
- Infrastructure
- Pre-existing road
- Turbine

Figure 4 - PGSW identified by aerial photograph interpretation (OEH 2016)

0 1,000 2,000  
 Metres  
 Scale 1:37,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
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 Last edited by jturner on 03 October 2018  
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### 3.3 Jacobs 2017

To refine the mapping of PGSW within the works area for the Silverton Wind Farm, AGL commissioned a low level aerial survey and GIS mapping of the ecological community (Jacobs in litt. 30 August 2017). Porcupine Grass is readily identified in high quality aerial imagery. Using purpose-flown four band ortho-rectified aerial imagery from 2017, image analysis techniques were used by Jacobs to extract small polygons defining areas covered by Porcupine Grass, which were then manually validated.

A 3 x 3 metre grid was generated to identify areas that support ten percent or more Porcupine Grass. These cells were converted into polygons to identify the main areas dominated by Porcupine Grass.

#### 3.3.1 Quantitative mapping

Using a GIS, areas containing Porcupine Grass were mapped by buffering the Porcupine Grass polygons (hence expanding them) by 15 metres to fill in numerous small holes and gaps. The resulting polygon was then 'debuffered' (reduced) by 15 metres to bring the outer bounding polygon back to reflect the outside edge of the Porcupine Grass areas. The mapping was then manually edited to remove any obvious errors (Figure 5).

#### 3.3.2 Qualitative mapping

A bounding polygon was also manually mapped using API around areas containing Porcupine Grass at greater than ten percent cover. The resulting polygon file was then manually edited to remove any obvious errors (Figure 5).

#### 3.3.3 Comments on the likely extent of the community

As discussed in Section 2.1.3, Jacobs highlighted that there is variation in the structure and composition of PGSW. Without an opportunity to undertake field validation, they noted (Jacobs in litt. 30 August 2017) the three variants that were observed during Biosis fieldwork in 2017.

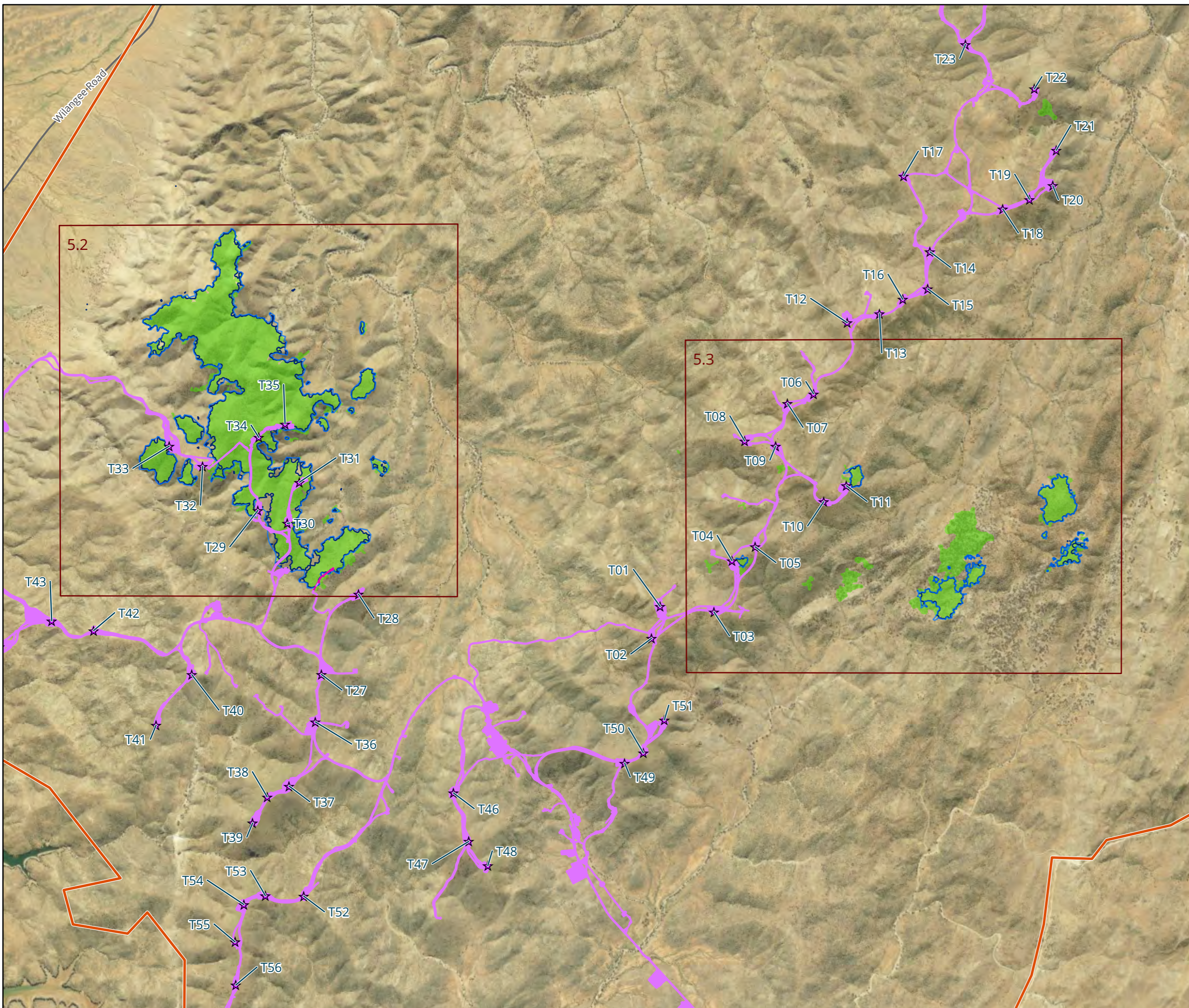
Jacobs determined that their qualitative mapped distribution of the Porcupine Grass appeared to be the most accurate mapping of the PGSW. It includes all areas with substantial Porcupine Grass cover, much of the area likely to represent a degraded form of the community, and many likely transitional areas. It also excludes several areas that are considered likely to have been mistakenly included in the distribution mapped by OEH and/or NGH Environmental (Jacobs in litt. 30 August 2017).

### 3.4 EHP 2017

A desktop review and field investigation of pegged areas of proposed disturbance to PGSW was undertaken by EHP (2017). This assessment was constrained to an examination of the access tracks, turbine foundations, crane hardstands, blade laydown areas, power pole pads for the overhead cables and the underground cables. The field assessment was completed in July 2017 by a site ecologist (EHP) and a site engineer (Catcon). This survey identified inaccuracies in the mapping included in the biodiversity assessment and appended to the MOD 3 project approval, as there were several patches of unmapped PGSW within areas of proposed civil works. Therefore, revisions to the proposed design were investigated.

Further inspections of potential alternative layouts to minimise impacts were then completed by the Silverton Wind Farm consortium's project manager and the project design manager. A third inspection of the revised design for the access track alignment and turbine locations was undertaken by a site ecologist and the site engineer in September 2017.

These surveys were all constrained to areas of proposed construction impact, no further survey of the remainder of the community was undertaken at this time.



**Legend**

- Study area
- PGSW (Biosis 2017)
- Infrastructure
- Pre-existing road
- Turbine

**PGSW (Jacobs 2017)**

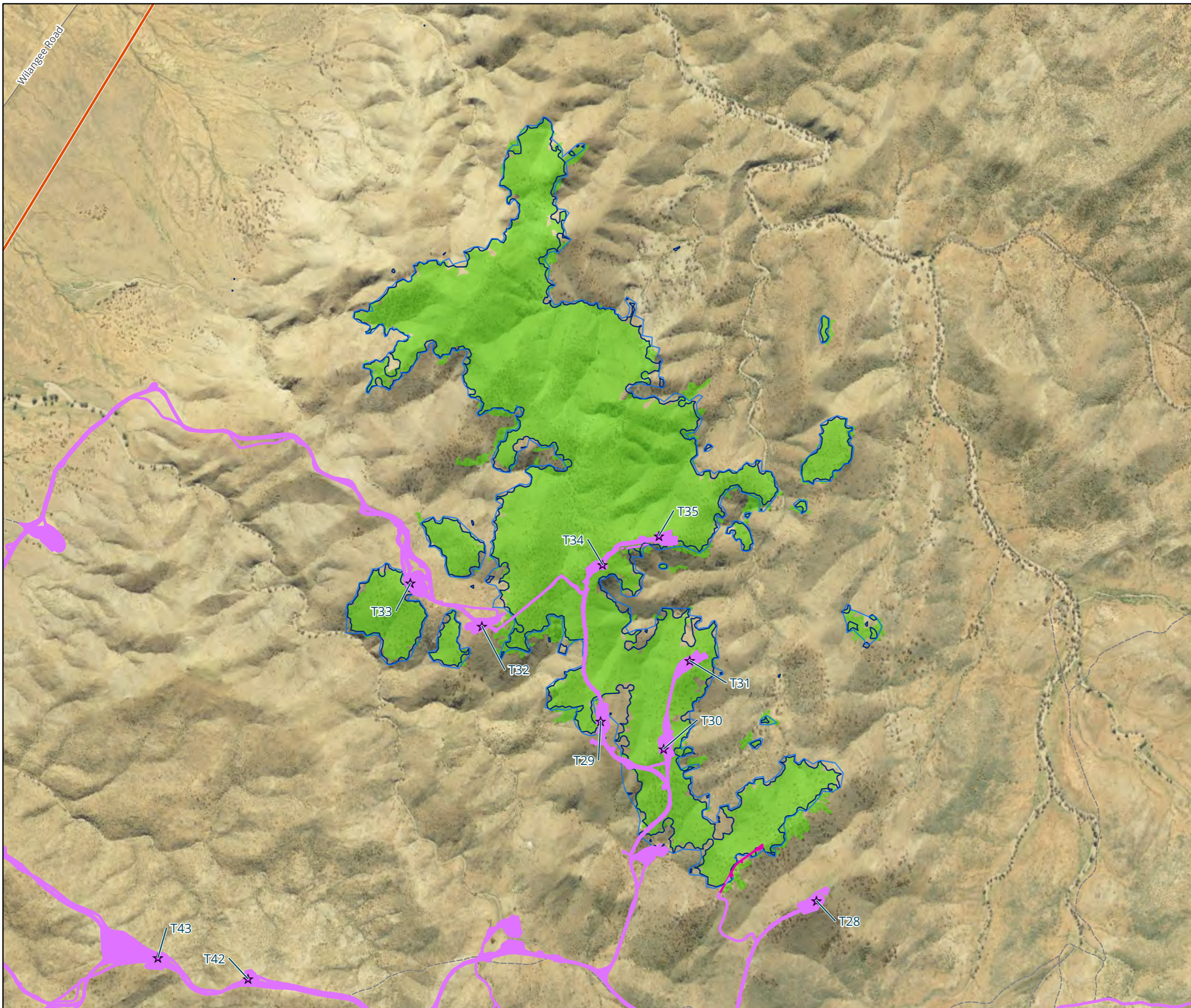
- Qualitative
- Quantitative

Figure 5.1 -  
PGSW by remote sensing  
(Jacobs 2017) - overview

0 1,000 2,000  
Metres  
Scale 1:37,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
Checked by RW, drawn by ARL  
Last edited by jturner on 03 October 2018  
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**Legend**

- Study area
- PGSW (Biosis 2017)
- Infrastructure
- Pre-existing road
- Turbine

**PGSW (Jacobs 2017)**

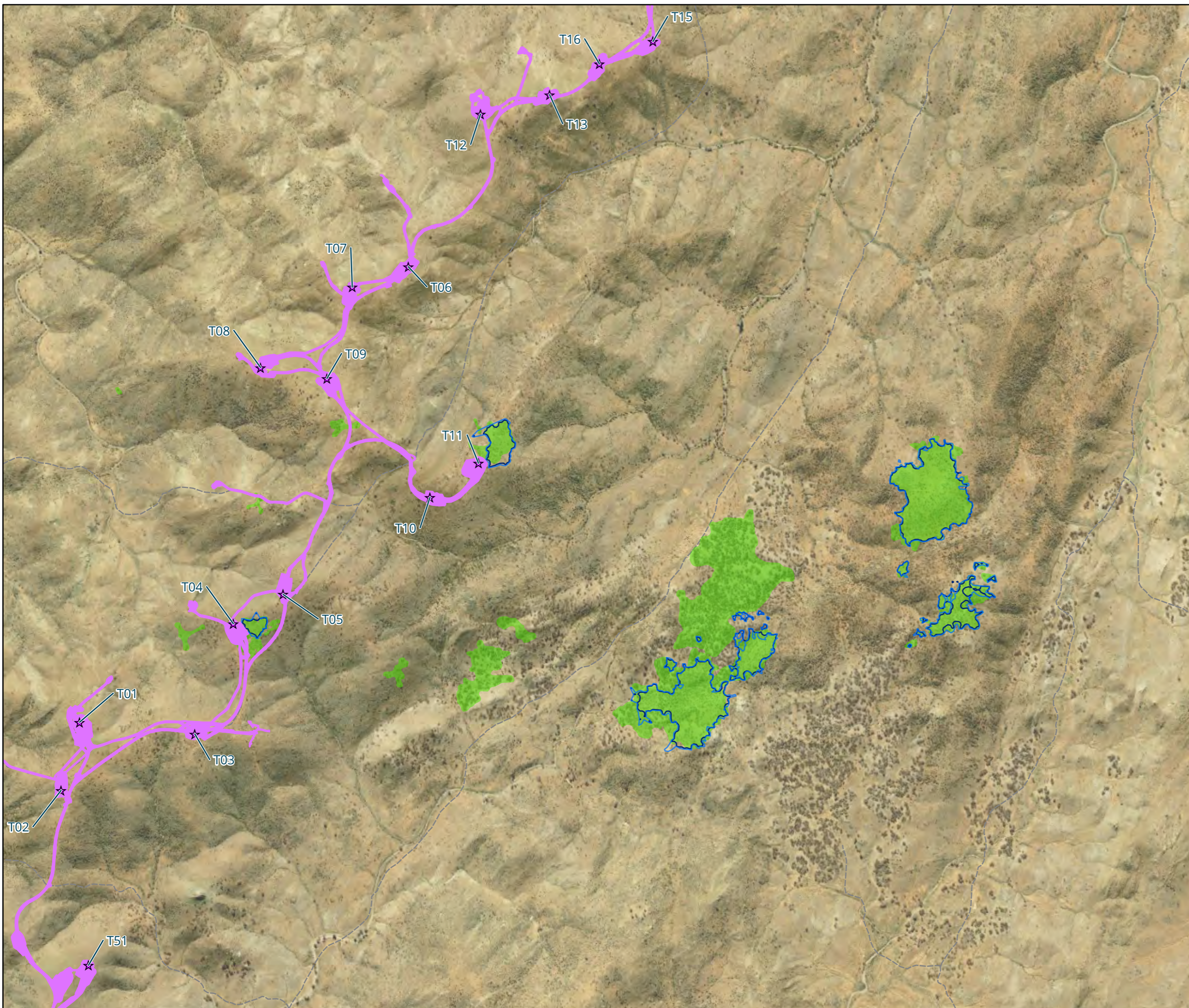
- Qualitative
- Quantitative

Figure 5.2 –  
PGSW by remote sensing  
(Jacobs 2017) - west

0 1,000  
 Metres  
 Scale 1:17,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
 Checked by RW, drawn by ARL  
 Last edited by jturner on 03 October 2018  
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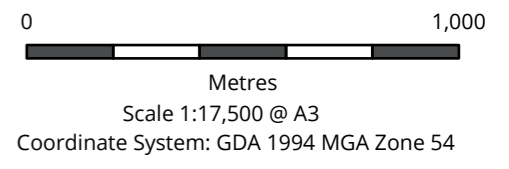
**Legend**

- Study area
- PGSW (Biosis 2017)
- Infrastructure
- Pre-existing road
- Turbine

**PGSW (Jacobs 2017)**

- Qualitative
- Quantitative

Figure 5.3 –  
PGSW by remote sensing  
(Jacobs 2017) - east



Matter 26380  
Checked by RW, drawn by ARL  
Last edited by jturner on 03 October 2018  
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## 3.5 Biosis 2017

In 2017, Biosis was commissioned to map and validate the full extent of the PGSW community within the Silverton Wind Farm study area through field survey and mapping using the methods outlined below. The Biosis 2017 mapping (Figures 1-9) is used to define the extent of PGSW for this Recovery Plan.

### 3.5.1 Field survey

A field survey was undertaken between 11 and 13 December 2017 to map and validate the full extent of PGSW. Two botanists investigated areas of different photo pattern identified prior to fieldwork, to make observations about the presence of the community. Additionally, they focussed survey effort on areas where previous mapping of this community by NGH Environmental, OEH, Jacobs and EHP has shown discrepancies. The primary focus was to validate areas that had been:

- Mapped as the community by Jacobs but not mapped by OEH or NGH Environmental.
- Mapped as the community by OEH but not included in the Jacobs mapping.
- Areas at the periphery of the community as mapped by Jacobs.

As discussed in Section 2.1.3, the community was defined by the presence of Porcupine Grass hummock grassland without eucalypt species present, or eucalypt species present with or without Porcupine Grass. These structural variants were used as the basis for classification. Specifically PGSW was classified as:

- Porcupine grass with eucalypts
- Porcupine grass only
- eucalypts only.

The presence and extent of this community was mapped using Tablet Personal Computer units (GDA94) and aerial photo interpretation.

A general broad survey of the area was also undertaken to help determine the extent and quality of vegetation and a species list was collected.

### 3.5.2 Mapping

Vegetation mapping was based on a combination of high quality aerial imagery, previous mapping and on ground validation. Biosis ecologists used a Geographic Information System (GIS) to manually produce a shapefile of the three PGSW community variants, which are all considered to meet the definition of the Critically Endangered Ecological Community, as discussed in Section 2.1.3. Vegetation mapping layers that were created in previous studies were used initially to determine the overall extent of vegetation as well as identify the areas that required validation. These layers were then amended to demonstrate the maximum extent of the PGSW community incorporating the field survey results. The final mapping aligned closely with the qualitative mapping by Jacobs discussed in Section 3.3.2.



## 4 Impacts, threats and management issues

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### 4.1 Herbivore impacts

#### 4.1.1 Goats

Feral goats pose a significant threat to biodiversity and are listed as a key threatening process under Commonwealth and NSW state legislation. Goats can have substantial impacts on the environment, including:

- Causing changes to vegetation structure and habitat components.
- Reducing plant species diversity and cover through selective grazing of palatable species.
- Significantly contributing to total grazing pressure.
- Trampling and causing physical damage to sensitive plants.
- Damaging soil surface, leading to loss of cryptogamic crust, important for nutrient cycling, as well as for annual and seasonal flora.
- Competing with native fauna for resources such as food, water and shelter.

The presence of unmanaged goats is considered to be incompatible with the management of areas for the conservation of biodiversity (DEWHA 2008). A general management assumption is that even very low densities of feral goats will be sufficient to inhibit nearly all regeneration of the most palatable species (Parkes et al. 1996). Goats also have the ability to feed on low nutrient fibrous vegetation (e.g. leaves, twigs, bark), allowing them to continue to feed under adverse environmental conditions. Because of this generalist herbivory behaviour, goats are likely to have a more significant impact on PGSW than other herbivores (DEWHA 2008).

Despite the threat to PGSW within the Silverton Wind Farm, goats are considered to be a commodity and are managed by the leaseholders for their income potential. The issues and conflicts associated with this management approach in relation to managing the PGSW are discussed further in the Silverton Wind Farm GMP (Biosis 2018c).

#### 4.1.2 Other herbivores

The presence of too many herbivores may lead to overgrazing and impede the recovery of PGSW, however the current impact of herbivory on PGSW is not fully understood. Herbivores that are likely to be present within the community include goats, rabbits *Oryctolagus cuniculus* and kangaroos (e.g. Red Kangaroo *Macropus rufus*, Eastern Grey Kangaroo *M. giganteus*, Western Grey Kangaroo *M. fuliginosus* and Euro *M. robustus*). A comparison of the grazing pressure by these herbivores is summarised in Table 2.

Most evidence of unmanaged goat impacts on vegetation is anecdotal or is confounded due to the presence of other grazing animals such as kangaroos. Kangaroos and feral goats are of comparable body size and their diets often overlap (Parkes et al. 1996; Landsberg & Stol 1996). Kangaroos, however, are predominantly grass eaters, whereas feral goats are much more general, browsing on shrubs when grass and forbs are not available (Landsberg & Stol 1996). In a study on the spatial distribution of sheep, feral goats and kangaroos in woody rangeland paddocks in north-western NSW by Landsberg & Stol (1996), the results emphasised the extent to which kangaroos differ from goats in their selection of grazing areas despite the similarities in their diet. The results also showed that kangaroos are much more selective about the environment in which they graze, potentially leading to high grazing pressure on their selected grazing areas. Generally, in the woody

rangelands where kangaroos and goats co-exist, goats are frequently the most abundant herbivores and therefore have the most potential for widespread grazing pressure and impacts (Landsberg & Stol 1996).

**Table 2 Herbivore impacts on PGSW**

Herbivore	Impacts on PGSW biodiversity
<b>Goat</b> <i>Capra hircus</i>	Grazing of mature and recovering trees, grasses and shrubs. Herbivory of regenerating/germinating native species. Trampling of vegetation. Destruction and fouling of rocky habitats. Potential weed seed vector. Removal of leaf litter.
<b>European rabbit</b> <i>Oryctolagus cuniculus</i>	Grazing of mature and recovering trees, grasses and shrubs. Herbivory of regenerating/germinating native species. Erosion of Aeolian soils and subgrades through diggings and warren creation. Potential weed seed vector.
<b>Macropod species</b>	Grazing of mature and recovering trees, grasses and shrubs. Herbivory of regenerating/germinating native species. Potential weed seed vector.

## 4.2 Silvertown Wind Farm development

The construction and maintenance of Silvertown Wind Farm is identified in the Community Listing (NSW Scientific Committee 2010) as a potential threat to the community. Direct impacts on PGSW were identified, as well as the risk of increased colonisation opportunities for weeds and possibly feral animals.

### 4.2.1 Project application – 2008 EIS report

The biodiversity assessment report prepared by NGH Environmental (2008b) for the Silvertown Wind Farm EIS identified that the early design drawings would lead to an impact on PGSW of 4.68 hectares. The recognition of the significance of PGSW led to major revisions to the wind farm layout and the proposed impacts were reduced to 0.81 hectares with a further 0.5 hectares for the underground power cables (Figure 6).

However, EHP (2017) found that the calculation of the proposed impact did not appear to:

- evaluate the impact on PGSW that will result from the construction of the crane hardstands and the blade laydown areas
- ensure access track siting is restricted to slopes of less than 17% to ensure safe transport of turbine components
- give regard to the impact on PGSW that will occur during the earthworks such as the cutting-in of hillsides and the filling-in of slopes.

Other than these omissions, the construction impacts from the 2008 EIS approval, based on the current mapping of PGSW, are outlined in Table 3.

**Table 3 Construction impacts – EIS approval 2008**

Impact Type	Area (ha)
Access	1.5
Wind turbine pad	0.8
<b>TOTAL</b>	<b>2.3</b>

#### 4.2.2 Modification No.3

In 2016, improvements in turbine efficiency allowed a modification to the wind farm (MOD 3) to install fewer, larger turbines, with a total of 167 turbines permitted. This resulted in significantly reduced impacts for the proposed wind farm, particularly a reduction in access tracks. The layout in relation to updated vegetation mapping is provided in Figure 7.

However, this construction footprint does not:

- give regard to the impact on PGSW that will occur during the earthworks such as the cutting-in of hillsides and the filling-in of slopes
- take account of the requirement that the maximum gradient of the access track must be 17% to ensure the effective and safe transport of turbine components to their approved locations
- incorporate impacts associated with underground cabling or pole hardstands for overhead cables.

Other than these omissions, the construction impacts from Modification No. 3, based on the current mapping of PGSW, are outlined in Table 4Table 3.

**Table 4 Construction impacts – Mod 3 approval December 2016**

Impact Type	Area (ha)
Access	1.5
Turbine and crane pad	1.4
<b>TOTAL</b>	<b>2.9</b>

#### 4.2.3 Revised development - December 2017

From the 167 turbine locations permitted under the MOD 3 project approval, a 58 turbine layout was prepared to maximise energy capture (EHP 2017). However, prior to construction, an assessment of the pegged layout identified that mapping of PGSW was inaccurate (EHP 2017). Further refinements to the layout were undertaken in Area 7 to reduce impacts to PGSW and approval to commence construction in Area 7 as indicated in Figure 8 was granted on 22 December 2017.

This assessment included the impact of all infrastructure associated with the wind farm (Figure 8) as summarised in Table 5.

**Table 5 Revised development construction impacts – approved December 2017**

Impact Type	Area (ha)
Access	4.3
OHL Hardstand	0.1
Turbine	1.9
UG Cable Reticulation	0.5
<b>TOTAL</b>	<b>6.8</b>

#### 4.2.4 Revised development - March 2018

During construction in Area 7, micro-siting resulted in further refinements to minimise impacts to PGSW. In particular, access to turbines 32 and 33 is now provided from the west of the wind farm, with only underground cabling linking turbines 32 and 34. Additionally, access to turbine 35 was altered, further reducing track construction within PGSW. The layout is provided in Figure 9 and the impacts summarised in Table 6.

**Table 6 Revised development construction impacts – March 2018**

Impact Type	Area (ha)*
Access	2.9
Batter	<0.1 (0.02)
OHL Hardstand	<b>TBC</b>
Turbine	1.6
UG Cable Reticulation	0.8
<b>TOTAL</b>	<b>5.4</b>

\* Clearance impacts on PGSW have been calculated using the most recent data available from GE/Catcon as at 29 March 2018. There will be some revision to the wind farm layout for the final report, but total impacts will be less than 6.81 hectares.

Note: figures in table may not sum to totals, any difference is due to rounding.

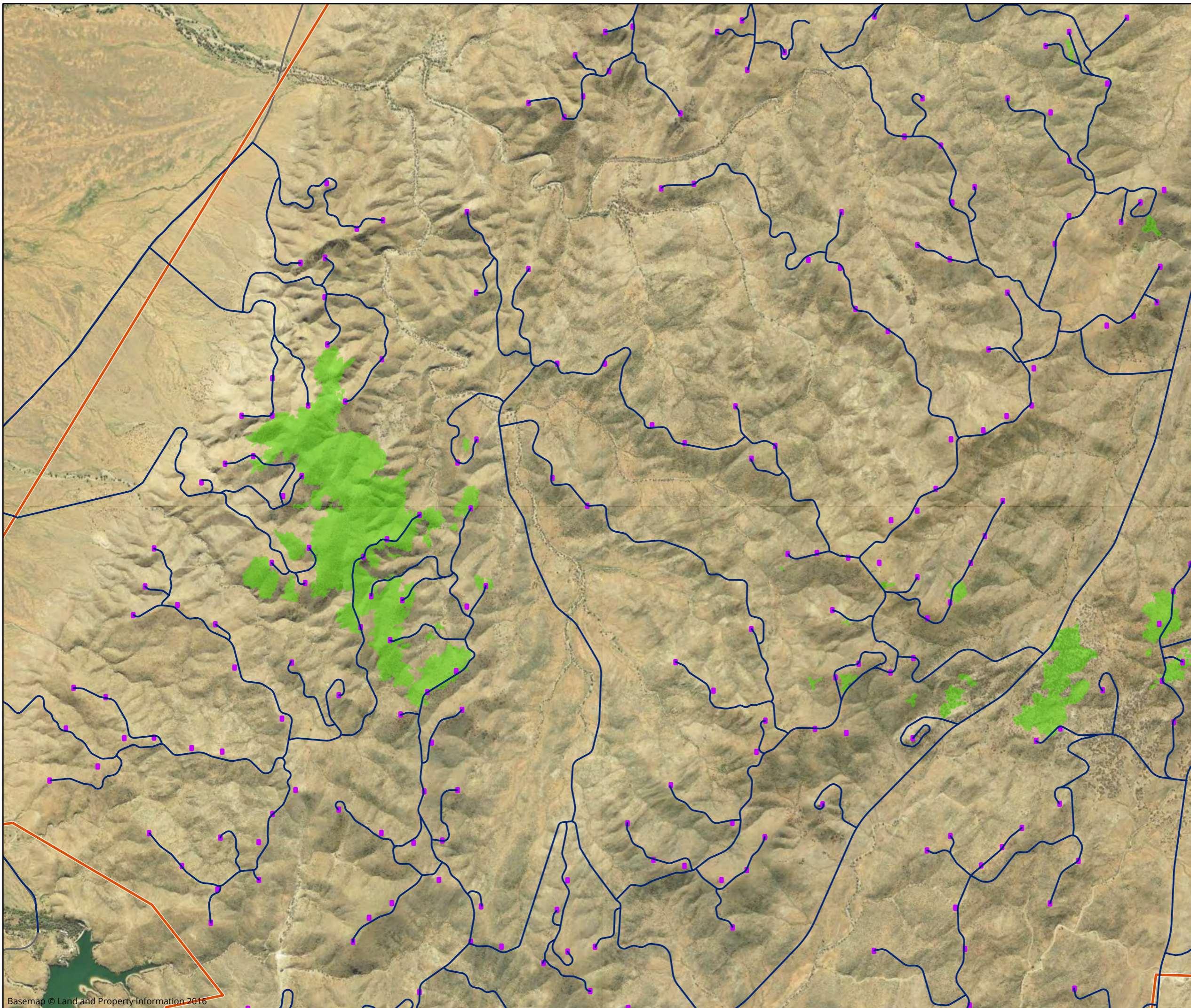
#### 4.2.5 Final development - October 2018

On-site monitoring of construction and survey of the final footprint has captured some additional clearance of the community that was required during construction, as mapped in Figure 10. However, the overall impact to the community is below the approved 6.81 hectares as outlined in Appendix 1.2.

Impact types were not readily separated as in previous iterations, as cabling and tracks have been aligned where possible to reduce impacts and hence impacts overlap.

**Table 7 Final construction impacts – October 2018**

Impact Type	Area (ha)*
Eucalypts only	0.26
Porcupine grass only	0.74
Porcupine Grass with eucalypts	5.39
<b>TOTAL</b>	<b>6.39</b>



**Legend**

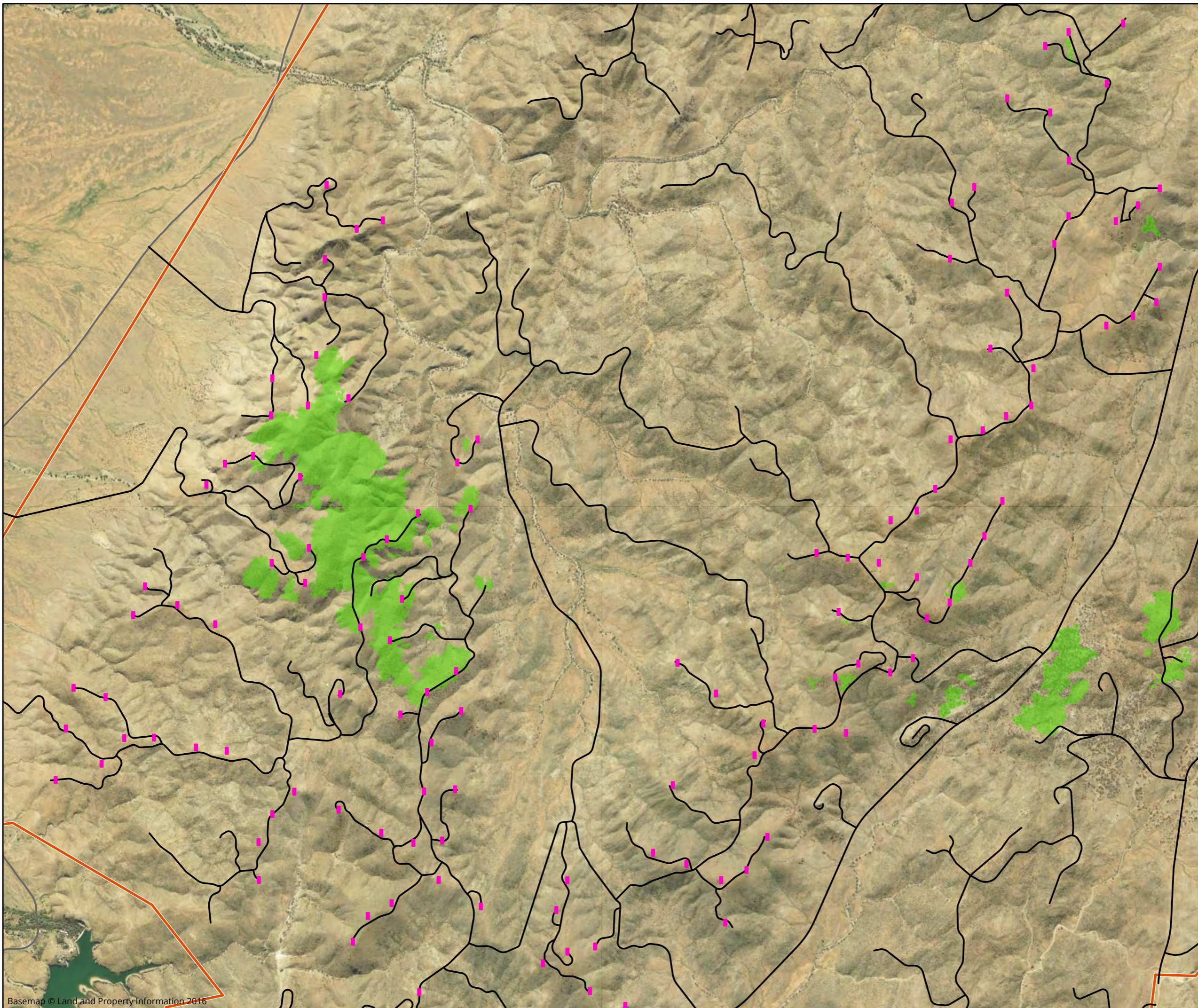
- Study area
- PGSW (Biosis 2017)
- Proposed windfarm layout (2008)**
- Turbine pad
- Access

Figure 6 – Proposed construction impacts (2008 EIS)

0 1,000 2,000  
Metres  
Scale 1:37,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
Checked by RW, drawn by ARL  
Last edited by alongmire on 05 September 2018  
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**Legend**

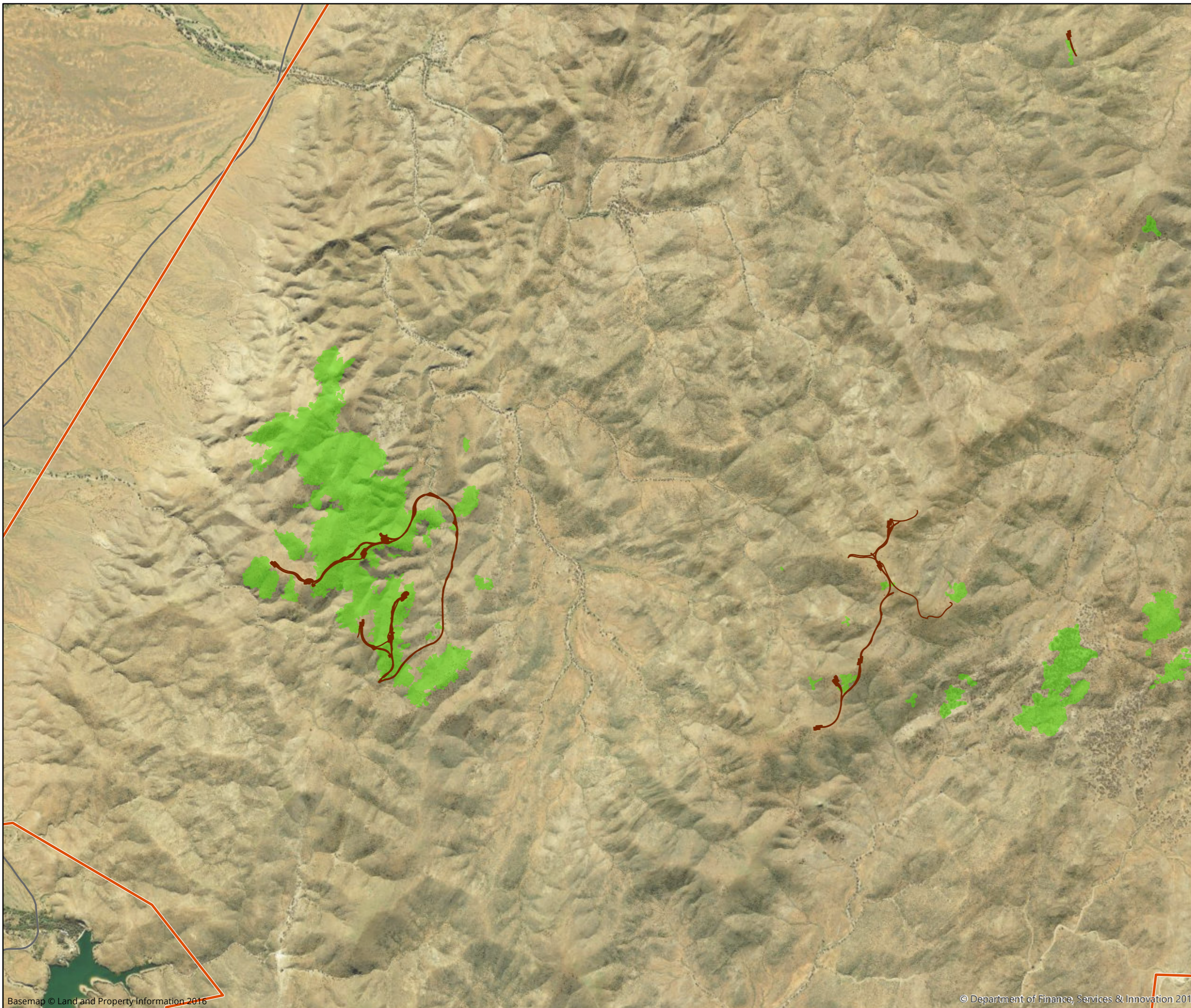
- Study area
- PGSW (Biosis 2017)
- Proposed windfarm layout (2016)**
- Turbine pad
- Access

Figure 7 – Proposed construction Impacts – MOD 3 approved layout December 2016

0 1,000 2,000  
 Metres  
 Scale 1:37,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
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 Last edited by alongmire on 05 September 2018  
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**Legend**




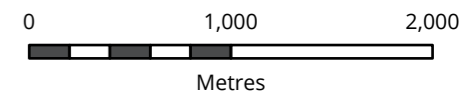
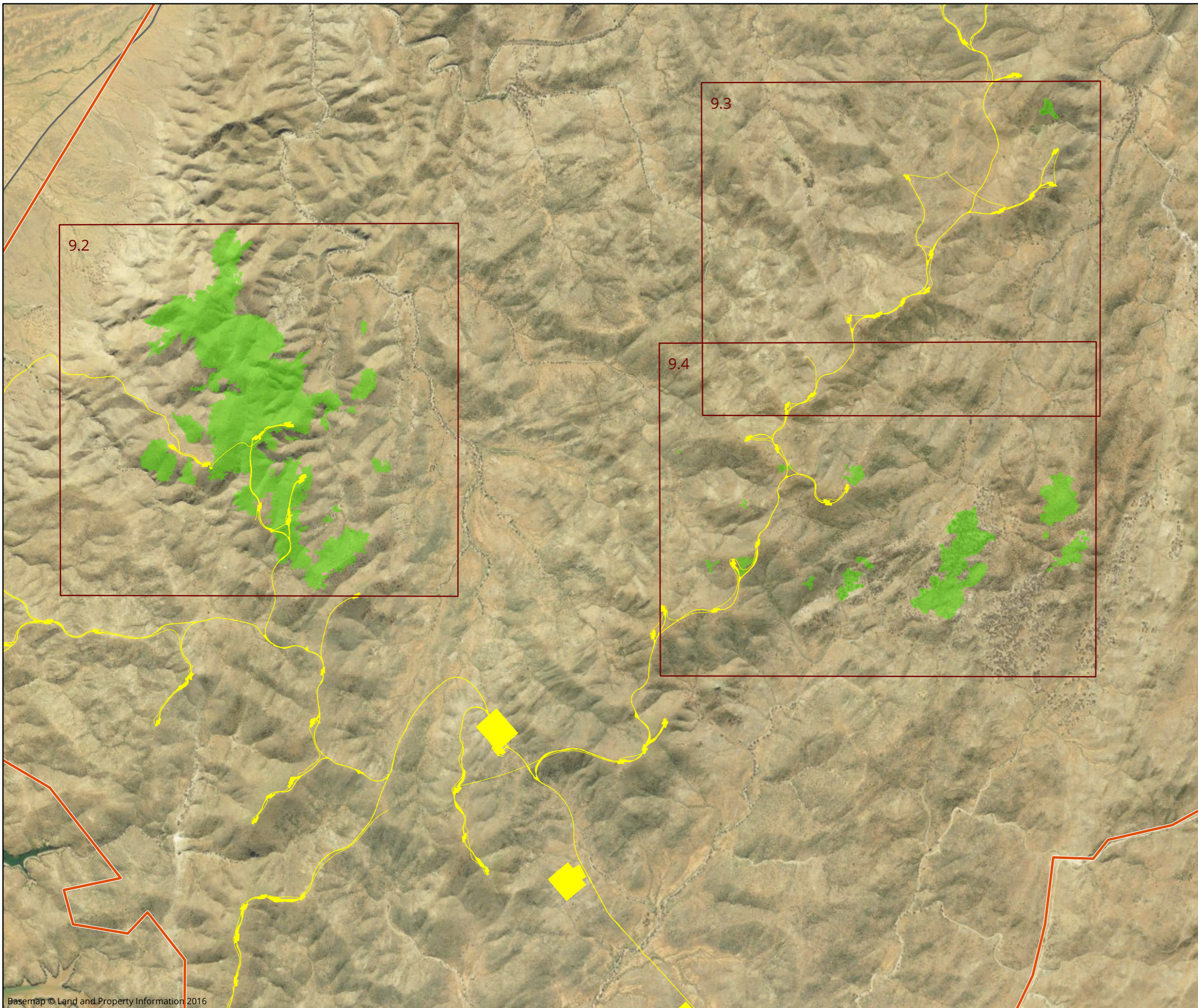
-  Study area
-  PGSW (Biosis 2017)
-  Proposed infrastructure

Figure 8 – Proposed construction impacts affecting PGSW – December 2017



Scale 1:37,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54





**Legend**

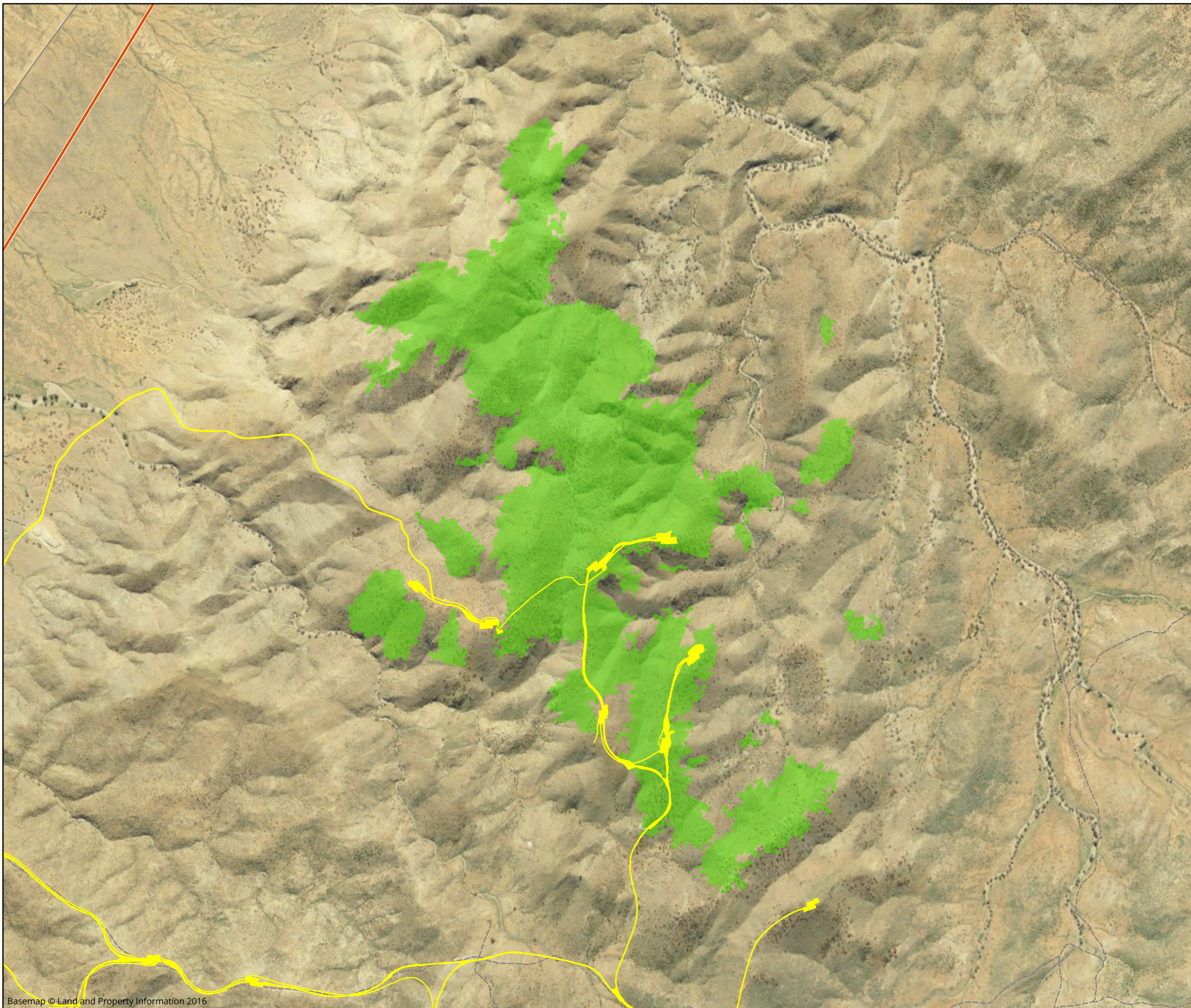
- Study area
- PGSW (Biosis 2017)
- Infrastructure proposed or constructed to March 2018

Figure 9.1 – Construction Impacts as at March 2018 - overview

0 1,000 2,000  
 Metres  
 Scale 1:37,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54







**Legend**




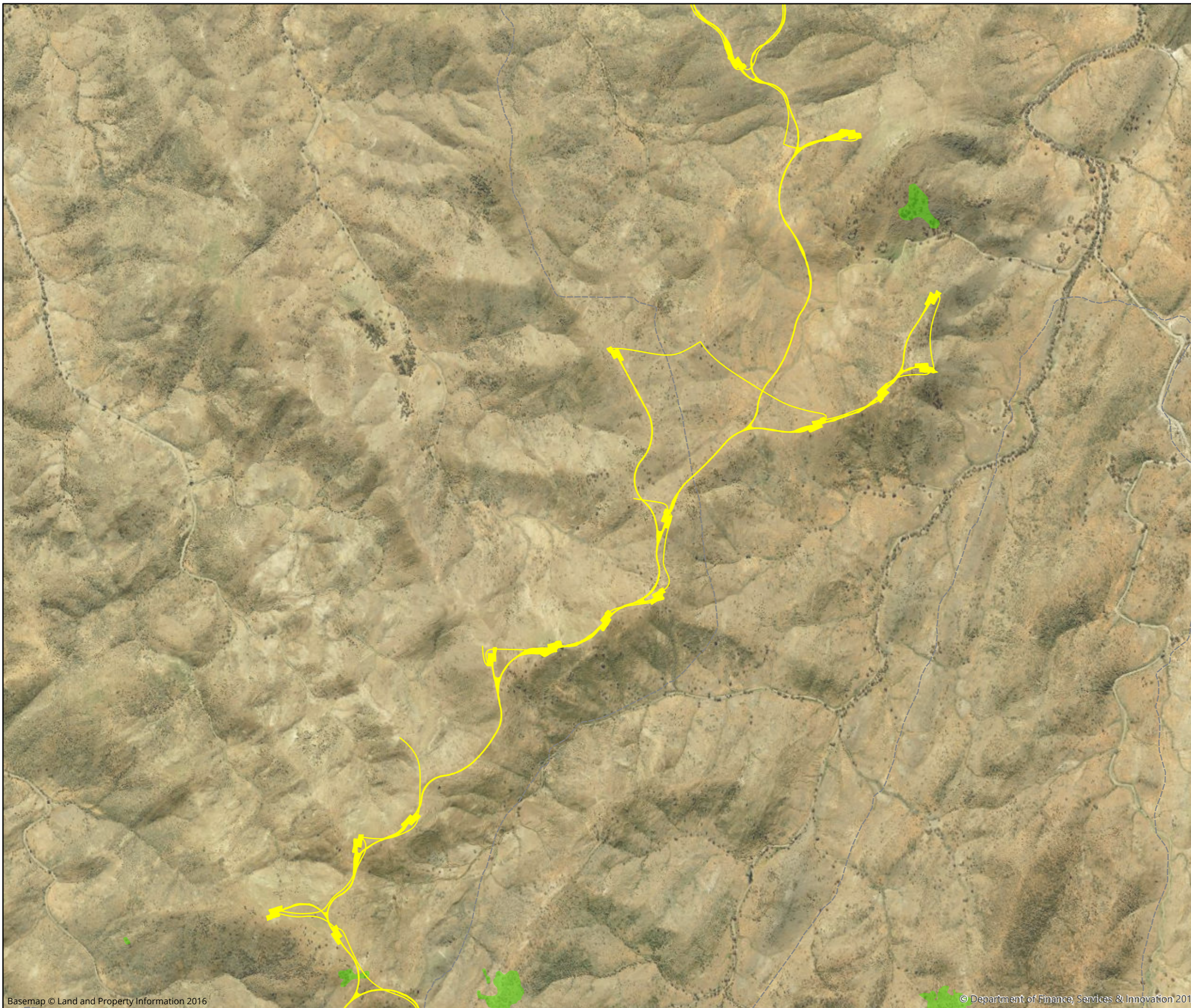
-  Study area
-  PGSW (Biosis 2017)
-  Infrastructure proposed or constructed to March 2018

Figure 9.2 – Construction Impacts as at March 2018 - west

0 1,000  
Metres  
Scale 1:17,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54





**Legend**




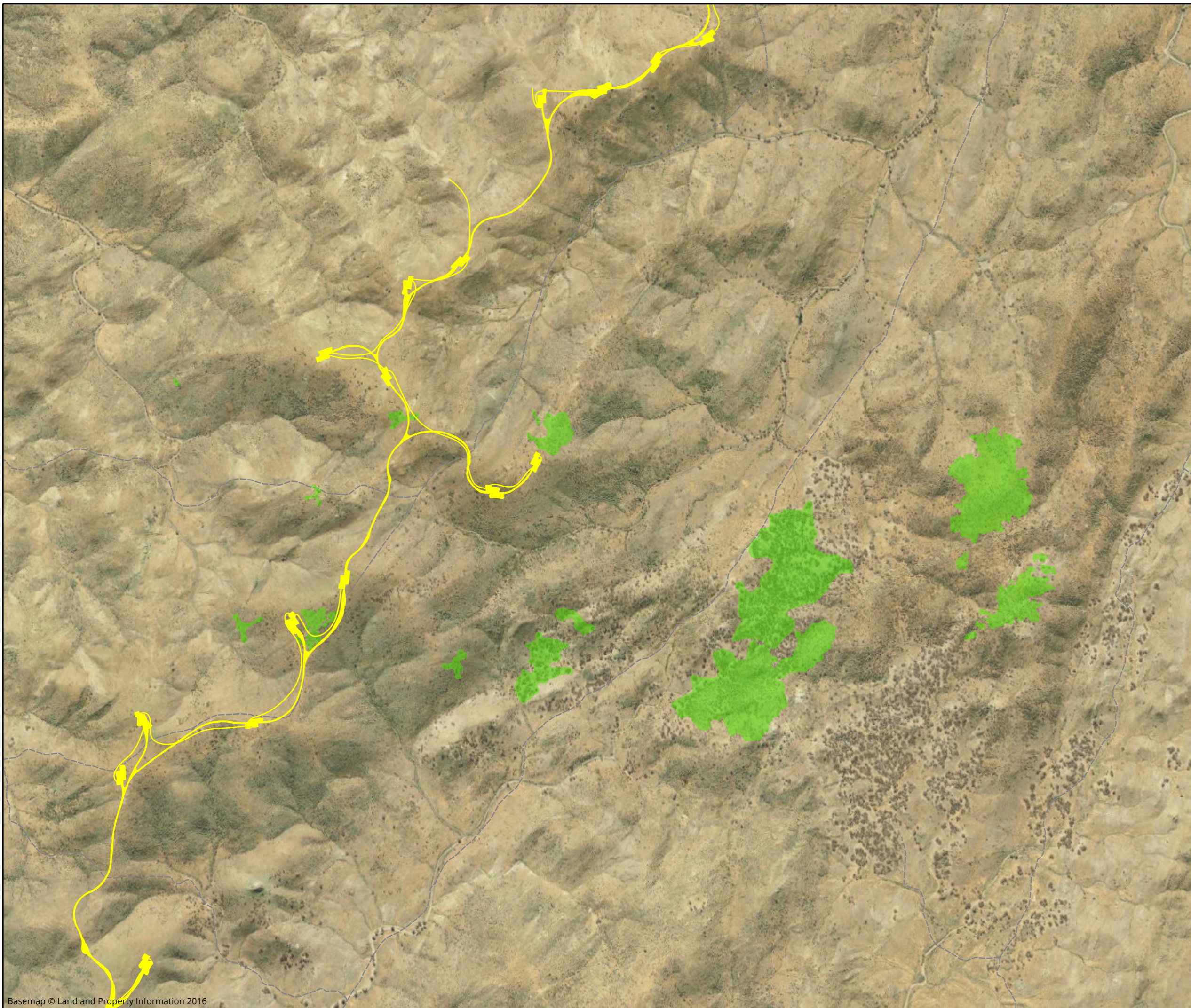
-  Study area
-  PGSW (Biosis 2017)
-  Infrastructure proposed or constructed to March 2018

Figure 9.3 – Construction Impacts as at March 2018 - north-east



Metres  
Scale 1:17,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54





**Legend**




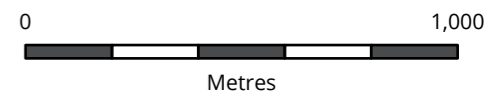
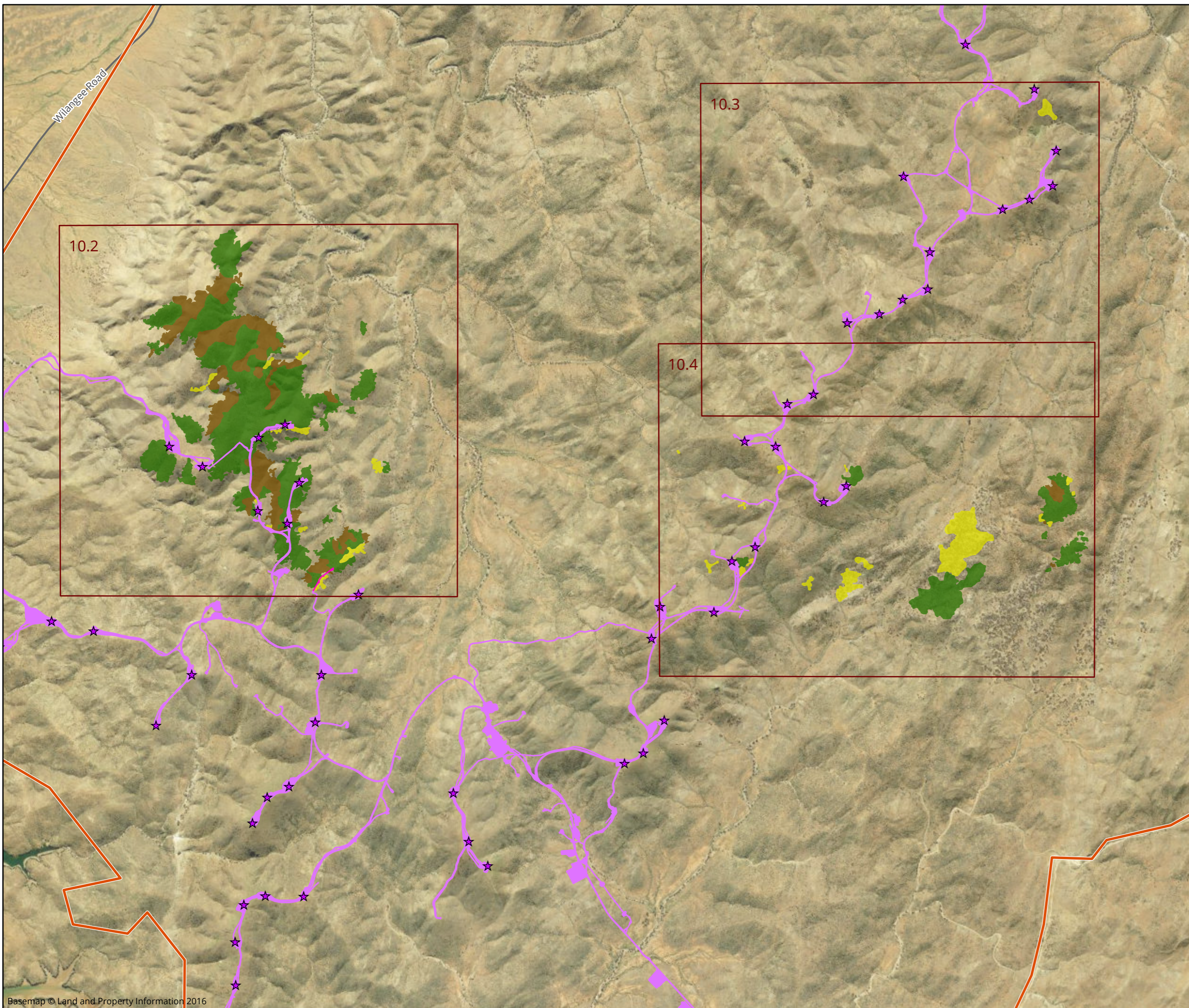
-  Study area
-  PGSW (Biosis 2017)
-  Infrastructure proposed or constructed to March 2018

Figure 9.4 – Construction Impacts as at March 2018 - south-east



Scale 1:17,500 @ A3  
Coordinate System: GDA 1994 MGA Zone 54

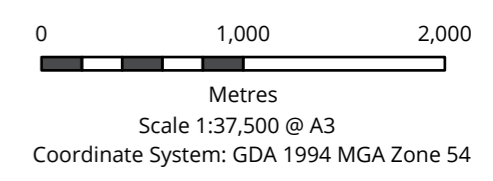




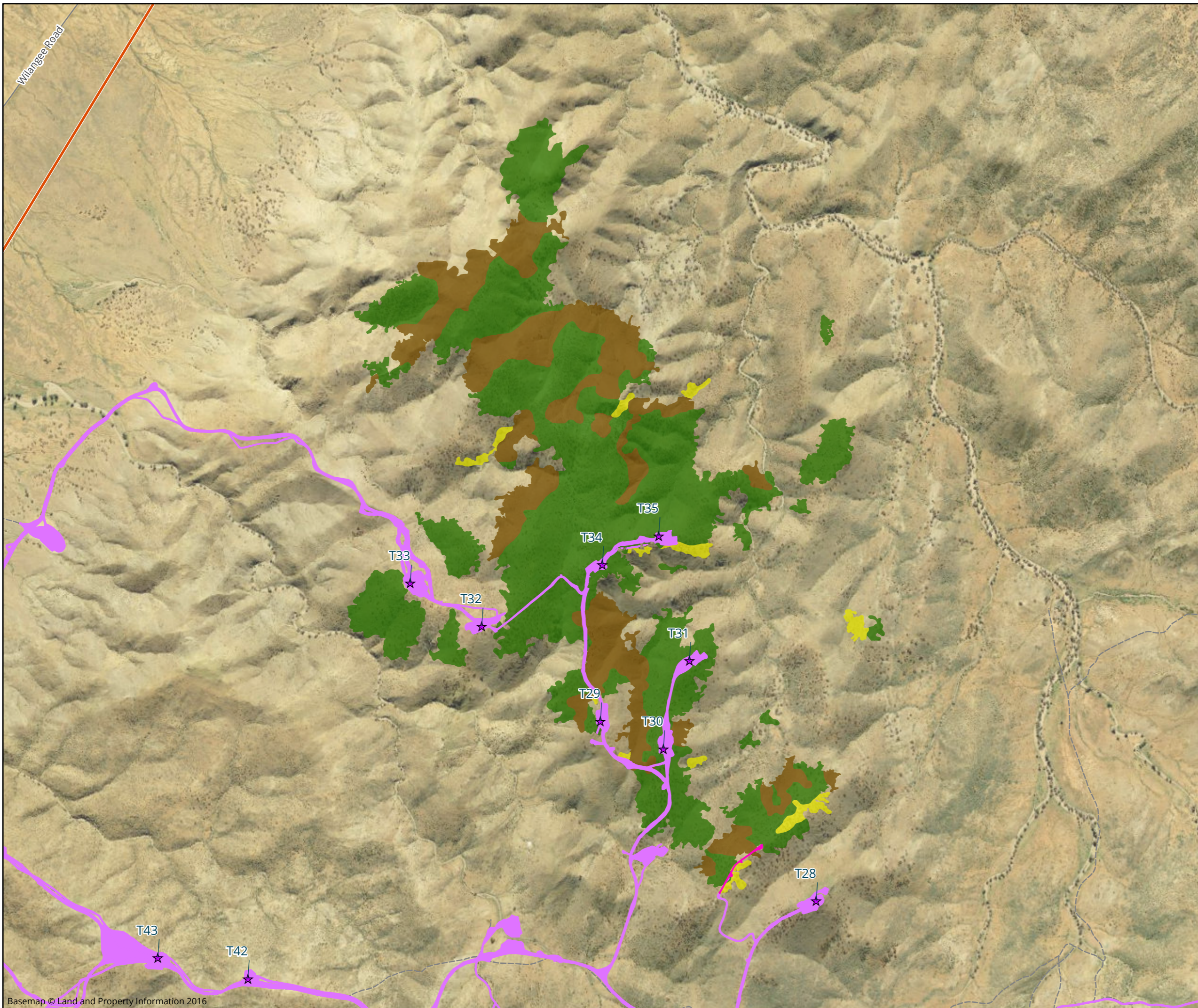
**Legend**

- Study area
  - Infrastructure
  - Pre-existing road
  - ★ Turbine
- PGSW structural variants**
- Porcupine grass with eucalypts
  - Porcupine grass only
  - Eucalypts only

Figure 10.1 – Final construction impacts October 2018 - overview



Matter 26380  
 Checked by, drawn by ARL  
 Last edited by jturner on 12 December 2018  
 Location:  
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**Legend**

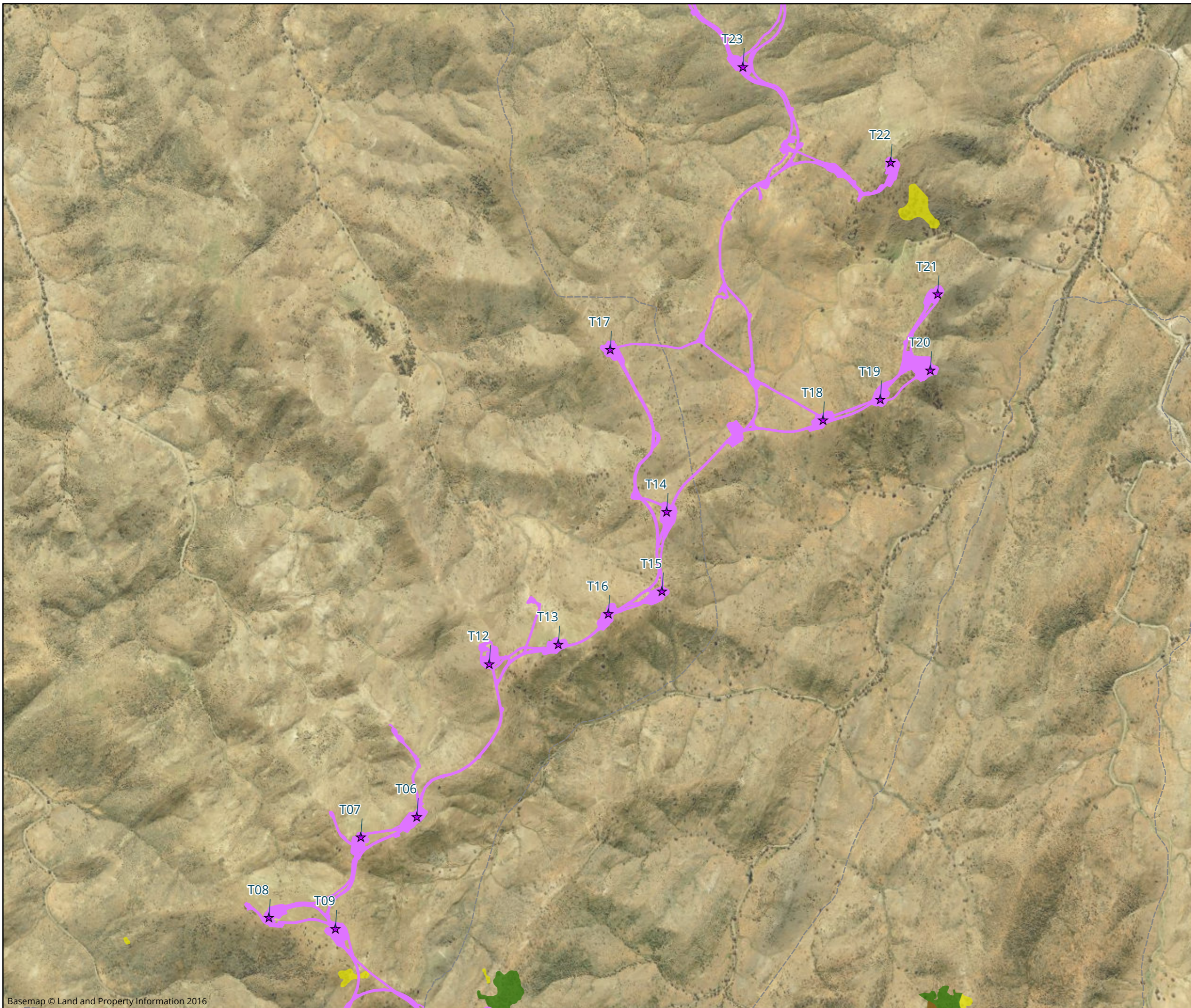
- Study area
  - Infrastructure
  - Pre-existing road
  - Turbine
- PGSW structural variants**
- Porcupine grass with eucalypts
  - Porcupine grass only
  - Eucalypts only

Figure 10.2 – Final construction impacts October 2018 - west

0 1,000  
 Metres  
 Scale 1:17,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
 Checked by, drawn by ARL  
 Last edited by jturner on 12 December 2018  
 Location:  
 \\bio-data-01\matters\26380s\26380\Mapping\26380\_PGSW\_GMP



**Legend**









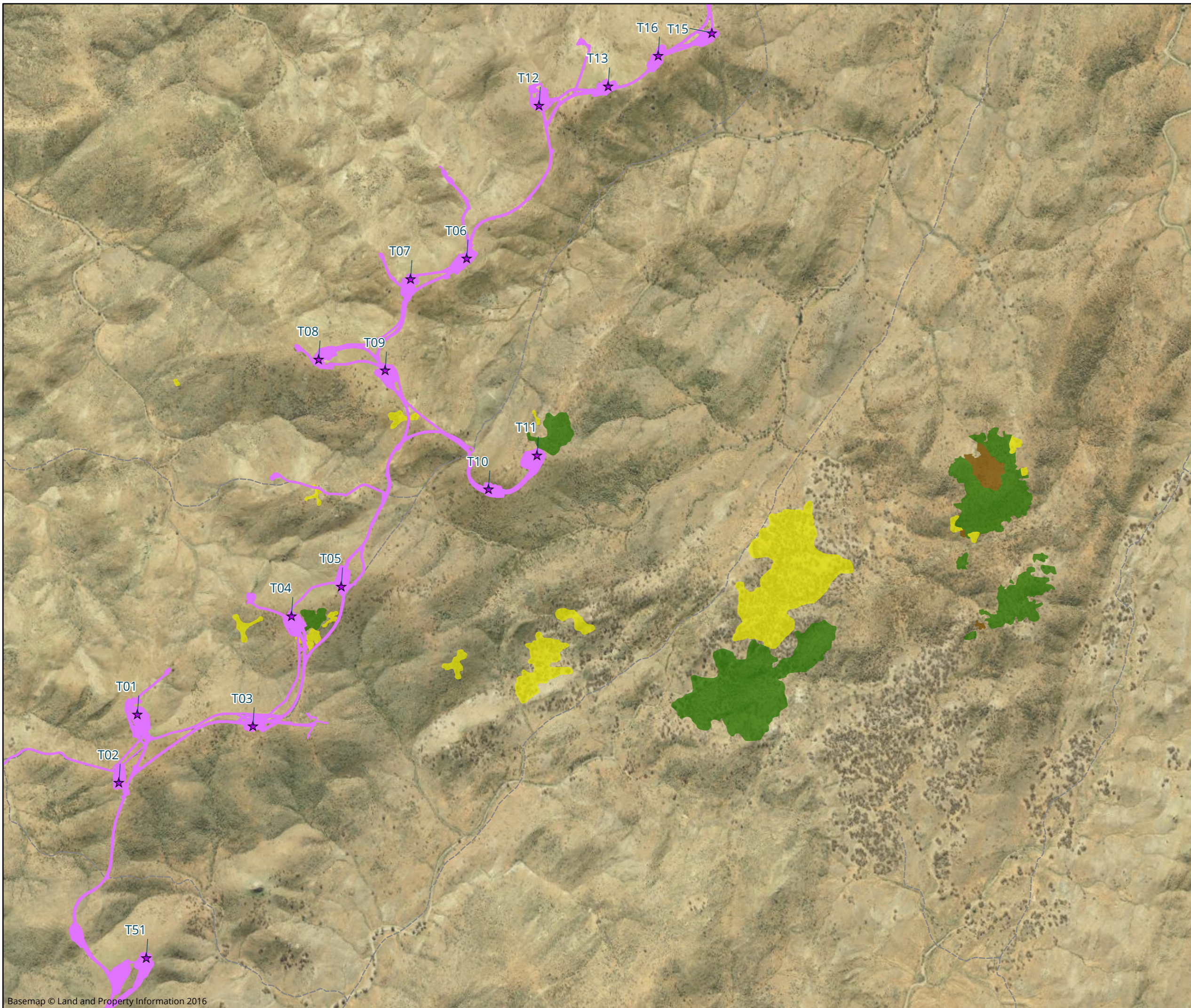
-  Study area
  -  Infrastructure
  -  Pre-existing road
  -  Turbine
- PGSW structural variants**
-  Porcupine grass with eucalypts
  -  Porcupine grass only
  -  Eucalypts only

Figure 10.3 – Final construction impacts October 2018 - north-east

0 1,000  
  
 Metres  
 Scale 1:17,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



Matter 26380  
 Checked by: drawn by ARL  
 Last edited by jturner on 12 December 2018  
 Location:  
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**Legend**

- Study area
  - Infrastructure
  - Pre-existing road
  - Turbine
- PGSW structural variants**
- Porcupine grass with eucalypts
  - Porcupine grass only
  - Eucalypts only

Figure 10.4 – Final construction impacts October 2018 - south-east

0 1,000  
 Metres  
 Scale 1:17,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



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 Last edited by jturner on 12 December 2018  
 Location:  
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#### 4.2.6 Avoidance/minimisation and micro-siting

As discussed above, preliminary layouts did not consider detailed impacts to the community, particularly the significant impacts associated with undertaking civil works in hilly terrain with steep slopes and relatively narrow ridgelines. Therefore, although subsequent designs have generally reduced track extent within the community, the calculated impacts have increased due to accounting for the construction of cuttings and batters.

During the design phase for the final MOD 3 layout, the consortium's project manager and the project design manager inspected the proposed access track alignment to minimise impact to PGSW by investigating options to reduce the total access track length and ensuring micro-siting turbines outside PGSW where terrain allowed.

The final design (Figure 10) has reduced impacts from the December 2017 approval by:

- Providing access to turbines 32 and 33 from the west.
- Removing track access between turbines 32 and 34, so impacts reduced to underground cabling only.
- Removing track access between turbines 30 and 35, hence reducing impacts to PGSW north-west of turbine 35.
- The cable route has been updated with cable placement as close as possible to the access roads.

#### 4.2.7 Limitations and assumptions

Clearance impacts on vegetation have been calculated using the final 'as constructed' survey data provided by GE/Catcon on the 2 October 2018, combined with data captured during on-site monitoring of construction in Area 7 by Biosis.

### 4.3 Track management and maintenance

Porcupine Grass Sparse Woodland occurs on the highest and steepest slopes within the wind farm. Therefore, dirt access roads throughout the study area require careful management to prevent the initiation of erosion and to ensure sediment does not runoff into the community. Runoff may smother vegetation and sediment may introduce weed propagules, as well as providing a disturbed soil surface susceptible to weed invasion.

### 4.4 Invasion by exotic weed species

As outlined in Section 2.1.1, PGSW has a low incidence of exotic weed species (Appendix 3). However, a number of invasive weeds have been recorded in the study area in surrounding vegetation communities. Priority weeds identified include Saffron Thistle *Carthamus lanatus*, Patterson's Curse *Echium plantagineum* and African Boxthorn. These species have potential to spread into PGSW.

Disturbed ground resulting from construction and subsequent scheduled maintenance activities during operation of the wind farm increase the colonisation opportunities for weeds within the study area.

### 4.5 Mining or quarrying

Silverton historically was a key mining area in Western NSW, where areas such as the Barrier Range supported small townships for the mining boom in 1880 (Kearns 1973). Today, most of the current operations are located within the Broken Hill region extracting zinc, lead and silver.



Impacts associated with any proposed leases would include:

- Open cut mining to impact on PGSW via vegetation removal, changes in hydrology, increased incidence of exotic flora and fauna species.
- Long wall mining options may alter local hydrological systems and result in slumping of the bedrock.

## 4.6 Harvesting or collecting of key species

The PCT community profile report (PCT359, OEH 2017b) suggests that past disturbance of PGSW may have included cutting of trees for fencing and use in towns such as Silverton. Ongoing impacts of this type are considered unlikely.

## 4.7 Fire regimes

According to NSW VIS: Classification Version 2.1, (PCT359, Appendix 4) fire is infrequent in the community. It notes that Porcupine Grass could burn occasionally depending on fuel loads.

Studies of fire regimes in Mallee – Porcupine Grass communities in western NSW have identified that fires are typically small and patchy. Although the Porcupine Grass is highly flammable, the perennial fuels of the hummocks and the leaf litter, stems and branches of the associated eucalypt species are discontinuous and cannot carry extensive fires (Noble and Vines 1993).

Extensive mallee wildfires typically occur following above-average rainfall seasons, often associated with La Niña conditions. The rainfall results in the production of dense, aerated, ephemeral fuels of species such as Balcarra Speargrass *Austrostipa nitida* and other Speargrass species. Even the abundant seed fall from speargrass can provide a dense mat of fine fuel. These annual fuels link patches of the perennial fuels and combined, enable fire to readily traverse bare ground formerly separating stands of Porcupine Grass (Noble and Vines 1993). Once senescent, the short-lived grasses decompose and fuel loads again become insufficient to carry a fire.

The relationship between fire, grazing and climate are the three major factors regulating vegetation dynamics in arid and semi-arid rangeland ecosystems. Significant rainfall events trigger the flowering and seed set which may also be followed by fire if accumulated biomass is ignited by lightning or another source. The suitability of post-fire rainfall largely drives the success or failure of germination and seedling establishment (Noble and Vines 1993).

Although management of herbivore grazing is anticipated to increase fuel loads during high rainfall events, it is expected that the community will not carry a major fire in most seasons. Noble and Vines (1993) note that although conditions may be conducive to the spread of fire on cycles of 15-20 years, there may not always be a source of ignition.

Many species occurring within Mallee – Porcupine Grass communities require intermediate to late successional vegetation (e.g. areas of long-unburnt 35-100 years vegetation) before habitat becomes suitable (Haslem et al. 2011). Additionally, many species in this mallee ecosystem type exhibit great longevity coupled with an ability to resprout following fire (e.g. *Eucalyptus*, *Triodia*) or are ephemeral with a persistent soil seed bank (Giljohann et al. 2015). Therefore, it is important to ensure that areas of long-unburnt vegetation persist within the landscape.

Maintaining some vegetation in early post-fire conditions as a 'fire-break' may prevent extensive wildfire (e.g. >100 000 ha) and facilitate the persistence of a greater proportion of the landscape at more advanced stages along the post-fire chronosequence (Sandell et al. 2006, cited in Giljohann et al. 2015). However, the

use of prescribed fire over large areas demands careful consideration of the overall amount and spatial distribution of vegetation of all fire-ages (Clarke 2008, cited in Giljohann et al. 2015), and recognition that some habitat components continue to develop for at least a century after fire (Haslem et. al 2011). Therefore, any strategic use of prescribed fire to reduce the risk of wildfire involves a trade-off and must be carefully considered before being implemented.

Given the very small area of occupancy of this plant community, the use of prescribed fire is not recommended due to the potential or possibility for it to consume a large proportion of the plant community.

#### **4.8 Climate change and altered climatic patterns**

Reduced rainfall, higher temperatures and evaporative rates associated with climate change may affect the community (NSW Scientific Committee 2010), and 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the BC Act.

The floristic assemblage of PGSW is heavily influenced by seasonal precipitation, or lack thereof. During significant periods of drought, key species such as Porcupine Grass may senesce (Sass et al. 2011). Similarly, decline of canopy species has been recorded in similar circumstances.

The interactive effects of grazing by feral goats and altered climatic conditions are unknown but are likely to result in reduced vegetation condition and species diversity.

## 5 Proposed recovery objectives, actions and performance criteria

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### 5.1 Overall objective

The removal of PGSW from the schedules of the BC Act is not a recovery objective due to the naturally restricted extent of the community. However improved management of PGSW is proposed with a primary focus on the reduction of grazing and browsing by goats, whilst ensuring exotic weed species do not spread within the community.

### 5.2 Key outputs/actions

#### 5.2.1 Monitoring

Monitoring will begin with baseline data collection (spring 2018) followed by a program of management actions, on-going annual monitoring and adaptive management responses as outlined in the BAMP (Biosis 2018b). The monitoring program will be reviewed in 2021, following three years of management to ensure there is a net gain in the conservation value of PGSW.

Twenty survey sites (20 x 20 metre quadrat and an associated 5 x 5 metre subplot) are to be stratified proportionally within the three known variants of the community.

- Vegetation condition (floristics and structure) will be measured in the 20 x 20 metre quadrat using NSW vegetation survey standards (DECCW 2009).
- Woody species occur in low abundance within the community. Therefore an assessment of all woody individuals within the 20 x 20 metre quadrats will be undertaken in line with the method used by AREA Environmental Consultants and Communication (2017) to assess the browsing impacts of goats in Mutawintji NP.

Absolute abundances of all species will be recorded in the 5 x 5 metre subplots. This will improve the ability to identify individual species responses to management actions, particularly of annual and ephemeral species. Herbivore abundance will also be monitored through scat counts within the subplots and estimates of goat populations from leaseholders within the Silverton Wind Farm site. Details of the monitoring are provided in the BAMP (Biosis 2018b).

#### 5.2.2 Protection of the community

A goat fence was erected around the majority of the PGSW by Blore lease holding in May 2014 as part of the Mundi Mundi Conservation Project funded by the Total Grazing Pressure Program, Western LLS (Figure 2). The fence was erected to temporarily exclude and manage goats for the purposes of protecting PGSW and endangered Barrier Range Dragon. This fence will allow improved management of feral goats within PGSW as outlined in Section 5.2.4 and the GMP (Biosis 2018c).

#### 5.2.3 Track management and maintenance

For all roads within the study area, inspections are to occur on a 6-monthly basis in accordance with VMP (Biosis 2018d). Additional inspections will be undertaken after significant rain events (>25 millimetres), farmers' works that affect or alter the roads, significant traffic movements and the like. Any degraded roads, erosion control or sediment structures identified within the site should be reinstated back to construction standards as per the VMP.

The management of tracks within the wind farm is detailed within the VMP (Biosis 2018d). Due to the siting of tracks within and above the PGSW community, the following measures will be implemented to minimise the impact of tracks on the community:

- For all areas uphill of or adjacent to PGSW (Figure 11), tracks will be inspected monthly and within a week after significant rainfall (>25 mm) events.
- Tracks will be inspected weekly in areas where construction is continuing.
- Disturbance associated with any upgrade and maintenance activities will be limited to the existing road, drainage and batter areas.
- There should be no impact to areas of adjacent vegetation and habitat.
- Stockpiles or excavated material will not be placed uphill of or adjacent to areas of PGSW (as shown in Figure 11).
- Erosion and sediment controls will be implemented where there is a risk of runoff occurring.
- All biomass and spoil derived via road and batter upgrades are to be monitored for opportunistic weed seed germination and treated as a part of the annual weed management program in accordance with Section 4.4.

#### 5.2.4 Grazing management

Since the construction of a goat fence around PGSW in May 2014 to exclude and manage goats for the purposes of protecting the PGSW and endangered Barrier Range Dragon, an average of approximately 500 goats have been grazed in the PGSW plot. When goats are grazed in the PGSW, a draft is taken approximately every two months. Since 2014, goats have been excluded during the following periods:

- June 2014 to April 2015
- September 2015 to February 2016
- August 2017 to December 2018.

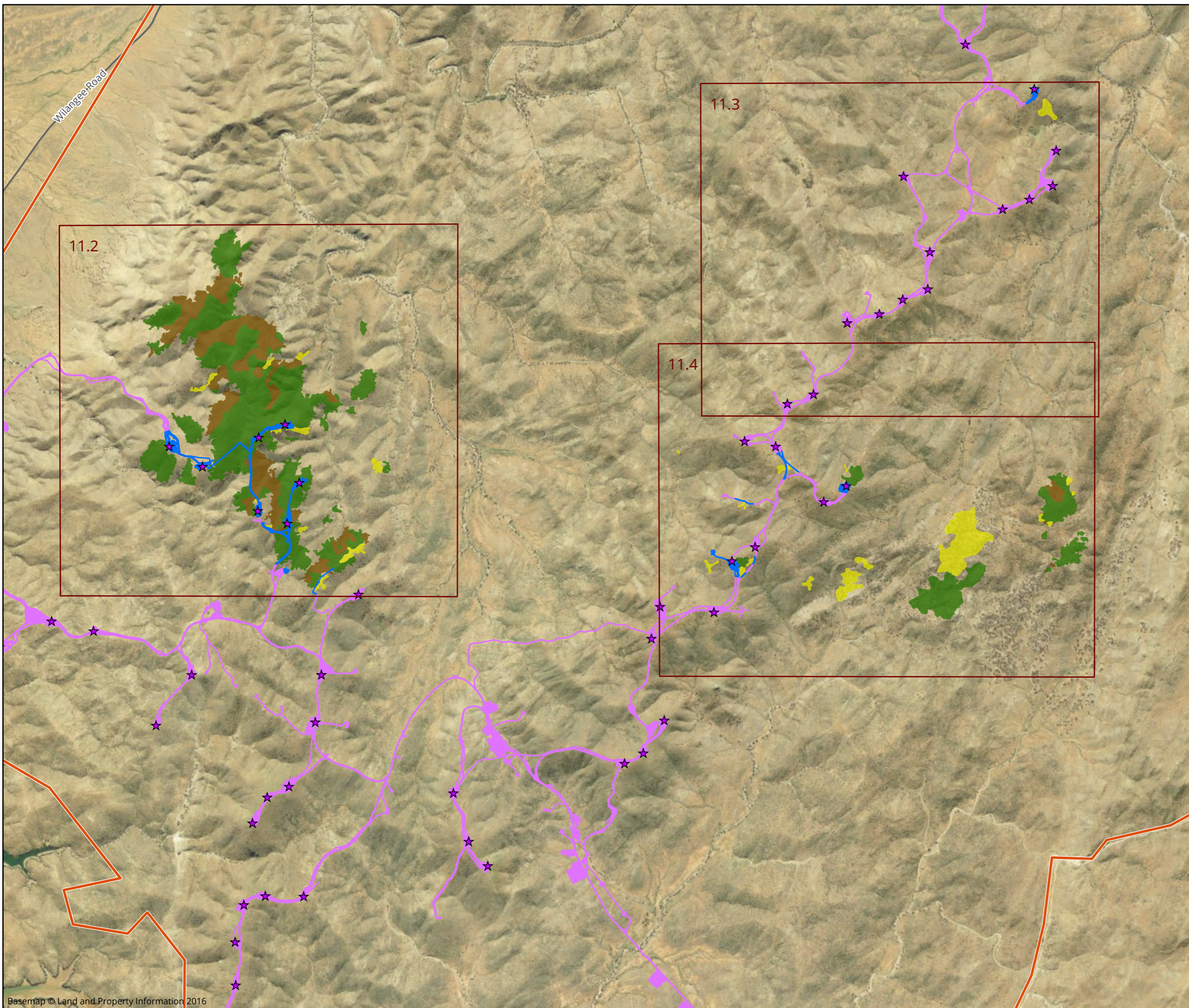
This equates to 33 months out of 55, approximately 60% of the total time since fence construction.

Grazing by feral goats will primarily be reduced within PGSW through the implementation of exclusion periods (utilising the existing goat fence), trapping at existing water points and mustering as outlined in the GMP (Biosis 2018c). Goats will be excluded from the fenced PGSW area from June to January (inclusive) each year for the next three years, at which time the BAMP will be reviewed (Biosis 20108a) unless climatic conditions are such that ground cover increases significantly. If there is greater than 40 % ground cover of annual species, the leaseholder will allow seed production to occur, and then reserves the right to utilise the vegetation as feed. Goats will be excluded when the cover of these annual species falls to less than 40 %.

If grazing is to be initiated during the exclusion period:

- The leaseholder Blore will notify GE operational staff/project ecologist that ground cover is greater than 40 % and seeding of ephemeral species has occurred.
- Photopoint monitoring will be initiated and submitted to the project ecologist on a fortnightly basis to confirm the level of vegetation cover is maintained above 40%.

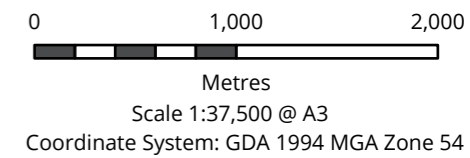
Goats may also need to be excluded from the fenced area at other times during the February to May period if the results of on-going monitoring indicate that the PGSW is not recovering to the desired level, if the climatic conditions are poor (e.g. low rainfall), and for at least three years following fire. On-going mustering will also need to occur in the fenced PGSW area to actively remove any stray goats during the exclusion period.

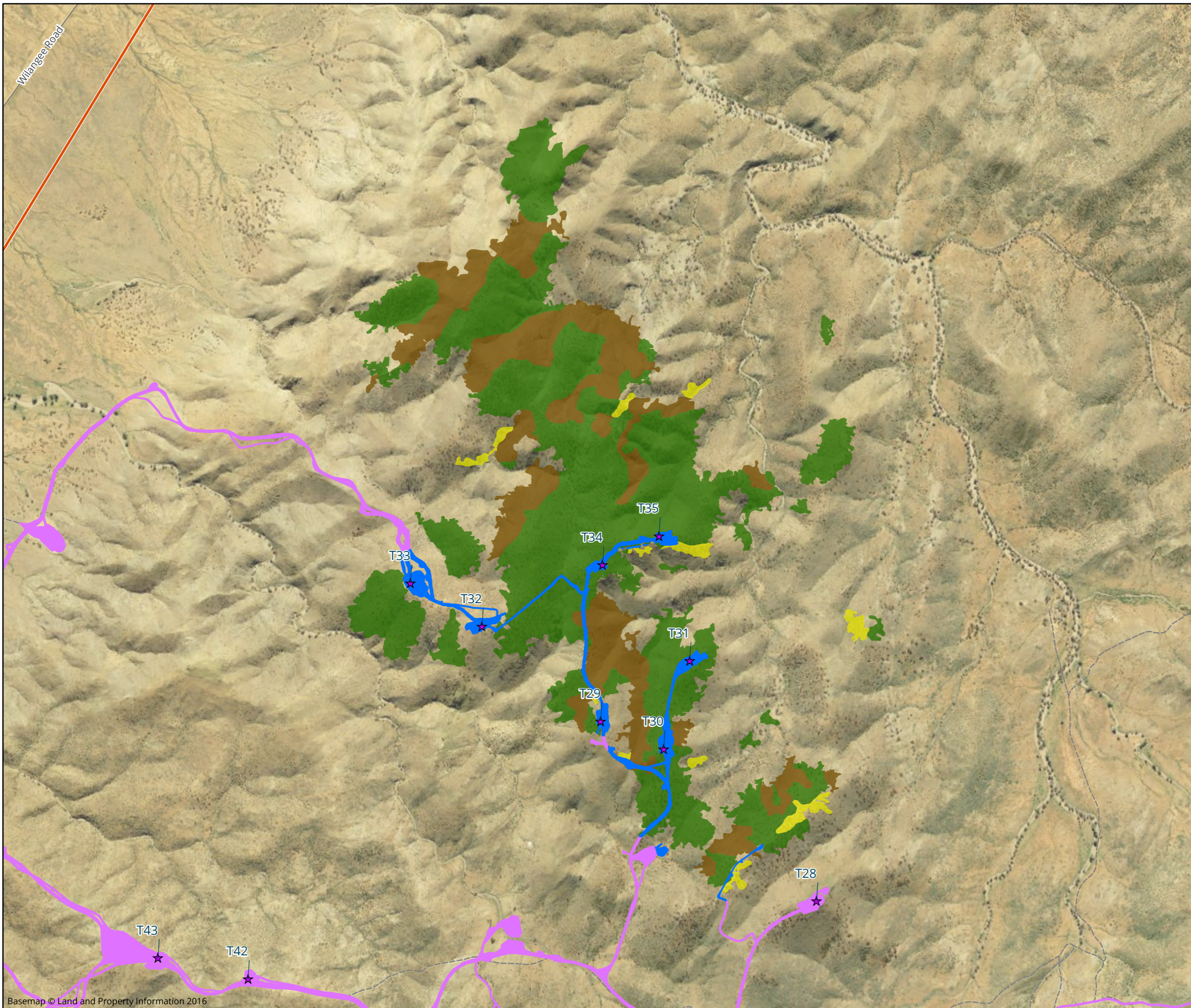


**Legend**

- Study area
  - ★ Turbine
  - Infrastructure with no PGSW downslope
  - Infrastructure with PGSW downslope
- PGSW structural variants**
- Porcupine grass with eucalypts
  - Porcupine grass only
  - Eucalypts only

Figure 11.1 – Infrastructure with PGSW downslope - overview





**Legend**

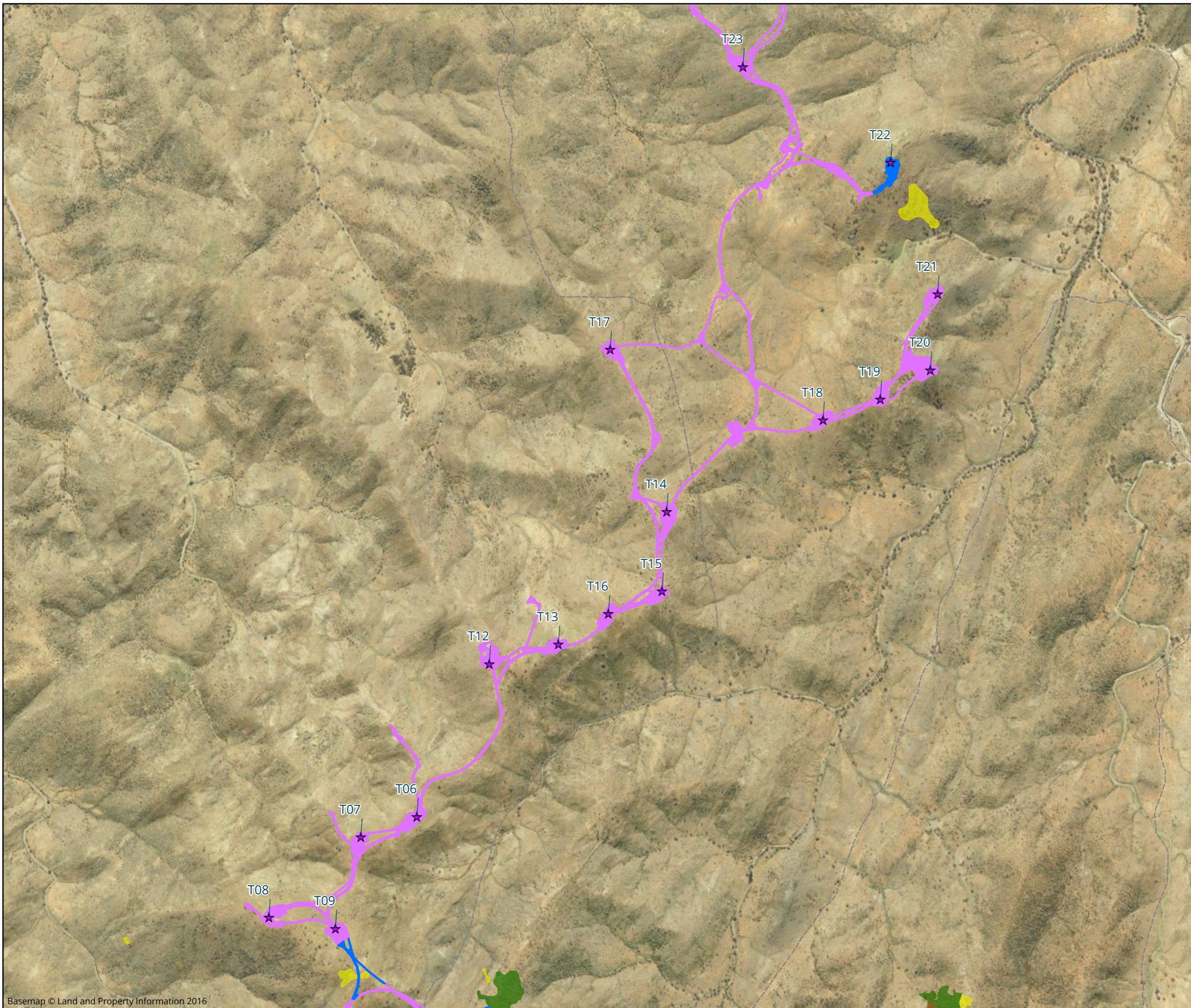
- ▭ Study area
  - ★ Turbine
  - ▭ Infrastructure with no PGSW downslope
  - ▭ Infrastructure with PGSW downslope
- PGSW structural variants**
- ▭ Porcupine grass with eucalypts
  - ▭ Porcupine grass only
  - ▭ Eucalypts only

Figure 11.2 - Infrastructure with PGSW downslope - west

0 1,000  
 Metres  
 Scale 1:17,500 @ A3  
 Coordinate System: GDA 1994 MGA Zone 54



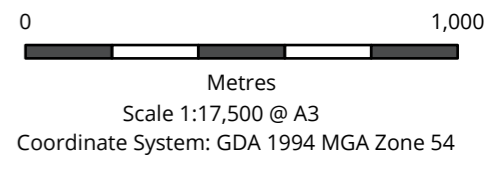
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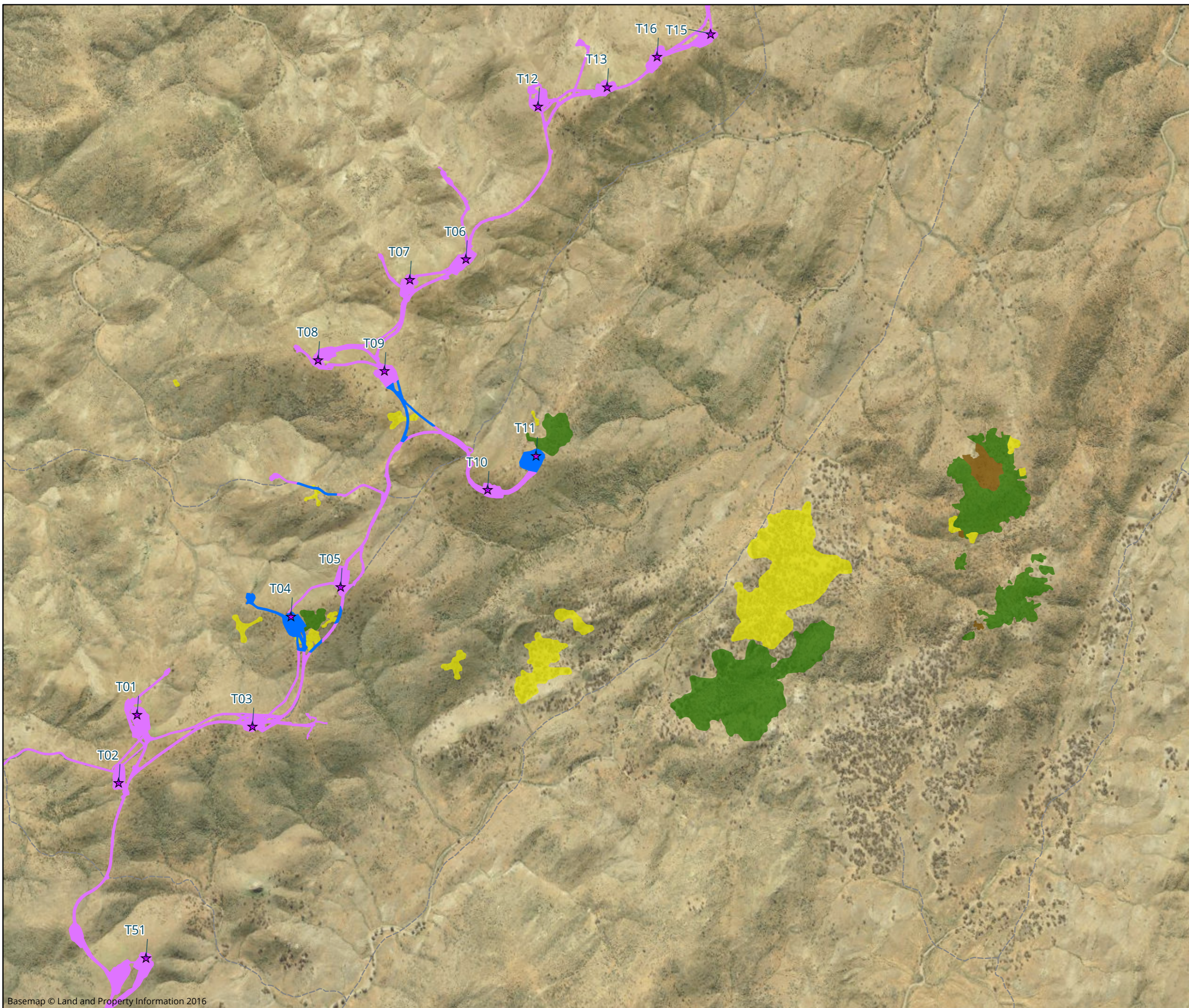
**Legend**

- ▭ Study area
  - ★ Turbine
  - ▬ Infrastructure with no PGSW downslope
  - ▬ Infrastructure with PGSW downslope
- PGSW structural variants**
- ▭ Porcupine grass with eucalypts
  - ▭ Porcupine grass only
  - ▭ Eucalypts only

Figure 11.3 – Infrastructure with PGSW downslope - north-east



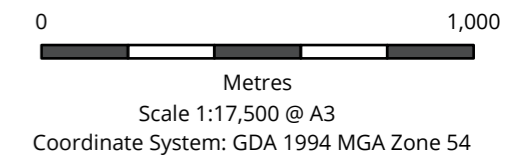
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**Legend**

- Study area
- Turbine
- Infrastructure with no PGSW downslope
- Infrastructure with PGSW downslope
- PGSW structural variants**
- Porcupine grass with eucalypts
- Porcupine grass only
- Eucalypts only

Figure 11.4 – Infrastructure with PGSW downslope - south-east



Matter 26380  
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 Last edited by jturner on 12 December 2018  
 Location:  
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### 5.2.5 Weed management

To safeguard against the potential introduction or spread of invasive species, strict hygiene protocols are to be implemented by all personnel working within the Silverton Wind Farm in accordance with the VMP (Biosis 2018d).

Low weed densities across the study area will be maintained through an annual weed management program as outlined in the VMP (Biosis 2018d) and BAMP (Biosis 2018b).

A seasonal weed monitoring program is to be implemented in coordination with the weed management program. Details pertaining to the frequency and timing of monitoring are provided with the BAMP (Biosis 2018b).

### 5.2.6 Fire regimes

Studies of fire in Mallee vegetation with an understorey of Porcupine Grass in Murray Sunset National Park recommend a strategy to fight wildfires with no prescribed burning. This approach does not exclude fire from the ecosystem, rather ensures the extent burnt by wildfire is reduced (Giljohann et al. 2015; Kelly et al. 2014). This research found that it is likely that increased sources of ignition in the landscape have resulted in a risk of wildfires in mallee-Porcupine Grass communities at an interval which threatens the survival of long-unburnt vegetation. A strategy of fighting wildfires will allow the occasional establishment of recently burnt areas and ensure the development and retention of areas of medium to long-unburnt vegetation (Giljohann et al. 2015). Only when the late successional vegetation is dominant is it suggested the best strategy would be to burn small areas of late successional vegetation to ensure the availability of intermediate successional vegetation (Kelly et al. 2014).

As outlined in Section 4.7, prescribed fire is not recommended due to the potential or possibility for it to consume a large proportion of the PGSW plant community.

Following fire, grazing pressures exerted by several different herbivores can accelerate seedling mortality. Regenerating Porcupine Grass and regrowth of established plants is more palatable to herbivores compared to the normally inedible, pungent leaves of the mature individuals. This appears to be exacerbated if fire is followed by drought. In more favourable seasons following fire, Noble and Vines (1993) found that there is usually minimal grazing of Porcupine Grass, presumably because of the grazing is dispersed by an increased availability of food. If total grazing pressure is contained in such a season, significant recruitment can occur and improvement in vegetation condition would be expected.

Long-term monitoring of the community and its response to wildfire will allow the development of a greater understanding of the response of the community to fire. In addition, ongoing research in similar mallee communities is likely to provide insight into optimal fire management strategies.

## 5.3 Other actions

### 5.3.1 Foxes and feral cats

Other feral animal species have the potential to impede the recovery of PGSW, including Foxes *Vulpes vulpes*, Wild Dogs *Canis lupus familiaris* and Feral Cats *Felis catus*. These species may impact on the dynamics of the system, by preying on native fauna species. Foxes also have the potential to introduce weed seeds into the area.

Control of both foxes and cats at Silverton Wind Farm is likely to benefit fauna species within the community. The NSW Government gazetted the *Local Land Services (European Red Fox) Pest Control Order* in 2014, making foxes a declared pest species under the *Local Land Services Act 2013*. Under the Act all land managers in NSW, whether on public or private land, have an obligation to control declared pest species on their land, which

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includes foxes under the Pest Control Order. All control measures will be carried out in accordance with NSW legislation, policy and strategies administered by the Department of Primary Industries.

### **5.3.2 Climate change**

Minimising the impact and intensity of other threats to biodiversity has been identified as the most effective strategy for enabling species to withstand or adapt to climate change (DECCW 2010). Therefore, improving the management of PGSW in line with this recovery plan seeks to improve the ability of PGSW to withstand the impact of climate change.

Ongoing review of the BAMP should incorporate any new knowledge resulting from revisions to regional climate projections in association with field data. In particular, management of feral goats, exotic weeds and fire may require new practices or increased management activities in response to changes in the frequency, intensity and seasonality of extreme climatic events (DECCW 2010).

## 5.4 Performance criteria

A summary of performance criteria/tasks, responsibilities and timing are provided in Table 8. Many of these actions are duplicated in the GMP (Biosis 2018c) and VMP (Biosis 2018d). All performance criteria are compiled in the BAMP (Biosis 2018b).

**Table 8 Management actions and monitoring of PGSW**

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
<b>Baseline performance criteria</b>						
1.1	<b>Mapping of PGSW</b>	Finalise mapping of full extent of PSGW including areas of occurrence within the proposed Silverton Wind Farm	Map prepared of PGSW, including delineation of three observed variants of the community	Shapefile prepared and provided to OEH	Biosis	Shape files prepared, still to be provided to OEH
1.2	<b>Mapping of existing fencing</b>	Position of existing goat control fencing and associated infrastructure to control access to water and facilitate mustering will be accurately mapped	Updated map of goat management infrastructure prepared	Shapefiles prepared showing fencing and associated infrastructure and submitted to OEH	Project Ecologist or GE operational staff	March 2019
1.3	<b>Estimate Feral Goat populations</b>	Collection of landholder population estimates	All four landholders contacted to gather baseline information about goat populations and management	Records from landowner discussions to be documented	Project Ecologist or GE operational staff	March 2019
1.4	<b>Baseline vegetation monitoring</b>	Establishment of 20 permanent plots to monitor PGSW vegetation condition and grazing pressure	Data capture method developed Vegetation monitoring quadrats established and baseline survey completed in spring 2018	Datasheets prepared Annual monitoring report	GE/ Project Ecologist	Field work completed October 2018 Monitoring report to be prepared by

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
						March 2019
1.6	<b>Site inductions</b>	Biodiversity information to be included as part of the site induction for all contract and subcontract staff working within the study area. Up to date spatial data identifying threatened species/habitat and significant vegetation communities will be provided to all personnel undertaking maintenance works.	Inductions completed for all contract and subcontract staff Staff aware of key vegetation values and issues as per BAMP	Induction sheets and associated support materials developed	GE operational staff/Project Ecologist	Initial site inductions conducted December 2018
1.7	<b>Hygiene protocols</b>	Strict hygiene protocols implemented to reduce the potential introduction or spread of invasive flora and fauna species.	No new invasive species introduced.	Inspection checklists submitted.	Project Manager / all personnel working in the VMP area	Ongoing
1.8	<b>Baseline weed mapping</b>	Documenting weed populations	Location of existing weed populations recorded during baseline survey incorporated into a mapping shapefile	Mapping shapefile prepared	Vegetation management contractor/ Project Ecologist	December 2018
1.9	<b>Fire preparedness</b>	Develop fire suppression guidelines	Fire suppression guidelines will be prepared in consultation with Project Ecologist, using Mumbida Wind Farm documentation as a	Guidelines submitted	GE operational staff / Project Ecologist	In preparation, due January 2019

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
			template (SWFS 2013 and GEP&W 2007)			
<b>Ongoing performance criteria</b>						
<b>2.1</b>	<b>Site inductions</b>	Biodiversity information to be included as part of the site inductions	Inductions completed for all contract and subcontract staff Staff aware of key vegetation values and issues as per BAMP.	Signed induction sheets completed and submitted	GE operational staff	Ongoing
<b>2.2.1</b>	<b>Maintain fencing to exclude feral goats</b>	Work with leaseholder to ensure fences are maintained as required	Work with leaseholder to ensure fences are maintained and any damage repaired within two weeks of notification. Fences maintained.  Vegetation protected. If necessary, additional fencing should be implemented for areas of sensitive vegetation as required where restoration measures are impeded (e.g. by Feral Goat grazing pressure/trampling).	Inspection checklists submitted.	Leaseholders/ GE operational staff / fencing contractor	Fence lines to be inspected quarterly and documented via inspection checklist. New fences to be implemented as required
<b>2.2.2</b>	<b>Implement any required additional fencing to exclude Feral Goats</b>	Additional fencing implemented for areas of sensitive vegetation as required where restoration measures implemented under the VMP are impeded. Monitoring implemented.	Sensitive restoration areas protected from Feral Goat pressures as required.	Maintenance activity records submitted. Inspection checklists submitted.	GE operational staff / fencing contractor	New fences to be implemented as required. Fence lines to be inspected quarterly and documented via inspection checklist.

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
2.4	<b>Feral goat exclusion</b>	Goats excluded in PGSW area	<p>No Feral Goats within the exclusion fencing from June to January unless cover of ephemeral flora species is greater than 40%</p> <ul style="list-style-type: none"> <li>Goat fenced closed</li> <li>All goats removed via trapped watering points</li> <li>Active mustering as required</li> </ul> <p>If there is greater than 40 % ground cover of annual species, the leaseholder will allow seed production to occur, and then reserves the right to utilise the vegetation as feed. Goats will again be excluded when the cover of these annual species falls to less than 40 %.</p> <p>If monitoring shows signs of grazing pressure during exclusion period – initiate active on ground mustering to eliminate goats within PGSW area.</p>	Inspection report submitted.	Project Ecologist (monitoring) Leaseholder Blore (goat exclusion and mustering) GE Operational Staff	Surveillance monitoring of enclosure at monthly intervals
2.5.1	<b>Ensure reduced stocking of feral goats</b>	Feral Goat population within goat fence to be reduced	Achieved maximum stocking rate of approximately 0.26 weaner goats	Surveillance monitoring of enclosure at monthly intervals Inspection report	Leaseholder Blore (goat exclusion and mustering)	February to May (inclusive) each year

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
			per hectare (GMP Section 3.1 pg 10) <ul style="list-style-type: none"> <li>Active trapping at trapped watering points</li> <li>Initiate mustering when observed goat numbers exceed 100.</li> </ul>	submitted.		
2.5.2	<b>Ensure reduced stocking of feral goats</b>	Alternative Feral Goat management	Feral Goat control managed by GE contract staff if leaseholder Blore ceases management	Surveillance monitoring of enclosure at monthly intervals Inspection report submitted.	GE contract staff / GE operational staff	When notified by leaseholder Blore that mustering is not financially viable
2.6	<b>Feral Goat population monitoring</b>	Collection of leaseholder population estimates	All four leaseholders contacted to gather baseline information about goat abundance and harvesting activities	Records from landowner discussions to be submitted	Project Ecologist or GE operational staff	Annually in line with spring survey
2.7	<b>Feral Goat population monitoring</b>	Scat counts in subplots as per BAMP	Decrease in goat scat abundance	Annual monitoring report	Project Ecologist	Annually in spring 2019-2021
2.11.1	<b>Monitoring of tracks and hardstands above PGSW</b>	Increased visual monitoring of track and hardstand areas in areas uphill of or adjacent to PGSW	Road assets and supporting roadside drainage maintained Silt / Spoil appropriately sited outside PGSW and location provided to Vegetation Management contractors and Project Ecologist.	Inspection Checklists submitted.	Project Manager / all personnel working in the VMP area	Inspected monthly. Or weekly where construction is ongoing Also within a week after significant rainfall (>25 mm) events

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
2.11.2	<b>Management of road and road side drainage above PGSW</b>	Stockpiles and excavated material including sediment removed from tracks and drains for maintenance activities will not be placed uphill of or adjacent to areas of PGSW or in rocky outcrops or artificial Barrier Range Dragon habitats.	Road assets and supporting roadside drainage maintained. No impact to PGSW or Barrier Range Dragon habitat. Silt / Spoil appropriately sited and location provided to Vegetation Management contractors and Project Ecologist.	Maintenance activity records submitted.	GE operational staff	Ongoing as required.
2.12	<b>Hygiene protocols</b>	Strict hygiene protocols implemented to reduce the potential introduction or spread of invasive flora and fauna species.	No new invasive species introduced.	Inspection Checklists submitted.	Project Manager / all personnel working in the VMP area	Ongoing
2.13	<b>Weed monitoring</b>	Inspections of <ul style="list-style-type: none"> <li>mapped priority weed locations</li> <li>temporary disturbance areas</li> <li>restoration areas</li> <li>all other asset/infrastructure maintenance areas.</li> </ul>	Any new weed incursions mapped for inclusion in weed management program Spatial data to be updated with any new infestations/priority weed locations and distributed between GE, Vegetation Management Contractor and Project Ecologist.	Site inspection checklists submitted.  Mapping shapefile prepared Mapping shapefile prepared and shared between GE / Project Ecologist / Vegetation Management Contractor. Annual monitoring report submitted.	GE operational staff/ Project Ecologist	Ongoing observations by GE staff. Twice-yearly site inspections by the Project Ecologist or more frequently as required e.g. 1 and 3 months after significant rain events (>25 mm) or if required following maintenance inspections
2.14	<b>Weed control</b>	Weed control works are to be implemented in	Priority weeds limited to current cover levels.	Weed management operational checklists submitted.	Vegetation management contractor	Ongoing.



#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
		accordance with the VMP (Biosis 2018d)	New weeds identified and treated.	Weed Control Works Sheets submitted.		
2.15	<b>Monitoring of temporary disturbance areas</b>	Monitoring of temporary disturbance areas	Temporary disturbance areas monitored for regeneration success and soil stability.	Assess regeneration success and soil stability. Implement restoration (action no 2.16) as detailed below as required.	Site inspection checklists submitted.  Annual monitoring report submitted.	Project Ecologist
2.16	<b>Restoration including rehabilitation and revegetation</b>	Site rehabilitation to be implemented in accordance with the VMP  Disturbance areas rehabilitated with topsoil reinstated where possible and landform stabilised as soon as possible following disturbance.  Additional restoration implemented as required.	Initial rehabilitation implemented.  Restoration Plan implemented as required.  Site restored.	Site inspection checklists submitted.  Monitoring and restoration actions and outcomes documented in Annual Report.	Project Ecologist with input from Vegetation Management Contractors and GE staff as required.	Ongoing as required. Sites to be inspected twice-yearly for first 3 years, also 1 and 3 months after significant rain events
2.17	<b>Vegetation monitoring</b>	Monitoring of vegetation condition and grazing pressure in accordance with the BAMP	Predicted responses (given seasonal constraints discussed in BAMP): <ul style="list-style-type: none"> <li>• Increased litter cover</li> <li>• Increased abundance of native species</li> <li>• Increased cover of native species</li> </ul>	Annual monitoring report	Project Ecologist / Project Manager / Blore lease holding	Annually in spring 2019-2021

#	Management Action	Task / Performance Criteria	Measure / Target	Evidence of Completion	Responsibility	Timing
			<ul style="list-style-type: none"> <li>• 'Release' of woody species from grazing pressure</li> <li>• Evidence of recruitment of woody species</li> </ul> <p>If vegetation monitoring shows no reduction in grazing pressure during exclusion period – initiate active on ground mustering to eliminate goats within PGSW area in accordance with GMP.</p>			
<b>2.19</b>	<b>Fire preparedness</b>	Review fire preparedness	Check fire response plans and equipment twice yearly	Inspection checklists submitted.	GE Operational Staff	September and January each year
<b>2.26</b>	<b>Review of BAMP</b>	Comprehensive review of BAMP and supporting management plans	<p>Review all monitoring data and assess the response of biodiversity values to modified site management.</p> <p>Update management recommendations as appropriate in consultation with OEH to ensure there is a net gain in the conservation value of PGSW</p>	Reviewed BAMP and supporting plans submitted to OEH	GE/ Project Ecologist	January 2022

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## Appendices

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## Appendix 1 Project Approvals

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Mr Adam Mackett  
Project Manager  
AGL Energy Limited  
L24, 200 George Street  
SYDNEY NSW 2000

Dear Mr Mackett

*Adam*

**Silverton Wind Farm (08\_0022)  
Porcupine Grass Sparse Woodland Clearing**

I refer to the report provided on 18 October 2017 regarding the proposed clearing of Porcupine Grass Sparse Woodland (EEC) at the Silverton Wind Farm.

I note that following detailed project design and field surveys, AGL has identified that the project would result in additional clearing of this EEC.

As you would be aware, the project approval currently allows for a clearing limit of 0.81 hectares of EEC, unless otherwise agreed by the Secretary. I understand that AGL is seeking approval to allow an increase in clearing of EEC to around 7 hectares.

In consultation with the Office of Environment and Heritage (OEH), the Department has agreed to the request subject to the following:

- AGL to prepare a revised Recovery Plan for the Porcupine Grass Sparse Woodland (Recovery Plan) and Goat Management Plan that specifically addresses the additional impacts to the EEC (refer specific comments below); and
- AGL to demonstrate that the proposed micro-siting of the access tracks to minimise clearing of the EEC would not give rise to any additional biodiversity or heritage impacts.

At a minimum, in addition to addressing the requirements of the project approval, the plans must:

- be prepared by a suitably qualified expert (preferably with experience in the preparation of relevant plans) endorsed by OEH;
- include figures and tables detailing the final clearing footprint, infrastructure layout, environmental constraints and areas of EEC<sup>1</sup>;
- identify clear objectives, targets and performance indicators;
- detail baseline conditions, including pre-construction goat numbers and the results of the updated baseline mapping and analysis of EEC across the site;
- describe how the objectives, targets and performance measures will be achieved (including timeframes);
- describe the management measures proposed to control goats and address the increased clearing impacts on the EEC;

<sup>1</sup> The Recovery Plan should also clearly identify the final clearing footprint including how much EEC is proposed to be avoided through micro-siting of the access tracks (ie. a table comparing the original EA, approved and amended layout calculations).

- describe the proposed quantitative monitoring that will be used to measure whether the proposed actions are achieving the objectives, targets and performance indicators; and
- include a contingency plan (including timeframes, triggers and actions) that describes the measures (both proactive and reactive) that would be undertaken if the proposed actions are not achieving the objectives, targets and performance indicators.

The plans should also address the comments provided by OEH (letter dated 24 March 2017), and the Department's broader requirements for the preparation management plans (email from Stephen Shoemith dated 21 April 2017).

The Recovery Plan and Goat Management Plan must be prepared in consultation with OEH and approved by the Secretary prior to any works commencing in Area 7.

Based on its review of the draft documents provided to date, OEH has advised that it expects an increase in commitments (such as additional actions or increased resources) would be required to achieve measurable improvements in vegetation condition in the medium to long-term.

OEH has also advised it is happy to provide assistance regarding the technical aspects of the EEC mapping, however no further comments will be provided in relation to the draft documents until the next revisions are prepared as per the requirements of this letter.

If you have any further enquiries about this matter, please contact Stephen Shoemith on the above contact details.

Yours sincerely



Mike Young

**Director**

**Resource Assessments**

as nominee of the Secretary

2.11.17.





Davorin Jelaca  
Senior Project Manager  
Silverton Wind Farm

Via Email to: [Catherine.Powers12@ge.com](mailto:Catherine.Powers12@ge.com)

Dear Mr Jelaca

**Silverton Wind Farm (08\_0022)  
Construction Activities in Area 7**

I refer to your email dated 19 and 22 November 2017, seeking approval to commence construction in Area 7 at the Silverton Wind Farm.

The Department has reviewed the information you provided, in consultation with the Office of Environment and Heritage (OEH) and notes that the total clearing area of Porcupine Grass Sparse Woodland CEEC (Porcupine Grass) is confirmed as 6.81 hectares and significant improvements has been made in the development of the Porcupine Grass Sparse Woodland Recovery Plan (PGSWRP) and Goat Management Plan (GMP).

I note that the Silverton Wind Farm must undertake the construction activities in Area 7 in accordance with the approved Construction Biodiversity Management Plan, with supervision of an ecologist from Biosis and full demarcation of the disturbance footprint.

On this basis, the Department is satisfied that construction can commence in Area 7.

If you require further information, please contact Stephen Shoesmith on 9274 6164 or by email to [stephen.shoesmith@planning.nsw.gov.au](mailto:stephen.shoesmith@planning.nsw.gov.au).

Yours sincerely

Mike Young  
Director

Resource Assessments  
as nominee of the Secretary

22/12/17.

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## Appendix 2 Consultancy endorsement by OEH

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## Appendix 3 Flora recorded within PGSW

### Notes to tables:

<b>Status – EPBC Act:</b> CE – Critically Endangered EN – Endangered VU – Vulnerable <b>Status – BC Act:</b> E1 – endangered species (Part 1, Schedule 1) E2 – endangered population (Part 2, Schedule 1) E4 – presumed extinct (Part 4, Schedule 1) E4A – critically endangered V – vulnerable (Part 1, Schedule 2)	<b>Source of Records</b> A – Biosis 2018 (This report) B – NGH Environmental (2008a) C – PGSW TS determination (NSW SC 2010) D – VIS flora survey database (OEH 2017c) E – PCT description (OEH 2017b, Appendix 4)
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**Table A.1 Flora species recorded within PGSW**

Scientific name	Common name	EPBC Act	BC Act	Source				
				A	B	C	D	E
<b>Native species</b>								
<i>Abutilon fraseri</i>	Dwarf Lantern-flower				x			
<i>Abutilon leucopetalum</i>	Desert Chinese Lantern			x	x			
<i>Acacia aneura</i>	Mulga Wattle			x	x	x		x
<i>Acacia salicina</i>	Willow Wattle					x		x
<i>Acacia tetragonophylla</i>	Curara, Kuara, Dead Finish			x	x	x	x	x
<i>Acacia victoriae</i>	Prickly Wattle			x		x	x	x
<i>Alectryon oleifolius</i>	Boonaree, Inland Rosewood			x				
<i>Amyema maidenii</i>	Nyinkin			x				
<i>Amyema preissi</i>	Wireleaf Mistletoe			x				
<i>Aristida nitidula</i>	Flat-awned Threeawn			x				
<i>Atriplex angulata</i>	Angular Saltbush					x	x	x
<i>Atriplex pumilio</i>	Mat Saltbush			x				
<i>Atriplex stipitata</i>	Mallee Saltbush			x	x			x
<i>Atriplex vesicaria</i>	Bladder Saltbush					x		x
<i>Austrostipa scabra</i>	Rough Spear-grass				x			
<i>Austrostipa</i> sp.	Speargrass				x			
<i>Boerhavia dominii</i>	Tarvine			x				
<i>Brachyscome ciliaris</i>	Variable Daisy				x			
<i>Brachyscome lineariloba</i>	Hard-head Daisy				x			
<i>Bulbine semibarbata</i>	Leek Lily				x			
<i>Calotis hispidula</i>	Bogan Flea			x	x			
<i>Cheilanthes austrotenuifolia</i>	Rock fern			x				
<i>Cheilanthes lasiophylla</i>	Woolly Cloak-fern			x				

Scientific name	Common name	EPBC Act	BC Act	Source				
				A	B	C	D	E
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Mulga Fern					X		X
<i>Chenopodium desertorum</i>	Frosted Goosefoot			X		X	X	X
<i>Cymbopogon ambiguus</i>	Lemon Grass, Scent Grass			X		X	X	X
<i>Daucus glochidiatus</i>	Australian Carrot				X	X		X
<i>Dissocarpus paradoxus</i>	Cannonball Burr			X				
<i>Dodonaea lobulata</i>	Lobed Leaf Hop Bush				X			
<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>	Narrow-leaf Hop-bush					X		X
<i>Einadia nutans</i>	Climbing Saltbush			X				
<i>Enchylaena tomentosa</i>	Ruby Saltbush			X	X	X	X	X
<i>Enneapogon cylindricus</i>	Jointed Nineawn					X		X
<i>Eremophila oppositifolia</i> ssp. <i>oppositifolia</i>	Weeooka				X			
<i>Eriochloa crebra</i>	Cup Grass			X				
<i>Erodium crinitum</i>	Blue Heron's-bill				X			
<i>Eucalyptus intertexta</i>	Gum Coolibah			X	X	X	X	X
<i>Eucalyptus socialis</i>	Red Mallee			X	X	X	X	X
<i>Euphorbia drummondii</i>	Caustic Weed, Spurgewort, Balsam, Creeping Caustic, Mat Spurge, Flat Spurge, Milkweed, Caustic Creeper			X				
<i>Glycine clandestina</i>	Twining Glycine			X				
<i>Goodenia pusilliflora</i>	Small-flower Goodenia				X			
<i>Hibiscus sturtii</i> var. <i>sturtii</i>	Hill Hibiscus			X				
<i>Lepidium papillosum</i>	Warty Peppercross				X			
<i>Maireana pyramidata</i>	Black Bluebush				X	X		X
<i>Maireana sclerolaenoides</i>	Woolly-fruit Bluebush				X			
<i>Maireana sedifolia</i>	Pearl Bluebush			X	X			
<i>Maireana trichoptera</i>	Hairy-wing Bluebush				X			
<i>Maireana triptera</i>	Three-wing Bluebush				X			
<i>Marsdenia australis</i>	Doubah, Native Pear, Cogola Bush			X				
<i>Myriocephalus rhizocephalus</i>	Woolly-heads				X			
<i>Omphalolappula concava</i>	Burr Stickseed				X			
<i>Oxalis perennans</i>	Grassland Wood-sorrel			X				
<i>Pittosporum angustifolium</i>	Weeping Pittosporum				X			
<i>Podolepis capillaris</i>	Invisible plant			X	X			
<i>Ptilotus obovatus</i>	Smoke Bush, Cotton bush			X	X	X	X	X
<i>Rhagodia spinescens</i>	Spiny Saltbush, Berry Saltbush			X	X			
<i>Rhagodia ulicina</i>	Spiny Goosefoot			X				

Scientific name	Common name	EPBC Act	BC Act	Source				
				A	B	C	D	E
<i>Rhodanthe microglossum</i>	Clustered Sunray				x			
<i>Rhodanthe pygmaea</i>	Pygmy Sunray				x			
<i>Sclerolaena diacantha</i>	Grey Copperburr				x			
<i>Sclerolaena lanicuspis</i>	Woolly Copperburr				x			
<i>Sclerolaena obliquicuspis</i>	Limestone Copperburr					x	x	x
<i>Sclerolaena patenticuspis</i>	Spear-fruit Copperburr			x				
<i>Senna artemisioides</i>	Silver Cassia				x	x		x
<i>Setaria paspalidioides</i>	Bristle Grass			x				
<i>Sida petrophila</i>	Rock Sida			x	x	x	x	x
<i>Sisymbrium erysimoides</i>	Smooth Mustard				x			
<i>Solanum ellipticum</i>	Potato Bush				x			
<i>Solanum quadriloculatum</i>	Tomato Bush				x			
<i>Solanum sturtianum</i>	Thargomindah Nightshade			x		x	x	x
<i>Stenopetalum lineare</i>	Narrow Thread-petal				x			
<i>Tetragonia moorei</i>	Annual Spinach				x			
<i>Triodia scariosa</i>	Porcupine Grass			x	x	x	x	x
<i>Vittadinia cuneata</i>	Fuzzweed			x				
<i>Wahlenbergia communis</i>	Tufted Bluebell			x				
<i>Zygophyllum apiculatum</i>	Pointed Twin-leaf				x			
<i>Zygophyllum iodocarpum</i>	Violet Twin-leaf				x			
<i>Zygophyllum ovatum</i>	Dwarf Twin-leaf				x			
<b>Exotic species</b>								
<i>Acetosa vesicaria</i>	Bladder Dock					x		
<i>Carrichtera annua</i>	Ward's Weed				x			
<i>Limonium lobatum</i>	Winged Sea-lavender				x			
<i>Sonchus oleraceus</i>	Common Sow-thistle				x			

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## Appendix 4 PCT 359 - Porcupine Grass - Red Mallee - Gum Coolabah hummock grassland low sparse woodland

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## VIS Classification - Community Profile Report

**Plant Community Type ID (PCT ID):**

359

**PCT Classification Confidence Level:** High

**PCT Common Name:** Porcupine Grass - Red Mallee - Gum Coolabah hummock grassland / low sparse woodland on metamorphic ranges on the Barrier Range, Broken Hill Complex Bioregion

**PCT Scientific Name:** *Eucalyptus socialis*, *Eucalyptus intertexta* / *Acacia tetragonophylla*, *Maireana pyramidata*, *Acacia aneura* s. lat., *Acacia aneura*, *Dodonaea viscosa* subsp. *angustissima* / *Triodia scariosa* subsp. *scariosa*, *Sida petrophila*, *Chenopodium desertorum*, *Cymbopogon ambiguus*

**Photo 1:**

**Original Entry:** jbenison 21/02/2008

21/02/2008

**Vegetation Description:** This community contains an unusual occurrence of Red Mallee and Gum Coolabah growing in a Porcupine Grass dominated landscape on rocky ranges in the arid zone. Hummock grassland to low sparse woodland with the ground cover dominated by the hummock grass Porcupine Grass (*Triodia scariosa* subsp. *scariosa*). Scattered trees include Red Mallee (*Eucalyptus socialis*) with Gum Coolabah (*Eucalyptus intertexta*). Shrubs are very sparse and include *Acacia aneura* sens lat., *Acacia victoriae* subsp. *arida*., *Acacia tetragonophylla*, *Maireana pyramidata*, *Enchylaena tomentosa*, *Senna* form taxon 'artemisioides' and *Atriplex vesicaria*. The ground cover is dominated by *Triodia scariosa* subsp. *scariosa*. Other ground cover species include *Ptilotus obovatus* var. *obovatus*, *Chenopodium desertorum*, *Sida petrophila*, *Cymbopogon ambiguus*, *Solanum sturtianum*, *Cheilanthes sieberi* subsp. *sieberi*, *Daucus glochidiatus*, *Atriplex angulata*, *Enneapogon cylindricus* and *Sclerolaena obliquicuspis*. Occurs in the arid climate zone on soils composed of eolian red sandy loam or lithosols deposited over rocky outcrops composed of Proterozoic gneiss, phyllite, schist, sandstone and slate (Willyama complex), with a relief to 200 m forming rocky hills in the Umberumberka Range section of the Barrier Range sub-region in the Broken Hill Complex Bioregion, north of Silverton. Grades into widespread hill Mulga communities such as (ID123) and contains elements of ID169 Curly Mallee open woodland that occurs further north on the Barrier Range near Corona but the ground cover in ID169 is not dominated by *Triodia*. Past disturbance may include cutting of trees for use in fencing and towns such as Silverton. A short term and averted threat was a proposed wind farm (plans now modified to lessen impact on plant community). The main long term threat is grazing by goats or stock. Reduced rainfall and hotter temperatures due to climate change could also impact on the regeneration of shrub and tree species. The combination of its very limited extent and current threats leads to an assessment of this community as being threatened requiring protection and management, particularly reduction of grazing pressure.

**Emergent species:** None

**Upper Stratum Species:** *Eucalyptus socialis*; *Eucalyptus intertexta*;

**Mid Stratum Species:** *Acacia tetragonophylla*; *Maireana pyramidata*; *Acacia aneura* s. lat.; *Dodonaea viscosa* subsp. *angustissima*; *Acacia salicina*; *Senna* form taxon 'artemisioides'; *Acacia victoriae* subsp. *arida*; *Enchylaena tomentosa*;

**Ground Stratum Species:** *Triodia scariosa* subsp. *scariosa*; *Sida petrophila*; *Cymbopogon ambiguus*; *Ptilotus obovatus* var. *obovatus*; *Chenopodium desertorum*; *Solanum sturtianum*; *Cheilanthes sieberi* subsp. *sieberi*; *Daucus glochidiatus*; *Atriplex vesicaria*; *Atriplex angulata*; *Enneapogon cylindricus*; *Sclerolaena obliquicuspis*;

**Threatened Plants:** Not Assessed

**Threatened Fauna:** Melastoma affine (Blue Tongue); Delma australis (Marble-faced Delma);

**Diagnostic Species:** Not Assessed

**Height Class (Walker & Hopkins 1990):** 2 - Range:0.26-0.50m (Low)

**Vegetation Formation:** Arid Shrublands (Acacia sub-formation);

**Vegetation Class:** Stony Desert Mulga Shrublands;

**NSW Landscape Name:** Barrier Ranges;

**Classification source:** Surveyed and mapped by NGH Environmental Pty Ltd (2008). Part of broad map unit 27 in Pickard & Norri

**Authority:** Surveyed and mapped by NGH Environmental Pty Ltd (2008). Part of broad map unit 27 in Pickard & Norris (1994).

Occurs in the Umberumberka Land System (Walker 1991). Some possible links to Floristic Group 9 in Playfair & Robinson (1997) in the North Olary Plains of South Australia. Community very distinct, although there was no plot data existed as of 2008.

**Pre-European Mapped Or Modelled:** Not mapped or modelled

**Current Extent Mapped Or Modelled:** Not mapped

**Adequacy of plot sampling:** None

**Number of plots to define PCT:** 0

**IBRA Bioregion:** Broken Hill Complex (>70%);

**IBRA Sub-Region:** Barrier Range (Not known); Barrier Range Outwash (Not known);

**LGA:** Unincorporated (>70%);

**Lithology:** Phyllite , Gneiss , Pegmatite , Slate

**Landform Pattern:** Hills

**Landform Element:** Hillcrest , Hillslope

**Pre-European Extent:** 500 ha ±30%. Estimated from extant vegetation maps: full range

**Pre-European Extent Accuracy:** 30

**Pre-European Comments:** A highly restricted community occurring on the southern Barrier Range - comprising a very small part of the 34,000 ha Umberumberka Land System (Walker 1991). Based on mapping in NGH Environmental Pty Ltd (2008) and reports on some further unmapped areas on the Barrier Range (S. Sass pers. comm.).

**Current Extent:** Not Assessed

**Current Extent Accuracy:** 30

**Current Extent Comments:** Mostly not cleared due to its occurrence on rocky hills in the arid zone but some trees may have been cut in the past for smelters at Silverton. Grazing by goats may reduce regeneration of woody species. Part of the current extent is mapped by NGH Environmental Pty Ltd (2008) with about 200 ha of other areas unmapped as of 2009.

**PCT Percent cleared:** 20.00

**% accuracy (of PCT % cleared estimate):** +/-30

**Variation and Natural Disturbance:** It is unusual for Red Mallee to grow on rocky ranges and this may also be the western-most occurrence of Gum Coolabah in NSW. Some areas on the ranges are devoid of trees and are true hummock grasslands - other areas contain scattered trees.

**Fire Regime:** Fire is infrequent. The hummock grass could burn occasionally depending on fuel loads.

**Associated TEC Degree of Fit:**

**Associated TEC Comments:**

**Citations:** (Pickard J. & Norris E., 1994 ; Playfair R. & Robinson A., 1997 ; Walker P., 1991 ; NGH Env., 2008)

**Full Reference Details:** (27; 295; 386; 400;). Pickard, J. & Norris, E.H. (1994) The natural vegetation of north-western New South Wales: notes to accompany the 1:1 000 000 vegetation map sheet. Cunninghamia 3(3): 423-464; Playfair, R.M. & Robinson, A.C. (1997) (eds.) A biological survey of the North Olary Plains, South Australia 1995-1997. (Natural Resources Group, Department of Environment and Natural Resources: South Australia); Walker, P.J. (1991) Land systems of western New South Wales. Technical Report No. 25 (Soil Conservation Service of New South Wales: Sydney); NGH Environmental (2008) Biodiversity Assessment: Stage 1 Proposed Silverton Wind Farm. Prepared for Silverton Wind Farm Developments Pty Ltd;

**Profile source:**

**PCT Definition Status:** Approved