Millennium Minerals Limited
Nullagine Gold Project
Vegetation of the
MML Nullagine Tenements

OCTOBER 2017 – VERSION 3.1

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Executive Summary

Plantecology undertook a vegetation survey of 5,277 hectares of Millennium Minerals Ltd tenements, to the east of the Nullagine townsite, from April 2016 to October 2017.

Twenty four vegetation associations were characterised and assigned to eight regional site types. The only site type that not widespread/common in the Pilbara, and not recorded in a conservation reserve, was hummock grasslands with chenopods on stony saline plains. This is a P3 Priority Ecological Community, that occurs in two land systems, is extensive (approximately 46,000 ha) and in generally very good to good condition. This Priority Ecological Community is examined in detail in the companion reports *Stony Plains of the Mosquito Land System PEC, May 2017/version 2.0*; and *Landforms and Soils associated with* a *Priority Ecological Community within the Mosquito Land System near Nullagine, East Pilbara*

The area is not listed as having high species and ecosystem diversity, and an inventory of only 296 species was compiled from 284 quadrats.

No large perennial waterbodies were present.

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1 INTRODUCTION

1.1 Objectives and Scope

This report includes:

- a review of publically available literature, and spatial data, relating to the vegetation;
- description/s and map/s of the regional vegetation types and their extents;
- description/s and map/s of vegetation onsite; and
- an assessment of the regional significance of the vegetation.

The associated reports, which should be read in conjunction with the vegetation report are:

- *Millennium Minerals Ltd – Nullagine Priority Flora Census Update, October 2017* (Woodgis, 2017)
- *Stony Plains of the Mosquito Land System PEC, May 2017/version 2.0* (Woodgis, 2017); and
- *Landforms and Soils associated with* a *Priority Ecological Community within the Mosquito Land System near Nullagine, East Pilbara* (Land Assessment, 2016).

1.2 Survey Area

The focus of the survey has been across an area of approximately 5,277 hectare area, within the tenements of Millennium Minerals Ltd that extend eastwards from the Nullagine townsite (Figure 1).

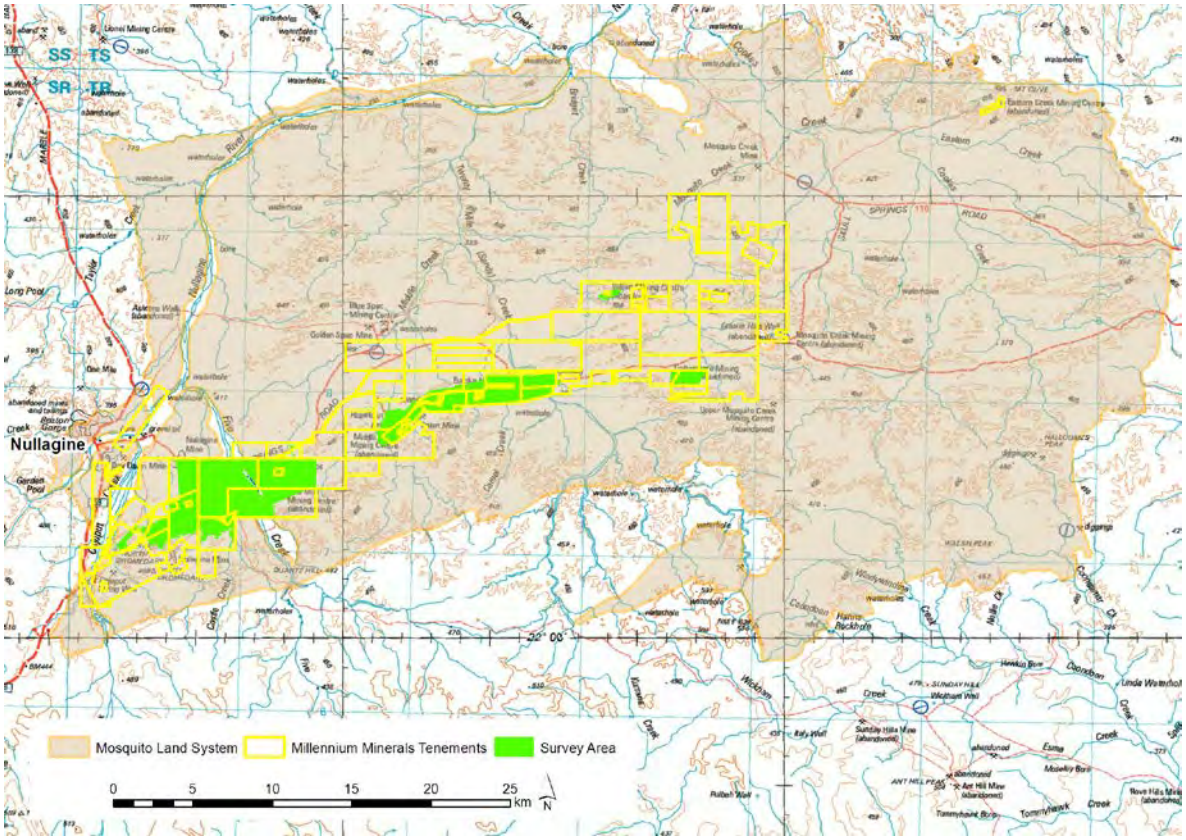

Figure 1: Location of Survey Area

2 METHOD

2.1 Field Surveys

An initial survey was undertaken in autumn 2016, with field mapping and quadrat establishment undertaken from 12 April until 09 June 2016.

For characterizing the *Stony saline plains of the Mosquito Land System* Priority Ecological Community, flora and soil data was collected, inside and outside of Millennium Minerals tenements, across the Mosquito Land System, from 19 until 28 July 2016, and 18 until 23 August 2016, at:

- 54 of 59 traverse sites identified by DAFWA as site type SSCG (Stony Spinifex Chenopod Grassland);
- 4 of 4 inventory sites identified by DAFWA as site type SSCG;
- 1 cutting that can be assigned to site type SSCG;
- 1 of 1 traverse sites identified by DAFWA as site type SXCS (Stony miXed Chenopod Shrubland);
- 9 of 51 traverse sites identified by DAFWA as site type PHSG (Plain Hard Spinifex Grassland);
- 2 of 2 inventory sites identified by DAFWA as site type PHSG;
- 1 cutting that can be assigned to site type PHSG;
- 11 vegetation quadrats established by Plantecology where high-resolution vegetation subassociation mapping has been completed.

Additional field mapping was conducted in conjunction with flora surveys:

- 12-21 April 2016;
- 11-16 May 2016;
- 02-09 June 2016;
- 03-18 August 2016;
- 12-20 January 2017;
- 17-23 February 2017;
- 13-23 March 2017;
- 6-13 April 2017;
- 20-27 April 2017;
- 18-25 May 2017; and
- 21-28 September 2017.

Additional quadrats were established, after significant rainfall:

- February-April 2017 (data analysis is not yet completed from this, but will be presented in future reports).

2.2 Flora Nomenclature

Nomenclature was consistent with that of the Western Australia Herbarium at the time of writing the report. This was verified by reference to up-to-date tables in the Max 3.2 software package.

2.3 Personnel

The roles and experience of the personnel involved the production of this report are summarised in Table 1.

Table 1: Project Team

Team Member	Professional Experience	Project Tasks
Andrew Waters (Licence SL009144). • Graduate Certificate in GIS • Bachelor of Science • Advanced Certificate of Horticulture	16 years in: • Avon Wheatbelt • Esperance Plains • Geraldton Sandplains • Jarrah Forest • Mallee • Murchison • Pilbara • Swan Coastal Plain	• Mapping • Report Writing • Quadrats • Flora Survey
Dr Shane Chalwell (Licence SL00959) • PhD (*Plant communities of greenstone hills of the Eastern Goldfields of Western Australia as analogues for the rehabilitation of rocky waste dumps*) • Bachelor of Science (Honors)	15 years in: • Avon Wheatbelt • Central Ranges • Coolgardie • Dampierland • Esperance Plains • Gascoyne • Geraldton Sandplains • Great Sandy Desert • Jarrah Forest • Mallee • Murchison • Ord-Victoria Plains • Pilbara • Swan Coastal Plain	• Quadrats • Flora Survey • Data Analysis • Flora Survey
Frank Obbens • Bachelor of Science	16 years in: • Avon Wheatbelt • Coolgardie • Jarrah Forest • Mallee • Murchison • Northern Sandplains • Pilbara • Swan Coastal Plain	• Plant Identifications

2.4 Limitations

Consistent with EPA Guidance Statement No. 51 (EPA, 2004), and reduce any possible misinterpretations of this report, an indication is provided below of the degree to which the following have limited data collection or the interpretation thereof:

- contextual information;
- disturbances;
- access, resources and intensity of sampling;
- timing and weather; and
- identification of plant taxa.

2.4.1 Contextual Information

The flora of the Chichester IBRA subregion is relatively poorly known, with few intensive studies, and quadrat-based floristic data available from only some localities (DPaW, 2002).

However, the Department of Agriculture and Food Western Australia's ('DAFWA's') *Technical Bulletin No. 92 - An inventory and condition survey of the Pilbara region, WA* (Vreeswyk, Payne, Leighton, & Hennig, 2004) provides a regional framework for assessing the extent, condition and significance of vegetation at the level of subformations (which is the NVIS, National Vegetation Inventory System, equivalent of the site types referred to in Bulletin No. 92). This framework is particularly relevant to surveys in the Mosquito Land System where a Priority Ecological Community was defined in terms of a site type in this survey.

Some additional information is available in the *Flora and Vegetation of proposed Tailings Storage Facility* (Mattiske Consulting Pty Ltd, 2016), and the *Flora and Vegetation of the Nullagine Project Areas* (Mattiske Consulting Pty Ltd, 2012). This second document consolidated the following three previous report, none of which included analyzable data, nor was any associated floristic data associated with quadrats supplied to Millennium Minerals Ltd:

- *Flora and Vegetation of the Golden Gate Lease* (Mattiske Consulting Pty Ltd, 2006);
- *Flora and Vegetation of the Shearers Lease* (Mattiske Consulting Pty Ltd, 2006); and
- *Flora and Vegetation of the Barton Lease* (Mattiske Consulting Pty Ltd, 2005).

2.4.2 Disturbances

Historic current disturbances from mining and grazing limited the interpretation of fine scale vegetation patterns in areas where it coincided with vegetation mosaics and subtle variations associated with microtopography. Fire also limited confirmation of vegetation in some areas, in particular two areas covering a total of approximately 170 ha that had been burnt within a month of the January 2017 site visit (Figure 2).

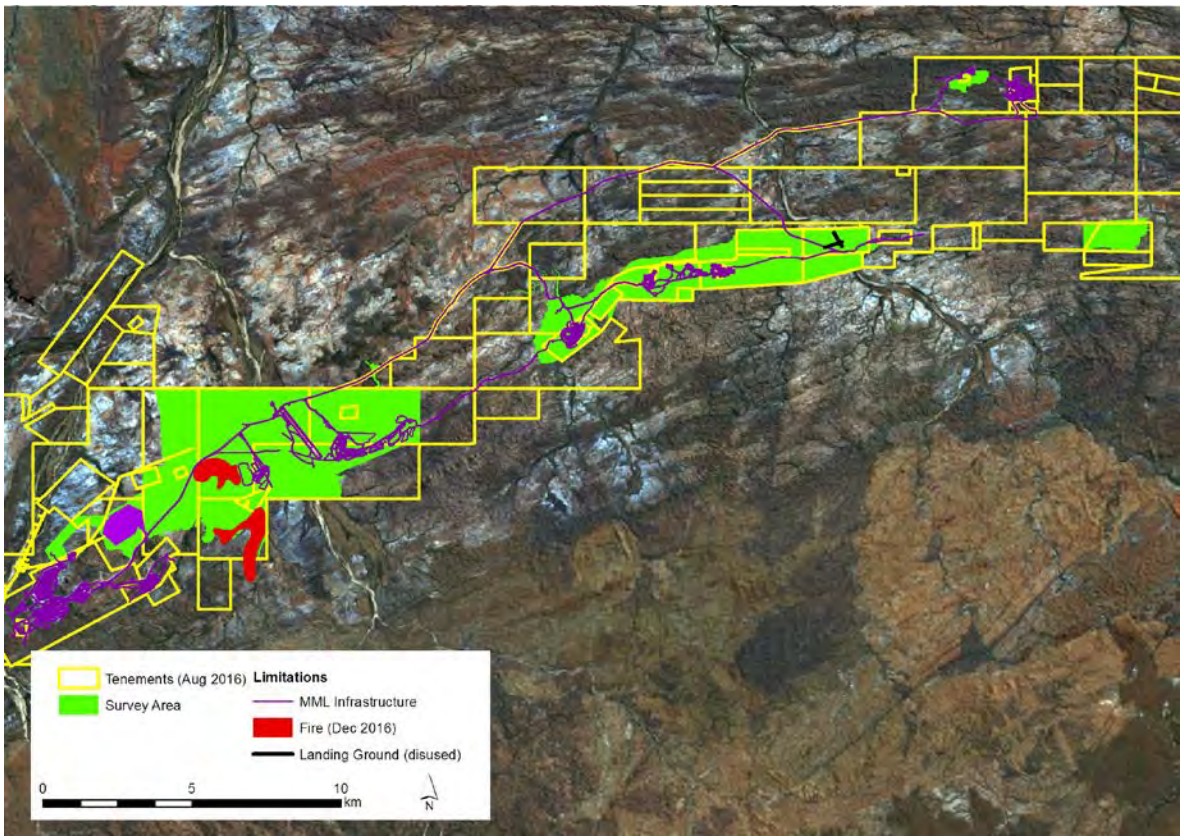

Figure 2: Limitations in Survey Areas

Some vegetation has been permanently altered by fire and/or grazing, where low sand rises on clay plains have, or are being, washed or blown away. In these areas the vegetation units can be equivocal and mapping reflects the current dominant community.

2.4.3 Access, Resources and Intensity of Sampling

The intensity of vegetation sampling did not result in all taxa in the survey area being recorded, but it is expected that all the dominant and more common/abundant taxa were recorded and this was an appropriate level of sampling for a core dataset the characterisation of vegetation for comparison with regional vegetation datasets, and determining likely occurrence of conservation significant flora habitat.

The intensity of the initial survey is indicated in Figure 1 and Table 2, with data from additional quadrats established, after significant rainfall in the summer of 2016/2017, to be presented in future reports (once plant identifications and floristic analysis is completed).

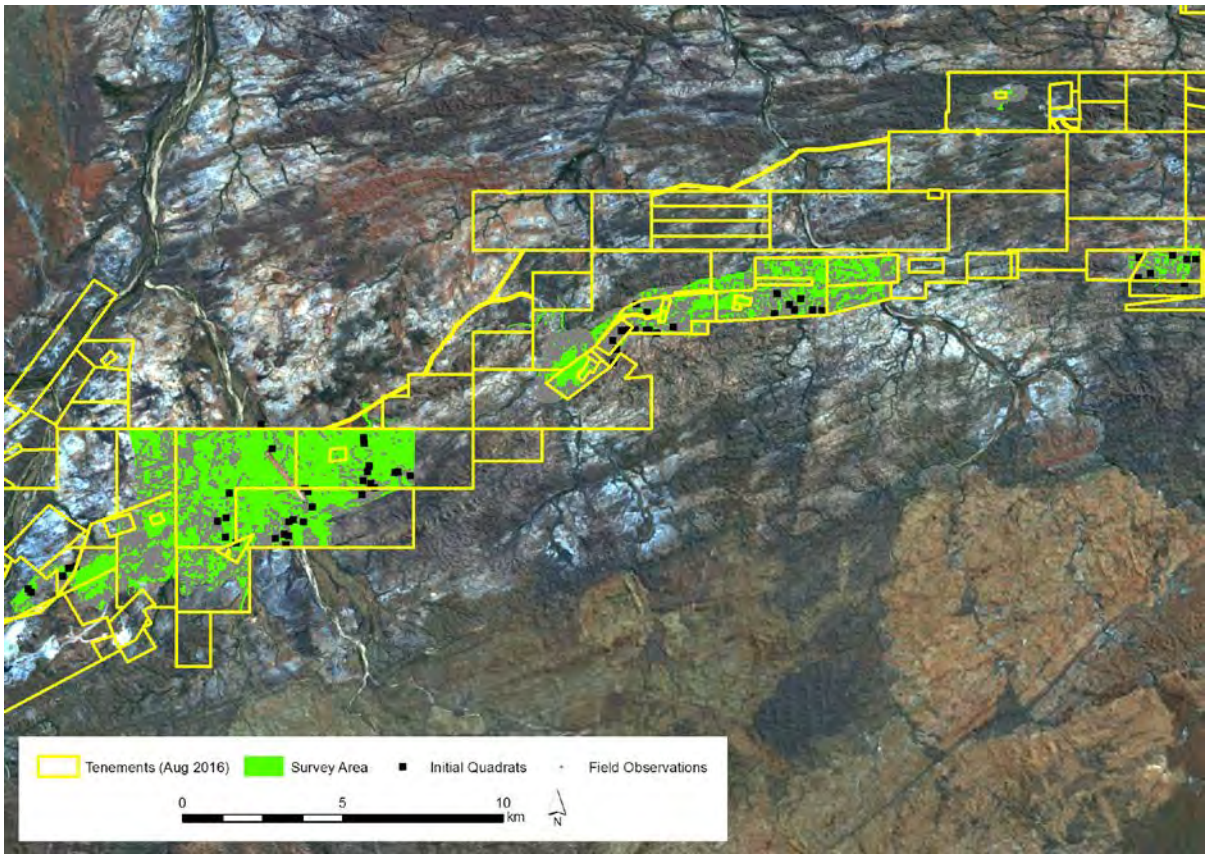

Figure 3: Quadrats and Traverses in Survey Areas

Table 2: Number of Quadrats in Vegetation Associations and Landforms

Landforms	Ridges, Footslopes and Stony Plains	Drainagelines	Alluvial Plains
Number of Quadrats	**33**	**14**	**9**

The majority (87%) of the locations previously identified as a PEC (DAFWA survey sites listed as supporting 'Stony plain spinifex grassland with chenopod shrubs') were revisited and described.

2.4.4 Timing and Weather

Whilst the timing of rain events, and the subsequent flowering of plants can be highly variable in the inland Pilbara, rainfall during the surveys, and in the 12 months, was higher than the long-term median.

A comparison of rainfall from 1961 until 1990 (the period used as the climate reference or 'climate normal' by the Bureau of Meteorology) for Nullagine (station 4027, which closed in 2004), with 2015-2017 rainfall from the MML mine site at Golden Eagle shown in Figure 4.

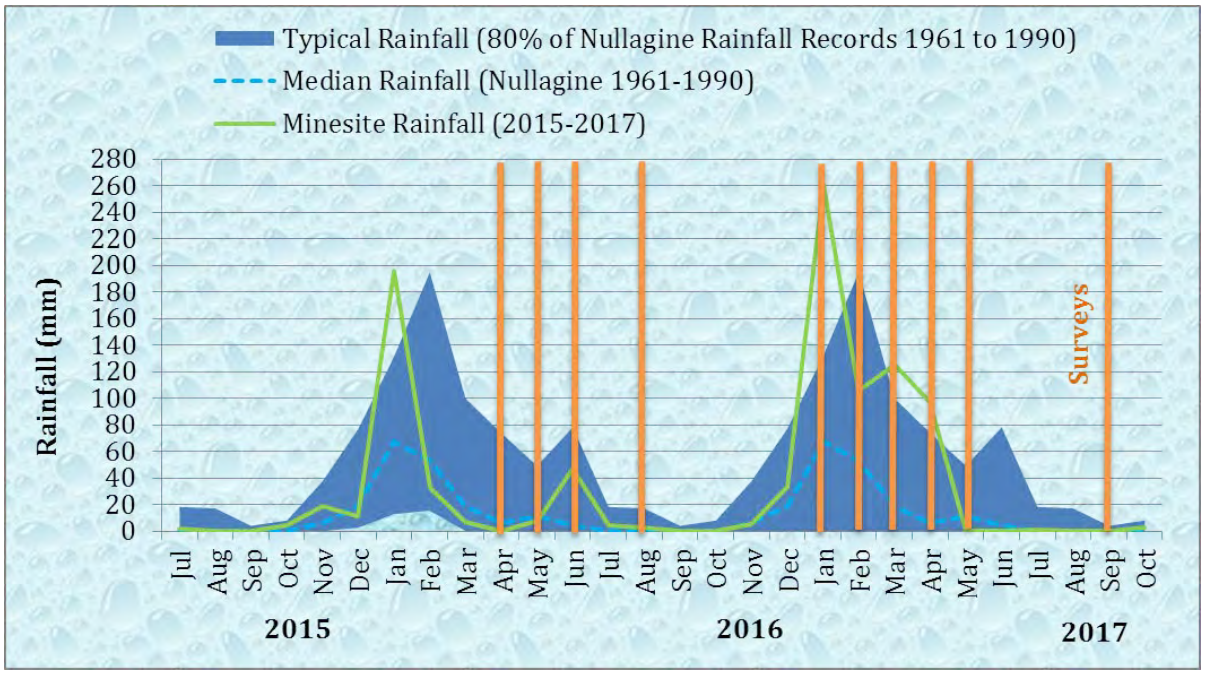

Figure 4: Comparison of Rainfall 2015 - 2016 with 'Climate Normal'

Figure 4 shows heavy rainfall in January 2016 followed by low rainfall in the following months, which is not untypical. However, the shallow soils of the extensive stony plains appears to dry very quickly and ephemeral species can be difficult to detect if not surveyed within a few weeks of major rain events. Whilst the initial survey was undertaken 3 months after the main rains, limiting the ability to survey for annual species, the flora records per site were comparable with that recorded in a nearby survey by Mattiske Consulting Pty Ltd (2016) in December 2015:

- during the survey 139 species were recorded from 59 sites, with 4 to 26, and an average of 12, taxa per site; and
- Mattiske Consulting Pty Ltd (2016) recorded 53 species from 20 sites, with 5 to 16, and an average of 11, taxa per site.

Triodia species lacked reproductive material for conclusive identification in some areas during the initial survey, but this has been addressed with areas being revisited in 2017 after rain for quality assurance, and establishment of additional quadrats in February 2017.

2.4.5 Identification of Plant Taxa

The expertise employed in the report was sufficient to provide confidence in the results and conclusions:

- the field survey was undertaken Andrew Waters and Dr Shane Chalwell (each individually with more than 15 years experience); and
- identification of plant specimens collected from quadrats, and for all priority species, undertaken by:
    - Frank Obbens, a taxonomist and research associate of the WA Herbarium (where he is a leading expert on Calandrinia plants) with more than 15 years experience, and
    - experts at the Western Australian herbarium, where appropriate.

3 RESULTS

3.1 Vegetation

3.1.1 Patterns within Land Systems

The survey area is contained within the two land systems:

- The Mosquito Land System, which covers 1,840 km² (1.0% of the Pilbara), is a unique system of stony plains and prominent ridges on schist and other metamorphic rocks that is restricted to several occurrences east of Nullagine (Vreeswyk, Payne, Leighton, & Hennig, 2004); and
- The River Land System, which covers 4,088 km² (2.3% of the Pilbara), consists of active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands, and dissects the Mosquito Land System (Vreeswyk, Payne, Leighton, & Hennig, 2004).

Table 3 shows the distribution of the major vegetation types by landforms.

Table 3: Summary of Vegetation by Landforms of Mosquito and River Land Systems

			Landforms									
			Mosquito Land System					River Land System				
Group (Floristic Formations)		**Site Types (Subformations)**	**Ridge and hill**	**Lower footslope**	**Stony plain**	**Stony saline plain**	**Drainage line and channels**	**Stony plains**	**Sandy levees and sand sheets**	**Upper terraces**	**Flood plains and lower terraces**	**Minor and major channels**
A Hill hummock grassland	HSPG	Hill spinifex grassland	X									
D Plain hummock grassland	PHSG	Plain hard spinifex grassland		X	X			X		X		
	PSSG	Plain soft spinifex grassland						X	X	X		
	SSCG	Stony plain spinifex grassland with chenopods				X						
H Alluvial plain hummock grassland	AHSG	Alluvial plain hard spinifex grassland					X				X	
	ASSG	Alluvial plain soft spinifex grassland					X		X		X	
I Alluvial plain tussock grassland	AEBG	Alluvial plain eucalypt buffel grass woodland					X		X		X	X
	APBG	Alluvial plain buffel grass woodland							X		X	
K Drainage shrubland and woodland	DAHW	Drainage acacia hummock grass shrubland/woodland					X				X	
	DEGW	Drainage eucalypt - acacia grassy woodland/shrubland					X	X	X		X	
	DEHW	Drainage hard spinifex grassland with eucalypts					X					
	DESG	Drainage soft spinifex grassland with eucalypts					X				X	
	GMEW	Gallery melaleuca eucalypt woodland										X

Source: Vreeswyk, Payne, Leighton, & Hennig (2004)

Table 4 summaries the landforms, soils and site types (which are equivalent to subformations under the NVIS framework) of the Mosquito Land System as described by DAFWA on the basis of 8 inventory sites and 153 traverse sites in the land system (Vreeswyk, Payne, Leighton, & Hennig, 2004).

Table 4: Landforms, Soils and Vegetation in Mosquito Land System

Landform	Soils	Site Types (Vegetation Subformations)	Extent within Land System
1. Ridge and hill ridges and hill tracts with narrow rounded summits and moderately inclined to steep upper slopes, surface mantles of very abundant platy pebbles, cobbles and stones of schist and greywacke, also rock outcrop; relief up to 100 m.	Stony soils with red shallow loams	HSPG Hummock grasslands of *Triodia wiseana* (hard spinifex) with isolated shrubs such as *Acacia aphanoclada*	40% 73,600 ha
2. Lower footslope very gently to gently inclined slopes extending up to 200 m below hills, surface mantles of abundant to very abundant pebbles and cobbles of schist and other rocks.	Red shallow loams	PHSG Hummock grasslands of *Triodia wiseana* with isolated shrubs	10% 18,400 ha
3. Stony plain gently undulating to undulating plains and interfluves between frequent small drainage lines usually <500 m apart, surface mantles of abundant or very abundant quartz pebbles.	Red shallow loams	PHSG Patchy hummock grasslands of *Triodia wiseana, Triodia longiceps* with isolated or very scattered shrubs such as *Acacia trachycarpa, Acacia synchronicia*	15% 27,600 ha
4. Stony saline plain undulating plains and interfluves between frequent small drainage lines usually <500 m apart; surface mantles abundant to very abundant quartz pebbles.	Shallow red/brown noncracking clays and red shallow loams	SSCG Patchy hummock grasslands of *Triodia longiceps* with isolated to scattered shrubs Acacia, Senna and Maireana spp.	25% 46, 000 ha
5. Drainage line and channels Narrow (20-100 m wide) drainage floors and small channels finely dendritic in upper parts becoming broader (up to 500 m) downstream, channels to 50 m wide.	Shallow red/brown noncracking clays and red shallow loams. Channels with river bed soils	DAHW Drainage acacia hummock grass shrubland/woodland	10% 18, 400 ha
		DESG Drainage spinifex grassland with eucalypt overstorey	
		DEGW Drainage eucalypt and acacia grassy woodland/shrubland	
		AHSG Alluvial plain hard spinifex grassland	
		ASSG Alluvial plain soft spinifex grassland	
		AEBG Aluvial plain eucalypt buffel grass woodland	

The non-stony saline plains in the west of the Mosquito Land System are captured in Table 4 as drainage floors supporting alluvial plain site types, described as being up to 500 m wide but actually up to 1 km wide and therefore appearing to be plains.

Table 5 summaries the landforms, soils and site types of the River Land System as described by DAFWA on the basis of 26 inventory sites and 401 traverse sites in the land system (Vreeswyk, Payne, Leighton, & Hennig, 2004).

Table 5: Landforms, Soils and Vegetation in River Land System

Landform	Soils	Site Types (Vegetation Subformations)	Extent within Land System
1. Sandy levees and sand sheets narrow (generally <300 m wide), ill-defined sandy levees flanking units 2 and 5 and raised up to 5 m (occasionally higher) above unit 3; also as broader sandy sheets, moundy surfaces.	Mostly red deep sands with red sandy earths, red loamy earths and some river bed soils	Hummock grasslands of *Triodia pungens* with very scattered to moderately close shrubs such as *Acacia trachycarpa* and *A. inaequilatera* (ASSG, PSSG). Tussock grasslands of *Cenchrus ciliaris*, *Eragrostis eriopoda* with very scattered to scattered acacia shrubs and trees (APBG) or open eucalypt woodlands with grass understorey of *C. ciliaris* (AEBW, DEGW).	15% 61,320 ha
2. Upper terraces level, upper terraces marginally higher (1-2 m) than unit 3, up to 500 m wide, surface mantle absent or few to many water worn pebbles; subject to occasional flooding.	Red deep sands	Hummock grasslands of *Triodia* spp. (hard spinifex) or *T. pungens* frequently with no shrubs, occasionally isolated to very scattered *Acacia* spp. shrubs and trees such as *Hakea suberea* (PHSG, PSSG).	5% 20,440 ha
3. Flood plains and lower terraces level flood plains and terraces flanking single and multiple channels of the major rivers, commonly 300-800 m wide but up to 2 km in lower reaches, often with moundy surfaces; subject to fairly regular flooding.	Deep red/brown noncracking clays and red loamy earths	Tussock grasslands of *Cenchrus ciliaris* or hummock grasslands mainly of *Triodia pungens* (APBG, ASSG, AHSG). Also scattered to moderately close *Eucalyptus victrix* or acacia woodlands/tall shrublands with prominent tussock grass understorey of *C. ciliaris, Chrysopogon fallax*, *Eulalia aurea* and others (AEBW, DEGW) or hummock grass understorey of *Triodia pungens* (DESG, DAHW).	50% 204,400 ha
4. Stony plains level to very gently inclined plains up to 500 m in extent with surface mantles of common to very abundant pebbles and water worn cobbles; some are active flood areas over old cobble beds between minor and major channels, others are raised above general flood levels.	Red shallow loams and red shallow sands	Hummock grasslands of *Triodia* spp. (soft and hard spinifex) with very scattered to scattered acacia shrubs (PSSG, PHSG). Also woodlands/tall shrublands with *Eucalyptus victrix, Acacia* spp. and tussock and hummock grasses (DEGW).	10% 40,880 ha
5. Minor and major channels Channels 30-1,000 m wide between sandy banks 1-10 m above channel beds, bedloads of sand, gravel, pebbles and stones.	River bed soils	Channels - no vegetation. Banks - close or closed fringing woodlands with *Eucalyptus camaldulensis E. victrix, Melaleuca argentea*, *M. glomerata, Sesbania formosa*, *Acacia coriacea* with understorey of sedges and grasses including *Cyprus vaginatus, Cenchrus ciliaris* and *Triodia pungens* (GMEW, AEBW).	20% 81,760 ha

3.1.2 Patterns within Survey Area

The 24 vegetation associations in the survey area are individually characterized in Appendix 1, with the distributions of the 8 site types they group into shown in Figure 5, Figure 6 and Figure 7.

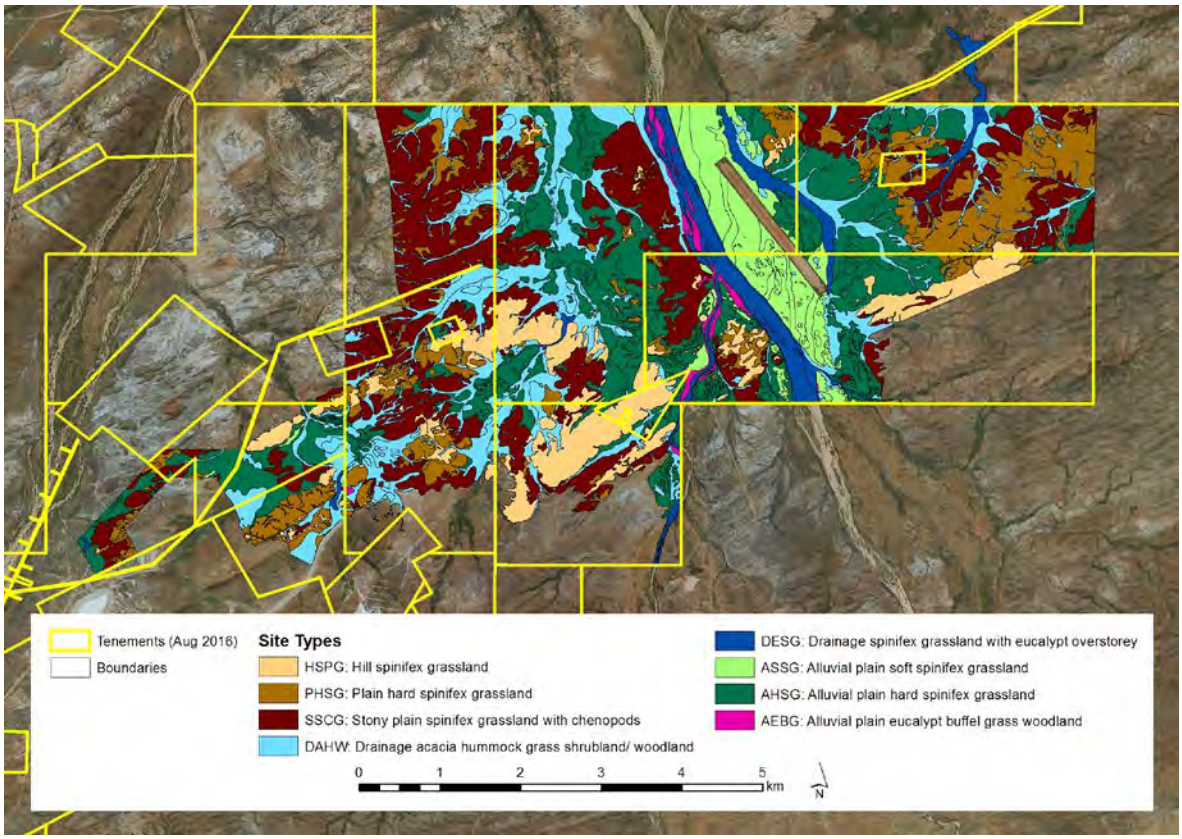

Figure 5: Vegetation in the Western (Camp to Maggie) Area

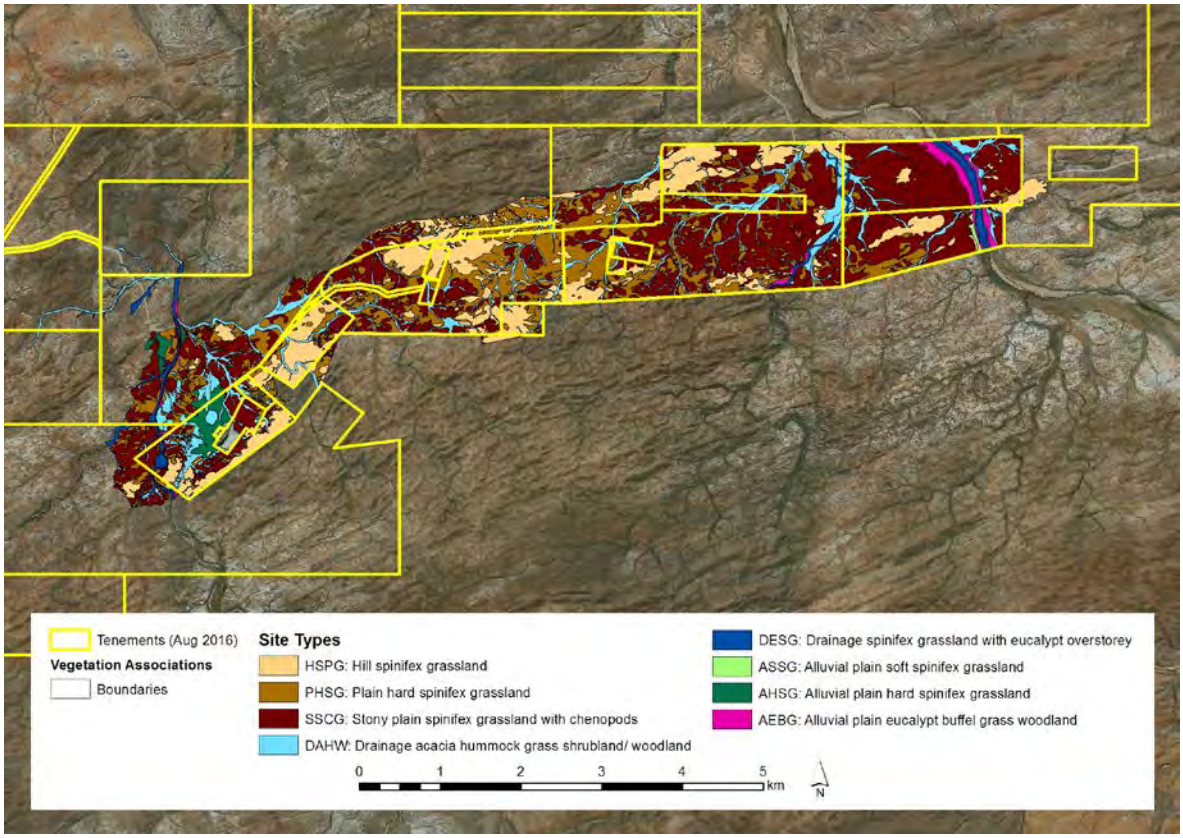

Figure 6: Vegetation in the Central (Bartons to Round Hill) Area

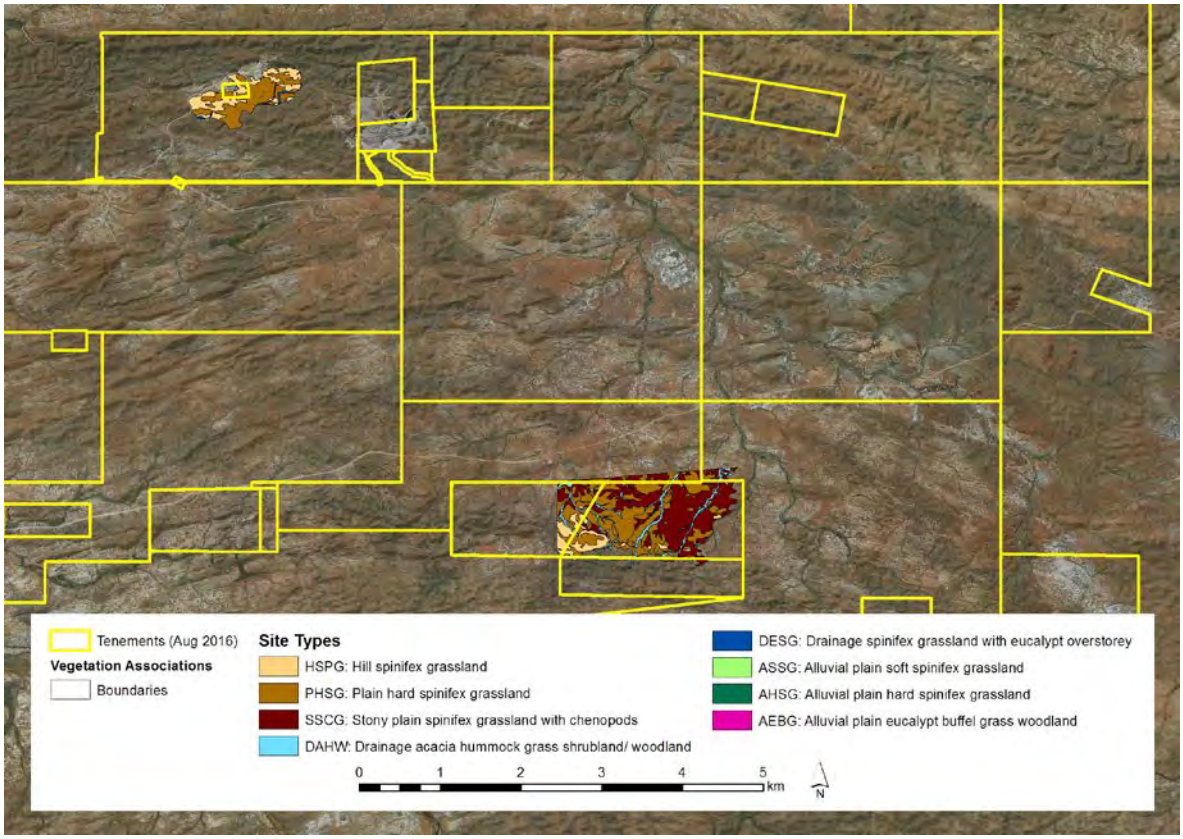

Figure 7: Vegetation in the Eastern (Golden Gate to Ard Patrick) Area

The floristic relationship between individual quadrats is shown in Figure 8.

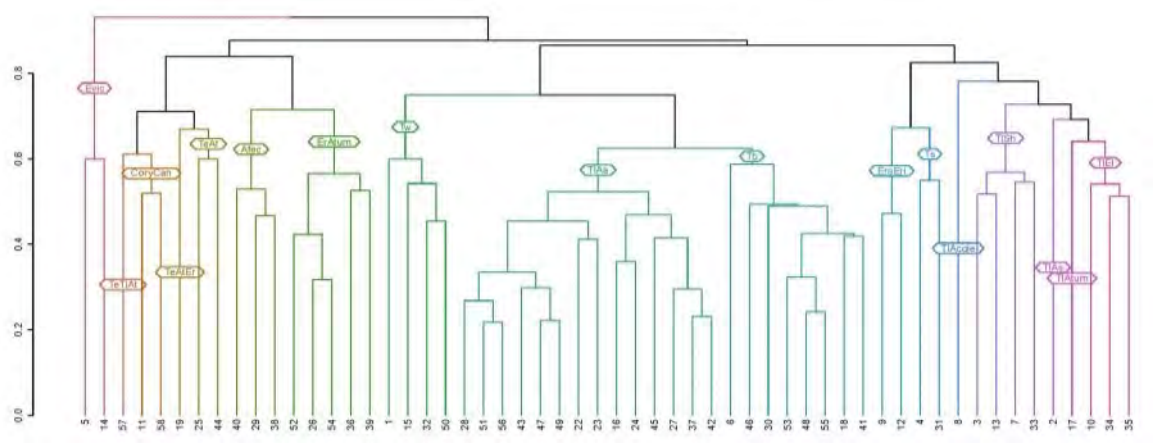

Figure 8: Dendrogram of quadrats

Vegetation associations can mosaic with, and transition into, each other due to the subtle microtopography in some areas but landscape-vegetation patterns can be elucidated with reference to the typical habitat of some of the indicative or dominant species in the associations. These are commented on Appendix 1.

The extents of the site types, and the vegetation associations they are divided into are listed in Table 6.

Table 6: Extents of Site Types and Vegetation Associations in Survey Areas

Site Types Vegetation Associations	Extent (ha)
AEBG: Alluvial plain eucalypt buffel grass woodland	**50.5**
C.ciliaris	50.5
AHSG: Alluvial plain hard spinifex grassland	**892.1**
T.longiceps-A.stellaticeps	28.4
T.longiceps-P.ferdinand-muelleri	622.4
T.longiceps-S.hostilis	241.3
ASSG: Alluvial plain soft spinifex grassland	**220.0**
E.eriopoda-A.trachycarpa	57.9
E.eriopoda-H.lorea	151.3
T.schinzii	10.7
DAHW: Drainage acacia hummock grass shrubland/ woodland	**794.0**
A.colei	101.4
A.fecunda	117.0
A.paraneura	23.6
A.tumida	79.0
T.epactia-A.trachycarpa	53.7
T.longiceps-A.trachycarpa	335.0
T.longiceps-E.eriopoda-A.trachycarpa	84.2
DESG: Drainage spinifex grassland with eucalypt overstorey	**223.2**
Creekbed	96.6
E.rowleyi-A.trachycarpa	30.3
E.victrix	58.0
T.longiceps-C.candida	38.3
HSPG: Hill spinifex grassland	**613.3**
T.wiseana	613.3
PHSG: Plain hard spinifex grassland	**982.7**
T.brizoides	216.3
T.longiceps-E.mucronata	208.9
T.longiceps-T.brizoides	475.6
T.longiceps-T.wiseana	82.0
SSCG: Stony plain spinifex grassland with chenopods	**1501.0**
T.longiceps-M.melanocoma	1501.0
Total	**5276.8**

3.2 Flora Diversity

Overall, 296 vascular plant taxa have now been recorded from 284 quadrats within the surveyed area. Previously, 259 species had been recorded from 213 sites across a more widespread but nearby areas within the Mosquito Land System (Mattiske Consulting Pty Ltd, 2012).

The species by site matrix has been supplied as an excel spreadsheet.

4 Assessment of Conservation Significance

4.1 Regional Significance of the Vegetation

The regional conservation significance of the vegetation was assessed with reference to:

- Vegetation System-Associations;
- Site Types;
- Threatened and Priority Ecological Communities;
- Species diversity; and
- Wetlands.

4.2 Vegetation System-Associations

The EPA established a position of applying a presumption against clearing of vegetation in areas where native vegetation had already been extensively cleared (in *Position Statement No. 2* (EPA, 2000) and *Guidance Statement 10* (EPA, 2006)). The scale used to determine the extent of vegetation types is that of the Vegetation System-Association, which (for the Pilbara):

- are the finest scale of mapping units used in the Comprehensive, Adequate and Representative (CAR) reserve system analysis for Western Australia (Government of Western Australia, 2015); and
- units that were mapped in the Pilbara at a scale of 1:1,000,000 by the Department of Agriculture and the Department of Environment and Conservation (Beard, 2013).

In non-constrained areas (i.e. outside urban areas), such as the survey area, the presumption against clearing applies:

- where the total extent remaining of a regional vegetation type is below a threshold of 30% of its estimated pre-European settlement extent; or
- when clearing would result in the percentage remaining falling below 30%.

The survey area is entirely contained within the Abydos Plain – Chichester 190.1 system association. The boundary of this system-association aligns with that of the Mosquito Land System (though without the excision of the Five Mile Creek, which is included in the River Land System).

The context of the proposed clearing in terms of these regional vegetation units is shown in Table 7.

Table 7: Total Extents of Abydos Plain – Chichester Plain 190.1 System-Associations

System-Association	Pre-European Extent	Current Extent	% Remaining	% Current Extent Protected (IUCN I - IV) for Conservation (proportion of Pre-European Extent)
ABYDOS PLAIN – CHICHESTER 190.1 Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* & *Acacia trachycarpa* over hard spinifex, *Triodia wiseana*	169,200 ha	169,051 ha	99.91 %	0 %

Source: Government of Western Australia (2015)
NB: Areas rounded to nearest hectare as per recommendation of Government of Western Australia (2015)

The absence of conservation reserves in the system-association is typical of the Pilbara. Only 37 of the 140 system-associations in the Pilbara IBRA Region contain conservation reserves (Government of Western Australia, 2015). The system (190, Hummock grasslands, sparse shrub steppe) was a medium priority for reservation (DPaW, 2002).

4.3 Land System and Site Types

Whilst there are no conservation reserves in the Mosquito Land System:

- This is typical of the Pilbara, where there are no DPaW-managed lands in approximately half of the land systems (EPA, 2014); and
- Most of the Mosquito Land System supports hard spinifex vegetation which is little grazed by livestock and has low susceptibility to degradation, and whilst mining activity on the system has resulted in localised disturbance and degradation, vegetation at traverse sites across the land system was assessed by Vreeswyk *et al*. (2004) as generally being in very good condition (77% very good, 18% good, fair 3% fair, and 2% poor).

The site types the vegetation associations are assigned to, are shown in Table 8.

Table 8: Assignment of Vegetation Associations to Site Types

Landforms / Vegetation Associations		Site Types											
		HSPG	PHSG	PSSG	SSCG	DAHW	DESG	DEGW	GMEW	AHSG	ASSG	APBG	AEBG
Ridges, Footslopes and Stony Plains	*Triodia wiseana*	X											
	Triodia brizoides		X										
	Triodia brizoides-Triodia longiceps		X										
	Triodia longiceps-Eriachne mucronata		X										
	Triodia longiceps-Triodia wiseana		X										
	Triodia longiceps-Maireana melanocoma				X								
Drainagelines	*Triodia longiceps-Acacia colei*					X							
	Triodia longiceps-Acacia fecunda					X							
	Triodia longiceps-Acacia paraneura					X							
	Triodia longiceps-Acacia tumida					X							
	Triodia longiceps-Acacia trachycarpa					X							
	Triodia longiceps-Eragrostis eriopoda-Acacia trachycarpa					X							
	Triodia epactia-Acacia trachycarpa					X							
	Eucalyptus rowleyi-Acacia trachycarpa						X						
	Eucalyptus victrix						X						
	Creekbed (centre of Eucalyptus victrix)						X						
	Triodia longiceps-Corymbia candida						X						
Alluvial Plains	*Triodia longiceps-Pluchea ferdinandi-muelleri*									X			
	Triodia longiceps-Sclerolaena hostilis									X			
	Triodia longiceps-Acacia stellaticeps									X			
	Eragrostis eriopoda-Acacia trachycarpa										X		
	Eragrostis eriopoda-Hakea lorea										X		
	Triodia schinzii										X		
	Cenchrus ciliaris												X

Seven of the nine native vegetation site types in either the Mosquito or River Land Systems are conserved in the 216,823 hectare DPaW-managed Meentheena Conservation Park, approximately 50 km north northeast of the survey area (see Table 9). The only site type not recorded in a conservation reserve was SSCG (Patchy hummock grasslands of *Triodia longiceps* with isolated to scattered shrubs Acacia, Senna and Maireana species). This is a Priority Ecological Community, and is discussed in Section 4.4.2.

Table 9: Extents and Reservation of Sites Types

	Site Types	No. of Land Systems (total 102)	Condition Rating	Nature conservation
Ridges, Footslopes and Stony Plains	HSPG Hill spinifex grassland	44	100% Good 0% Fair 0% Poor	HSPG is represented in conservation reserves in the Pilbara. It is in the Karijini National Park and Meentheena Conservation Park. It also occurs extensively on unallocated Crown land in the Pilbara.
	PHSG Plain hard spinifex grassland	53	98% Good 2% Fair 0% Poor	PHSG is the most common site type in the Pilbara. PHSG is well represented in conservation reserves in the Pilbara. It is in Karijini and Millstream-Chichester National Parks, Cane River Nature Reserve and the Meentheena Conservation Park. It occurs extensively on unallocated Crown land.
	SSCG Stony plain spinifex grassland with chenopod shrubs	2	87% Good 9% Fair 4% Poor	SSCG is a Priority Ecological Community. SSCG is uncommon and unusual in terms of plant species composition. It is locally impacted by grazing and mining disturbance and is largely confined to one land system, Mosquito. SSCG was not recorded on conservation reserves in the Pilbara. Two of the 67 DAFWA traverse records were on unallocated Crown land. This site type should be considered for reservation.
Drainagelines	DAHW Drainage acacia hummock grass shrubland/ woodland	36	91% Good 7% Fair 2% Poor	DAHW is well represented in conservation reserves. It is in Karijini National Park and in Meentheena Conservation Park, and in unallocated Crown land.
	DESG Drainage spinifex grassland with eucalypt overstorey	12	97% Good 3% Fair 0% Poor	DESG is in Millstream-Chichester National Park and Meentheena Conservation Park and also on unallocated Crown land.
	DEGW Drainage eucalypt and acacia grassy woodland/ shrubland	48	65% Good 16% Fair 19% Poor	This common site type is well represented in conservation reserves. It is in Karijini National Park, Cane River Nature Reserve, Meentheena Conservation Park and on unallocated Crown land.
	GMEW Gallery melaleuca eucalypt woodland	4	94% Good 6% Fair 0% Poor	GMEW vegetation is not particularly threatened by pastoral land use, although there may be locally altered environments near water holes. GMEW is in Karijini and Millstream-Chichester National Parks. It is well represented on unallocated Crown land, 6 of the 34 DAFWA traverse records were on unallocated Crown land.
Alluvial Plains	AHSG Alluvial plain hard spinifex grassland	15	81% Good 14% Fair 5% Poor	AHSG is represented in conservation reserves. It is in Cane River Nature Reserve and Meentheena Conservation Park. It was also recorded on unallocated Crown land.
	ASSG Alluvial plain soft spinifex grassland	28	76% Good 17% Fair 7% Poor	ASSG is represented, although poorly, on conservation reserves. It is in Cane River Nature Reserve and in Meentheena Conservation Park. It was also recorded on unallocated Crown land. Of the 525 DAFWA traverse records, 19 were on conservation reserves and 15 were on unallocated Crown land.
	APBG Alluvial plain buffel grass grassland	12	79% Good 17% Fair 4% Poor	These site types are defined in terms of the dominance of buffel grass (a weed species) and they should not be targeted for conservation. The plains which now support these site types presumably once supported native tussock grasses and/or saltbush shrubs.
	AEBG Alluvial plain eucalypt buffel grass woodland	2	90% Good 5% Fair 5% Poor	

4.4 Ecological Communities

DPaW maintains a state-wide dataset of ecological communities (naturally occurring biological assemblages that occur in a particular type of habitat) that are:

- Threatened Ecological Communities (TECs), which are ecological communities at risk of extinction through human action or inaction; and
- Priority Ecological Communities (PECs) for which there is insufficient information available for consideration as a TEC, or which are rare communities that are not currently threatened.

The detailed descriptions for each of the ecological communities conservation status codes used by DPaW are provided in Appendix 2. In addition to the recognition of significance by the Government of Western Australia through these listing, 17 of the TECs are also listed as Matters of National Environmental Significance (threatened ecological communities) and protected under the Commonwealth *EPBC Act 1999.*

4.4.1 Threatened Ecological Communities

There is only one terrestrial TEC in the Pilbara (DPaW, 2016). This TEC, Themeda grasslands on cracking clays (Hamersley Station), was characterised as *Alluvial plain kangaroo grass grassland* of the Brockman Land System (Site Type APKG) in *Technical Bulletin No. 92 - An inventory and condition survey of the Pilbara region, Western Australia* (Vreeswyk, Payne, Leighton, & Hennig, 2004). This vegetation type has not been recorded in the vicinity of the Mosquito Land System, and is not present in the survey area where there are no cracking clays.

4.4.2 Priority Ecological Communities

Approximately 1,500 hectares of the *Stony saline plains of the Mosquito Land System* PEC was mapped in the survey.

Stony saline plains of the Mosquito Land System were listed as a Priority 3(iii) Priority Ecological Community (PEC) as a result of a recommendation by the Department of Agriculture and Food, based on observations in *Technical Bulletin No. 92 - An inventory and condition survey of the Pilbara region, Western Australia* (Vreeswyk, Payne, Leighton, & Hennig, 2004) that the plant assemblage of hummock grasslands with chenopods on stony saline plains of the Mosquito Land System:

- were uncommon and unusual in the Pilbara in terms of plant species composition;
- locally impacted by grazing and mining disturbance;
- largely confined to one land system, although it was a common site type on the Mosquito Land System (and very minor site type on the Taylor Land System);
- was not recorded on conservation reserves;
- included chenopod low shrubs (such as *Maireana melanocoma*) that can be preferentially grazed and prone to decline if management is inappropriate;
- directly supported priority flora (*Atriplex spinulosa*);
- indirectly supported priority flora ('[t]he adjacent site type *Hill spinifex grassland* (HSPG) on hills of the Mosquito land system support[s] the priority species *Acacia aphanoclada*'); and
- required further investigation to fully describe it in terms of species assemblages and to clarify the extent of its distribution.

The PEC, as defined in *Technical Bulletin No. 92 - An inventory and condition survey of the Pilbara region, Western Australia* (Vreeswyk, Payne, Leighton, & Hennig, 2004) was not recorded on conservation reserves but:

- occurred in two Land Systems, as a major component of the Mosquito Land System and a minor component of the Taylor Land System
- was extensive, estimated to be 46, 000 ha in the Mosquito Land System; and
- in good to very condition (45% very good, 42% good, 11% fair, and 2% poor).

The locations and pasture condition where this PEC was recorded by DAFWA are shown in Figure 9.

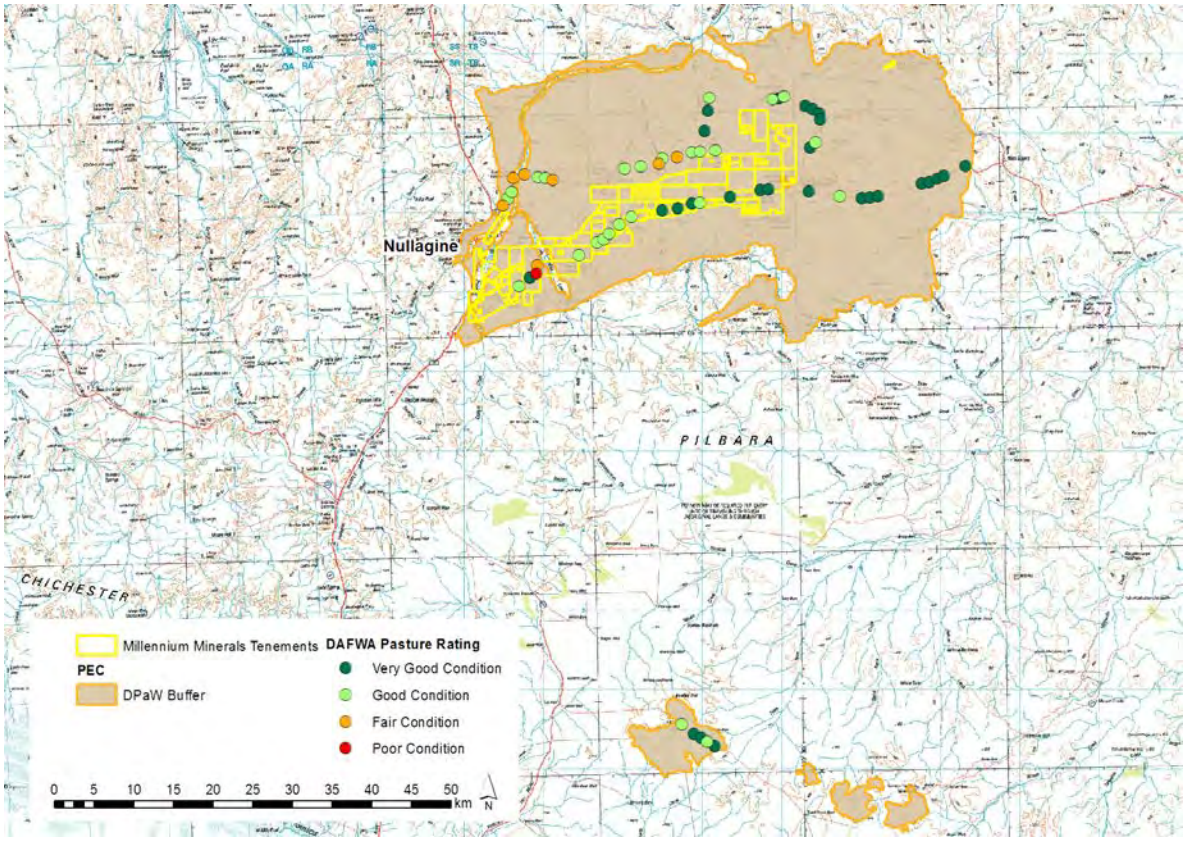

Figure 9: Condition of Sites where PEC was recorded by DAFWA (2004)

The characteristics of the Stony saline plains of the Mosquito Land System PEC are detailed in:

- *Landforms and Soils associated with* a *Priority Ecological Community within the Mosquito Land System near Nullagine, East Pilbara* (Land Assessment, 2016); and
- *Stony Plains of the Mosquito Land System PEC, May 2017/version 2.0* (Woodgis, 2017).

The ecological community can be characterised as *Triodia longiceps* grasslands with scattered *Maireana melanocoma* and *Sclerolaena* species, dissected by drainagelines typically dominated by (but not limited to) *Melaleuca eleuterostachya* and *Acacia bivenosa;* occurring on saline red brown non-cracking clays, with a mantle of quartz gravel and neutral subsurface soil material, on level to undulating plains.

The northern and southern occurrences of the PEC are sufficiently different soil-landform-vegetation units that the conservation value of each should be assessed individually as well as collectively.

DAFWA's estimate that the PEC occupies approximately 46,000 ha is reasonable, as it is consistent with an initial classification of satellite imagery shown in Figure 10.

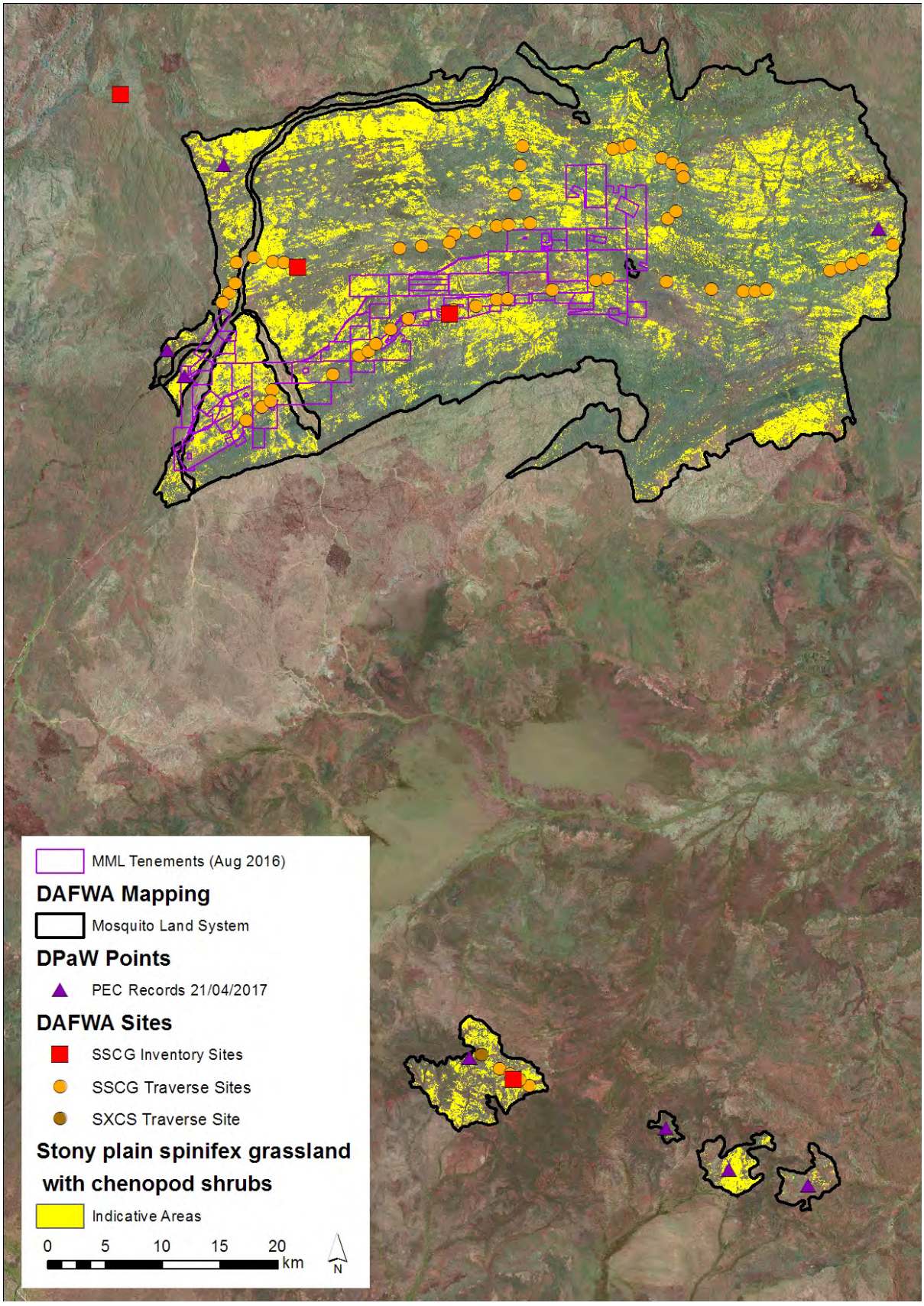

Figure 10: Indicative PEC Distribution

4.5 Species Diversity

The survey was not located in the only area listed for high species and ecosystem diversity in the Chichester IBRA Subregion, 'Cracking clay communities of the Chichester Range and Mungaroona Range' (DPaW, 2002).

An inventory of only 296 species was compiled from 284 quadrats in the survey. Previously, 259 species had been recorded from 213 sites across a more widespread but nearby areas within the Mosquito Land System (Mattiske Consulting Pty Ltd, 2012).

4.6 Wetlands

The wetlands mapped in the Mosquito Land System by Geoscience Australia at a scale of 1:250,000 are shown in Figure 11.

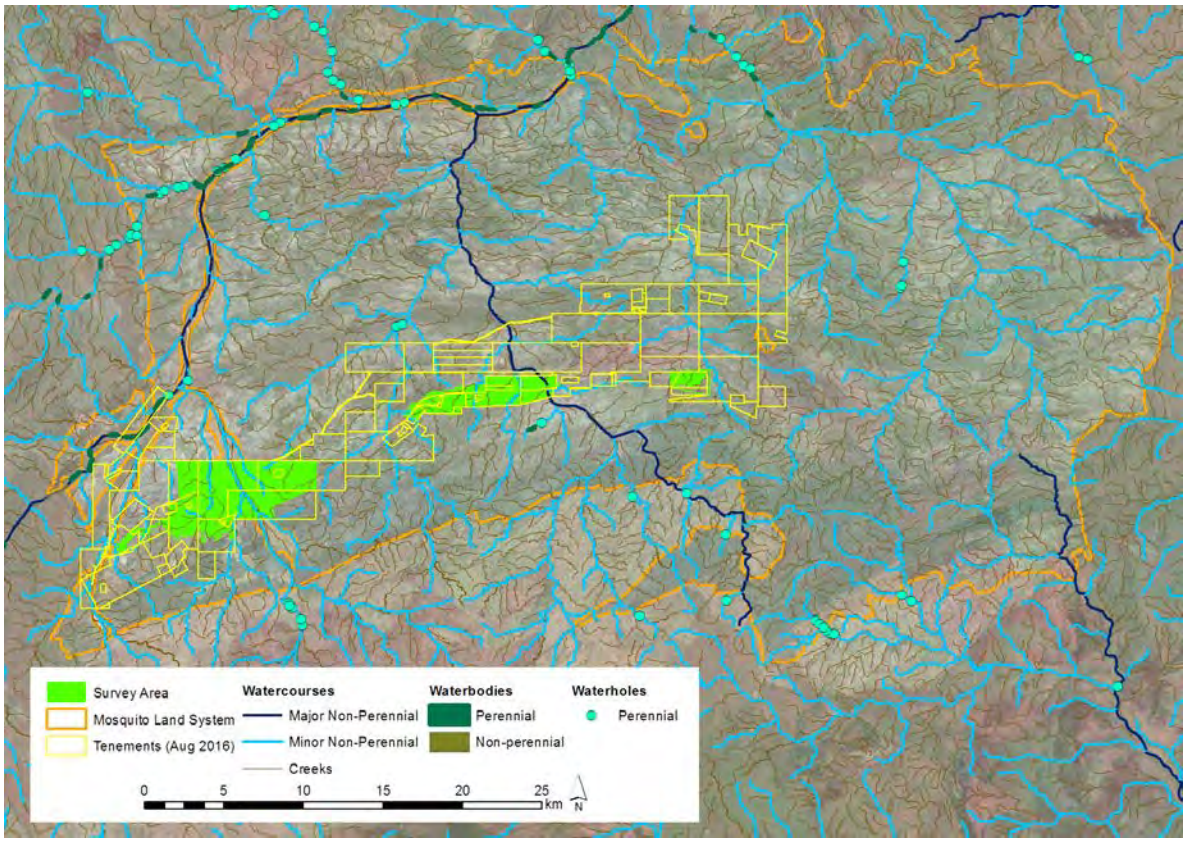

Figure 11: Wetlands in the Mosquito Land System

Geoscience Australia mapped:

- in the Mosquito Land System, 20 perennial waterholes and 17 perennial 'lakes' along the larger rivers and no gnamma holes, native wells, pools, rockholes, soaks or springs; and
- in the survey area, there were only ephemeral watercourses.

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APPENDIX 1: VEGETATION ASSOCIATION DESCRIPTIONS

Site Type SSCG: Patchy hummock grasslands of *Triodia longiceps* with isolated to scattered shrubs Acacia, Senna and Maireana species

***Triodia longiceps – Maireana melanocoma* shrubland**

Plate A1.01: Quadrat 28

Occurrence
- Gently inclined stony plains on quartz

Trees
- absent

Shrubs
- often absent/restricted to minor drainage lines dissecting community.
- shrubs include *Acacia arrecta, Acacia bivenosa,* , *Acacia fecunda, Melaleuca eleuterostachya.*
- better drained areas (domed or elevated areas) may support *Frankenia species* and *Ptilotus wilsonii* (P1)

Herbs
- often present but sparse.
- typical species include *Maireana melanocoma, Sclerolaena densiflora, Sclerolaena lanicuspis*

Maireana melanocoma
- occurs on hills and rocky uplands with skeletal soils underlain by rock or hardpan (Mitchell & Wilcox, 1994)
- rapidly disappears even under moderate grazing (Mitchell & Wilcox, 1994)

Grasses
- *Triodia longiceps* always present in low-medium densities

Site Type HSPG: Hummock grasslands of *Triodia wiseana* (hard spinifex) with isolated shrubs such as *Acacia aphanoclada*

***Triodia wiseana* grassland**

Plate A1.02: Quadrat 15

Occurrence
- Large Hills
- Rocky slopes (rocks typically appear to be fractured vertically)
- narrow bands along some drainagelines

Trees
- absent

Shrubs
- absent to medium densities
- possibly can be subdivided on basis of presence/absence of any shrubs, or presence of *Acacia aphanoclada, Acacia arrecta, Acacia inaequilatera*

Herbs
- usually absent.

Grasses
- *Triodia wiseana* always present in low-medium densities

Triodia wiseana
- occurs on calcareous soils including on upland fold ranges with calcareous dark brown light medium clays, on plains with stony calcrete soils, strongly alkaline dykes, deep calcareous gradational loams (WAM, 1991)
- also recorded as occurring on basic or dolomite derived soils by van Etten (1987)
- occurs in areas with seasonal waterlogging followed by extreme desiccation, which has resulted in pan horizons (35-65 cm deep) that largely exclude trees (WAM, 1991).

Site Type PHSG: Patchy hummock grasslands of *Triodia wiseana, T. longiceps* (hard spinifex) with isolated or very scattered shrubs such as *Acacia trachycarpa, A. synchronicia*

***Triodia brizoides* grassland**

Plate A1.03: Quadrat 18

Occurrence
- Foothills/Footslopes
- Rocky slopes where rocks typically appear to be fractured horizontally

Trees
- absent

Shrubs
- usually absent

Herbs
- usually absent

Grasses
- *Triodia brizoides* always present in low-medium densities

Triodia brizoides
- occurs in areas subject to seasonal waterlogging followed by extreme desiccation, which has resulted in pan horizons that largely exclude the presence of trees (WAM, 1991)
- occurs on fold ranges with non-calcareous dark red stony sandy loams over medium clays, and plains with stony ferricrete soils, dark red stony duplexes or gradational slightly alkaline medium textured soils with ferricrete (65 cm deep) (WAM, 1991)

Triodia brizoides-Triodia longiceps grassland

Plate A1.04: Quadrat 23

Occurrence

- Gently inclined stony plains on quartz
- footslopes slopes above
- transition between *Triodia brizoides* and *Triodia longiceps – Maireana melanocoma* vegetation types
- slightly redder and rougher stony surface (that is more solid underfoot (less prone to pugging) than *Triodia longiceps – Maireana melanocoma* vegetation type

Trees

- absent

Shrubs

- usually absent

Herbs

- usually absent

Grasses

- *Triodia brizoides* always present in low-medium densities
- *Triodia longiceps* often present in low densities

Triodia longiceps - Eriachne mucronata grassland

Plate A1.05: Quadrat 16

Occurrence
- stony slopes of undulating hills
- rocky hillocks

Trees
- absent

Shrubs
- absent to medium densities
- low diversity but variable *Acacia synchronicia, Senna* species

Herbs
- usually absent.

Grasses
- *Triodia longiceps* always present in low-medium densities
- *Eriachne mucronata* present on skeletal rock outcrops

Triodia longiceps
- occurs along small dry watercourses and rocky gullies (Burbidge, 1953)
- occurs on very strongly alkaline duplex friable clayey sand topsoil over compact massive columnar sandy clay subsoils often patchily duricrusted in thin sheets (profile highly alkaline and calcareous throughout, with non-sodic topsoil and extremely saline C horizon below the columnar layer), often with gypsic deposits on the surface; and calcareous sodic/gypsic soils of columnar clays with 6-30 cm of friable topsoil (WAM, 1991)
- occurs on calcrete and coarse textured alluvium along creeks, overlying hard alkaline red soil (Suijdendorp, 1978)
- in central Australia, generally associated with calcareous areas on rocky hills or gentle slopes liable to flooding from adjacent hills (Lazarides, 1970)
- in central Australia, occurs on soils on basic rocks, that are skeletal or shallow, sandy red earths and gritty clayey soils, and to a lesser extent , deeper duplex soils (Lazarides, 1970)

Triodia wiseana-Triodia longiceps grassland

Occurrence
- narrow shelves adjacent drainagelines and low rises

Trees
- absent

Shrubs
- variable
- *Acacia aphanoclada* usually absent

Herbs
- usually absent

Grasses
- *Triodia wiseana* always present in medium-high densities
- *Triodia longiceps* often present in low-mdeium densities

Site Type DAHW: Drainage acacia hummock grass shrubland/woodland

***Triodia longiceps - Acacia fecunda* shrubland**

Plate A1.06: Quadrat 29

Occurrence
- Upper intermediate drainagelines in stony areas
- Mostly east of Five Mile Creek

Trees
- scattered *Eucalyptus leucophloia*

Shrubs
- usually present in high densities
- shrubs include *Acacia fecunda*

Acacia fecunda
- favours water-gaining sites. (Maslin & van Leeuwen, 2008)

A. tumida
- absent (interzone of *Acacia fecunda* and *Acacia tumida* absorbed into as *Acacia tumida* drainageline vegetation unit)

Herbs
- absent

Grasses
- *Triodia longiceps* often present in medium-high densities

Triodia longiceps - Acacia tumida shrubland

Plate A1.07: Quadrat 17

Occurrence
- Lower intermediate drainagelines in stony areas
- Mostly east of Five Mile Creek

Trees
- scattered *Eucalyptus leucophloia*
- patches of *Eucalyptus rowleyi* (which grows in clay in banks, as opposed to *Acacia tumida* which grows in sand/stone in creekbeds)

Shrubs
- usually present in high densities
- shrubs include *Acacia tumida, Acacia fecunda*

Acacia tumida
- prefers sandy soils but can grow on hard stony soils (Tyler, 1988)
- generally occurs in open woodlands along seasonal creeks and drainage lines, on neutral to alkaline soils including sands, clay loams or gravely clays derived mainly from alluvium (McDonald, 2003).
- can vary in prominence over time as it is fast-growing and short-lived (Tyler, 1988) and most abundant at sites affected by fire or soil disturbance (McDonald, Butcher, Bell, & Nguyen, 2003).

Herbs
- absent

Grasses
- *Triodia longiceps* often present in medium-high densities

***Triodia longiceps - Acacia trachycarpa* shrubland**

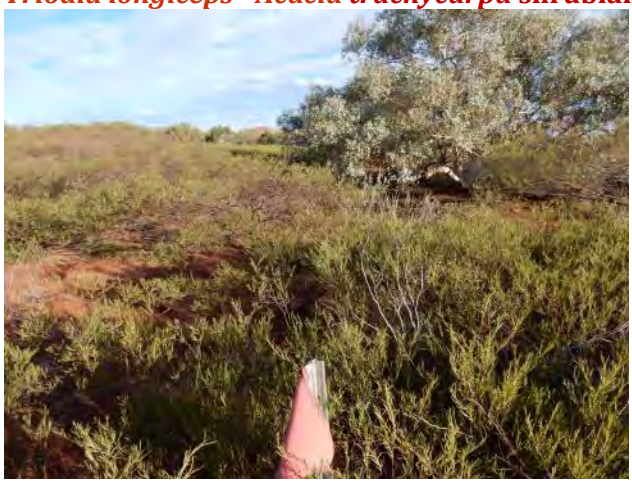

Plate A1.08: Quadrat 25

Occurrence
- Minor drainagelines in sand, clay and stony areas

Trees
- scattered *Eucalyptus leucophloia*

Shrubs
- usually present in high densities
- shrubs include *Acacia trachycarpa, Acacia bivenosa, Melaleuca eleuterostachya, Petalostylis labicheoides*

Acacia trachycarpa
- occurs on alluvial floodplains along rivers generally, with occasional individuals on granite outcrops (WAM, 1991)
- More generally it grows along watercourses, typically on sands, but also "lateritic" soils (Tyler, 1988).

Herbs
- absent

Grasses
- *Triodia longiceps* often present in medium-high densities

***Triodia longiceps – Eragrostis eriopoda – Acacia trachycarpa* shrubland**

Plate A1.09: *Triodia longiceps – Eragrostis eriopoda – Acacia trachycarpa* shrubland

Occurrence
- Shallow soil over clay
- Deeper soils within and adjacent intermediate drainagelines
- Mostly west of Five Mile Creek

Trees
- scattered *Eucalyptus leucophloia*

Shrubs
- *A.trachycarpa from* low to high densities

Herbs
- often present but sparse.

Grasses
- *Triodia longiceps* always present in medium-high densities
- *Eragrostis eriopoda* from scattered to high densities

***Triodia longiceps - Acacia colei* shrubland**

Plate A1.10: Quadrat 17

Occurrence

- Lower intermediate drainagelines in clay areas west of Five Mile Creek
- Larger/wetter drainagelines than *Triodia longiceps –Acacia trachycarpa* vegetation units

Trees

- scattered *Eucalyptus leucophloia*
- rarely *Eucalyptus rowleyi*

Shrubs

- usually present in high densities
- shrubs include *Acacia colei, Acacia acradenia*, *Acacia trachycarpa*

Acacia colei

- is a colonising species and may form dense regrowth populations in disturbed sites such as road verges, gravel pits and burnt areas (Maslin & J. E. Reid, 2010)
- grows in a variety of soils including red-brown stony clay, deep aeolian sand, red sandy loam and fine-textured clay and silty clay. These soils are typically neutral but range from acidic (pH 5.5) to alkaline (pH 8.5) (Maslin & J. E. Reid, 2010)
- Some populations occur on the margins of saline drainage systems (Maslin & J. E. Reid, 2010)

Acacia acradenia

- Occurs in upper portion of vegetation unit
- Common in the arid country of northern Australia (Maslin B. , 2001)
- Grows in skeletal sandy soils and red earths, on laterite, sandstone or calcrete, on rocky hillsides or in gorges, often along creeks (Maslin B. , 2001)

Herbs

- absent

Grasses

- *Triodia longiceps* often present in medium-high densities

***Triodia longiceps - Acacia paraneura* shrubland**

Plate A1.11: Quadrat 8

Occurrence
- shallow depressions in clay areas
- low flats adjacent *Triodia longiceps – Acacia colei* drainage lines in clay areas

Trees
- *Acacia paraneura*

Acacia paraneura
- most stands in survey area were small/immature
- Habitat data are poor, but the species is recorded from sandy and gravelly soils along streams and outwashes from hills (Maslin B. , 2001)

Shrubs
- scattered *Carissa lanceolata, Maireana planifolia*

Herbs
- scattered *Alternanthera nana, Cucumis variabilis, Fimbristylis dichotoma*

Grasses
- *Triodia longiceps, Aristida holathera* var. *holathera, Paspalidium rarum* present in low-high densities

***Triodia epactia - Acacia trachycarpa* shrubland**

Plate A1.12: Quadrat 25

Occurrence
- Peripheral to *Eucalyptus rowleyi-Acacia trachycarpa* vegetation unit
- Floodout on shallow sand over clay

Trees
- absent

Shrubs
- *Acacia trachycarpa* in high densities

Herbs
- scattered

Grasses
- *Triodia epactia* in medium - high densities

Triodia epactia
- Chiefly in deep, red or white or pink-brown, sandy soils (Simon & Alfonso, 2016)

Site Type DESG: Drainage spinifex grassland with eucalypt overstorey

***Eucalyptus rowleyi-Acacia trachycarpa* shrubland**

Plate A1.13: Quadrat 19

Occurrence
- Floodout on clay

Trees
- *Eucalyptus rowleyi*
- scattered *Eucalyptus leucophloia*

Eucalyptus rowleyi
- occurs on red sandy loams on plains and very minor and broad flood-out plains, often in small pure stands or in open mallee vegetation with other eucalypt species (Nicolle & French, 2012)

Shrubs
- usually present in high densities
- shrubs include *Acacia trachycarpa*

Herbs
- absent

Grasses
- *Triodia longiceps* often present in medium-high densities

Triodia longiceps - Corymbia candida woodland

Plate A1.14: Quadrat 11

Occurrence
- seep between hills
- floodout at interface of sand and clay

Trees
- *Corymbia candida* always present
- Scattered *Corymbia hamersleyana*

Corymbia candida
- prefers low-lying sites of red-soil plains but in the upper Gascoyne and around Telfer and Marble Bar can occur on stony sites (Slee, Brooker, Duffy, & West, 2006).

Shrubs
- usually present in high densities
- abundant *Acacia colei, Acacia acradenia*, *Acacia trachycarpa*
- scattered *Indigofera monophylla, Scaevola spinescens, Solanum morrisonii*

Herbs
- scattered

Grasses
- *Triodia longiceps*, *Themeda triandra, Chrysopogon fallax* often present in medium-high densities

Site Type DEWG: Drainage eucalypt and acacia grassy woodland/shrubland

***Triodia angusta - Eucalyptus victrix* woodland**

Plate A1.15: Quadrat 5

Occurrence

- Major creeklines (Five Mile and Twenty Mile Creeks)

Trees

Eucalyptus victrix always present
scattered *Eucalyptus camaldulensis, Acacia coriacea* subsp. *pendens, Melaleuca bracteata*

Eucalyptus victrix

- occurs on low-lying areas of red clay or clay loam subject to irregular flooding (Slee, Brooker, Duffy, & West, 2006)

Shrubs

- scattered *Atalaya hemiglauca, Flueggea virosa* subsp*. melanthesoides, Gossypium robinsonii*

Herbs

- scattered

Grasses

- *Triodia angusta* present in low to medium densities
- scattered *Eulalia aurea*

Triodia angusta

- habitat includes banks of rivers and creeks; stony watercourses; margins of salt flats and calcareous drainage floors (Simon & Alfonso, 2016)

Site Type ASSG: Alluvial plain soft spinifex grassland

***Triodia schinzii* grassland**

Plate A1.16: Quadrat 4

Occurrence
- Adjacent major creeklines (Five Mile and Twenty Mile Creeks)
- in small patches within *Eragrostis eriopoda – Hakea lorea* vegetation unit
- deep red sands

Trees
- scattered *Corymbia hamersleyana*

Shrubs
- Typically includes shrubs such as *Hakea lorea*

Herbs
- scattered

Grasses
- *Triodia schinzii* in medium - high densities

Triodia schinzii
- habitat includes sandy areas, such as alluvial creek levees (Simon & Alfonso, 2016)
- chiefly on plains, dunes, sandhills, swales and pindan in deep, red sands, sandy loams, clayey sands and sandy red earths; also on shallow stony soils, alluvial creek levees (Lazarides, 1997)
- one of the most palatable spinifex species (Lazarides, 1997).

Eragrostis eriopoda- Hakea lorea shrubland

Plate A1.17: Quadrat 4

Occurrence
- Adjacent major creeklines (Five Mile and Twenty Mile Creeks)
- Medium deep red sands

Trees
- scattered *Corymbia hamersleyana*

Shrubs
- Typically includes shrubs such as *Hakea lorea*
- Twenty Mile (Sandy) Creek also includes *Acacia ancistrocarpa* in this community.

Herbs
- scattered

Grasses
- ***Eragrostis eriopoda*** in medium - high densities

Eragrostis eriopoda
- occurs commonly in deep, red sands and sandy loams on sandplains, watercourse levees, dunes and swales (Lazarides, 1997)
- habitat includes sand plains, red clayey sands and red earths on sandplains and floodplains (Bowman, King, Reu, & Fisher, nd)
- moderately palatable and normally grazing is restricted to new growth and survives consistent stocking (Bowman, King, Reu, & Fisher, nd)
- tolerant of heavy stocking (Lazarides, 1997)

Eragrostis eriopoda- Acacia trachycarpa grassland

Plate A1.18: Quadrat 16

Occurrence
- Adjacent major creeklines (Five Mile and Twenty Mile Creeks)
- Slightly lower bands within *Eragrostis eriopoda – Hakea lorea* vegetation unit
- deep red sands

Trees
- scattered *Corymbia hamersleyana*

Shrubs
- *Acacia trachycarpa* in high densities

Herbs
- scattered

Grasses
- *Eragrostis eriopoda* in medium - high densities
- scattered *Triodia longiceps*

Site Type AHSG: Alluvial plain hard spinifex grassland

***Triodia longiceps - Acacia stellaticeps* shrubland**

Plate A1.19: Quadrat 2

Occurrence
- Peripheral to *Eragrostis eriopoda – Hakea lorea* vegetation unit
- Shallow sand over clay

Trees
- absent

Shrubs
- *Acacia stellaticeps* in high densities

Acacia stellaticeps
- can displace soft spinifex species, such as *Triodia schinzii*, under heavy grazing (Vreeswyk, Payne, Leighton, & Hennig, 2004)

Herbs
- scattered

Grasses
- *Triodia longiceps* in medium - high densities

Triodia longiceps – Pluchea ferdinandi-muelleri grassland

Plate A1.20: Quadrat 13

Occurrence
- Level shallow soils of varying depths over clay
- Mostly west of Five Mile Creek

Trees
- scattered *Eucalyptus leucophloia*

Shrubs
- usually present in low-medium densities
- shrubs include *Pluchea ferdinandi-muelleri, Pluchea tetrantha, Pterocaulon sphacelatum, Corchorus* species, *Senna* species
- variability due to variability in soil depth

Pluchea tetrantha
- Red sandy soils on plains, on alluvium, or on lateritic breakaways (Bean, 2015)

Herbs
- often present but sparse.

Grasses
- *Triodia longiceps* always present in medium-high densities

Triodia longiceps – Sclerolaena hostilis grassland

Plate A1.21: *Triodia longiceps – Sclerolaena hostilis* grassland

Occurrence
- Low-lying level plains
- Intermittently inundated clay flats next to five mile creek
- These are degraded communities within alluvial plain hard spinifex grasslands (Vreeswyk, Payne, Leighton, & Hennig, 2004)
- Heavy grazing after fire can result in patches of old *Triodia longiceps* with large areas of bare scalded ground between hummocks, and occasionally the spinifex is replaced by *Sclerolaena hostilis* (Vreeswyk, Payne, Leighton, & Hennig, 2004)

Trees
- absent

Shrubs
- absent

Herbs
- scattered *Sclerolaena hostilis*

Sclerolaena hostilis
- can displace spinifex species on degraded alluvial plains (Vreeswyk, Payne, Leighton, & Hennig, 2004)
- is palatable to stock and indicates good range condition (Mitchell & Wilcox, 1994)
- grows on semi-saline clays on the Roebourne Plain (Mitchell & Wilcox, 1994)

Grasses
- *Triodia longiceps* absent to present in low densities

Site Type AEBG: Alluvial plain eucalypt buffel grass woodland

***Cenchrus ciliaris* grassland**

Plate A1.22: *Cenhrus ciliaris* Grassland

Occurrence

- Adjacent major creeklines (Five Mile and Twenty Mile Creeks)
- degraded *Triodia angusta – Eucalyptus victrix* and *Eragrostis eriopoda – Hakea lorea* vegetation units

Trees

always present
scattered *Eucalyptus victrix, Acacia coriacea* subsp. *pendens, Melaleuca bracteata*

Shrubs

- scattered *Atalaya hemiglauca, Flueggea virosa* subsp. *melanthesoides, Gossypium robinsonii, Hakea lorea*

Herbs

- scattered

Grasses

**Cenchrus ciliaris* present in high densities

**Cenchrus ciliaris*

- a forage species now well established in Australia (Simon & Alfonso, 2016)
- is a weed that is well-established in the Pilbara, especially coastal areas and the floodplains of major rivers (Vreeswyk, Payne, Leighton, & Hennig, 2004)

APPENDIX 2: DPaW CONSERVATION SIGNIFICANCE CODES

DPaW – Ecological Community Codes

Presumed Totally Destroyed (PD)
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.
An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**
B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):
   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);
   ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.
B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):
   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);
   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;
   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.
C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):
   i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);
   ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.
B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):
   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);
   ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;
   iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.
C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.
An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.
B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.
C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Priority One: Poorly-known ecological communities
Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities
Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities
(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.
Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.
(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities
Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.