Assessment of the Flora and Vegetation at the Toro Energy Wiluna Uranium Project: Millipede Project Area.

Report prepared for

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1.0 SUMMARY

Toro Energy Ltd (Toro) is proposing to develop uranium resources within the Millipede Project of its Wiluna Uranium Project. The project area is contigious with the Toro Centipede project area, for which state and federal approval has been received. To develop the resources, Toro need to submit a mining application, within which a summary of environmental impacts is provided. One area for which potential impacts require an assessment relate to flora and vegetation. Toro contracted Niche Environmental Services (Niche) to undertake flora and vegetation studies over the proposed Millipede Project. This report documents the findings of survey work completed over the project area.

Prior to commencing the field surveys, a desktop review was undertaken. The key findings from the desktop review were:

- No flora and vegetation matters were noted in the *Protected Matters database* search that related to the project area;
- There were no Threatened (Declared Rare) Flora (T) listed for the project area and surrounds A total of 27 priority flora were listed in the DEC database, of which six were priority 1 taxa (P1), 17 were priority 3 taxa (3) and the remaining four were priority 4 taxa. No recrods were within the Millipede Project; and
- No Threatened Ecological Communities (TECs) as defined by the DEC were identified as occurring within the project area or surrounds. There were two vegetation Priority Ecological Communities (PECs) listed in the database, neither of which were within the survey areas.

Field surveys were conducted over the Millipede Project area as a part of regional surveys for the assessment of the Centipede Project, with these surveys conducted during 2010, with additional surveys conducted during October 2013. In total, 30 quadrats were surveyed within, or in close proximity to, the project area.

A total of 10 vegetation types were defined and delineated within the Millipede Project. The vegetation was located in five distinct landforms: playa (salt lake edge), fringing zone, dunes, calcrete platforms and claypans. Vegetation on playas and claypans was dominated by halophytic vegetation, primarily chenopods, while calcrete vegetation was dominated by *Acacia* species. The dunes were divided into foredunes, with *Acacia* species over spinifex, and dunes, with mallee eucalypts and *Acacia* species over spinifex, while the fringing vegetation was dominated by *Melaleuca xerophila.*

Of the vegetation units identified during the surveys, the salt lake *Tecticornia* vegetation units and the calcrete vegetation units hosting *Eremophila arachnoides* subsp. *arachnoides* were considered to have conservation significance. The salt lake units were presented as having conservation significance, largely due to unresolved taxonomy and a lack of understanding of the hydrological

requirements of this unit. The balance of the vegetation was not considered to have conservation significance.

A total of 185 species, including subspecies and variants, were recorded during the surveys. This figure does not include collections of *Tecticornia* species, for which taxonomic work is still ongoing. The 185 species were from 100 genera within 40 families, with Chenopodiaceae the most speciose. Two priority species were recorded during the surveys; *Eremophila arachnoides* Chinock subsp. *arachnoides* (Scrophulariaceae) (P3); and *Stackhousia clementii* Domin (Celastraceae) (P3). *Eremophila arachnoides* Chinock subsp. *arachnoides* was noted as being comparatively common, with an estimated population of this species within and near the Millipede project of 5 440 plants. There were nine records of *S. clementii* made during targeted searches in spring 2013, with greater than 300 plants observed, all within Abercrombie Creek. Based on the proposed development footprint within the Millipede project, these plants are all likely to be removed. It is noted that during previous surveys, approximately 500 – 1000 plants were recorded in a seasonal creek line to the west of the Millipede project.

No declared plants or environmental weeds were recorded in the Millipede project during the spring 2013 surveys. There have been previous records of the environmental weed *Acetosa vesicaria* (ruby dock) in the Centipede project area, although these records were not close to the Millipede project. Toro have conducted weed management activities within there tenements, and regularly monitor to ensure that new populations are identified and controlled.

The survey work as detailed in this report was conducted in accordance with the guidelines of the EPA. The work in general is considered to meet the underlying requirements for a Level 2 survey, in relation to timing and intensity of surveys. There is a need to assess the hydrological requirements of inferred groundwater dependent ecosystems and to complete taxonomic work of *Tecticornia* species prior to commencement of any meaningful disturbance.

2.0 INTRODUCTION

2.1 Project Background

Toro Energy Ltd (Toro) is proposing to develop uranium resources within the Millipede Project of its Wiluna Uranium Project. The project area is contigious with the Toro Centipede project area, for which state and federal approval has been received. To develop the resources, Toro need to submit a mining application, within which a summary of environmental impacts is provided. One area for which potential impacts require an assessment relate to flora and vegetation. Toro contracted Niche Environmental Services (Niche) to undertake flora and vegetation studies over the proposed Millipede Project. This report documents the findings of survey work completed over the project area.

2.2 Scope and Objectives of the Study

The level of assessment for the Centipede, Lake Way and West Creek Borefield of the Toro Wiluna Uranium Project was set by the EPA at Environmental Review and Management Programme (ERMP), which is the highest level of assessment. While this level of assessment no longer exists, it is considered that a Public Environmental Review, the current highest level of assessement for the EPA, will be set for the Millipede Project. To conform to the expected information requirements for the assessment, a Level 2 survey as defined by the EPA (2004) was considered appropriate. A Level 2 survey is the most comprehensive survey prescribed by the EPA, with the central requirement being a quadrat-based survey over proposed areas of disturbance.

A Level 2 survey is comprised of

- A desktop review to collect ecological data relevant to the area to be surveyed and surrounds, including:
    - Searches of relevant DEC databases;
    - A search of the EPBC Act Protected Matters database; and
    - Reviews of publicly-available ecological information.
- A site visit to
    - Conduct a reconnaissance survey with the objectives of:
        - Verifying the information collected in the desktop review;
        - Completing a census of the flora, with a focus on determining the presence of any flora of conservation significance;
        - Assessing the condition of the vegetation;
        - Developing a preliminary delineation and description of the vegetation; and
        - Identifying any potential impacts.
    - Complete a quadrat-based survey of the vegetation to assist with:
        - Enhancing knowledge of the flora and vegetation, with the specific aim of placing the vegetation in a local and regional context. This is achieved by collecting data in a manner consistent with known or recommended levels of

sampling effort and quadrat sizes. A minimum of two quadrats per vegetation unit is recommended.

This report contains the following

- An overview of the survey sites, which serves to place the survey sites in a regional context;
- The findings of the desktop review;
- A detailed description of the methods used;
- A summary of the flora recorded, with reference to flora of conservation significance;
- The findings of the field survey, incorporating a description of the vegetation, an assessment of the condition using the scale devised by Keighery (1994), an assessment of the extent of the vegetation and conservation significance of the vegetation; and
- An assessment of the adequacy of the survey.

3.0 SURVEY AREA

3.1 Study site

The Millipede Project is located approximately 27 km south-southeast of the town of Wiluna in Western Australia (**Figure 1**). The project is comprised of tenement M53/1095, which is 610 ha in area, and tenement M53/336, which is 567 ha in area (**Figure 2**). The Millipede Project is adjacent to the Centipede Project, which has received formal approval at both the State and Federal level.

3.2 Environmental Setting

3.2.1 IBRA Bioregion

The Toro Wiluna Uranium Project is located within the Murchison biogeographic region (bioregion) of the Interim Biogeographic Regionalisation for Australia (or IBRA) (Thackway and Cresswell, 1995). The Murchison bioregion comprises the northern part of the Yilgarn Craton and is further defined into two subregions; the Eastern Murchison (MUR1), and the Western Murchison (MUR2). The project is within the Eastern Murchison (MUR1) subregion.

The Eastern Murchison subregion is approximately 7 847 996 ha in size and comprises the “Southern Cross” and “Eastern Goldfields” terranes of the Yilgarn Craton (Cowan, 2001). The subregion was described by Cowan (2001) as being characterised by internal drainage, red sandplains, salt lake systems that are associated with an occluded Paleodrainage system, plains of red-brown soils, and breakaways (Cowan, 2001). Vegetation is dominated by Mulga woodlands, frequently rich in ephemeral species, hummock grasslands, saltbush and samphire shrublands (Cowan, 2001).

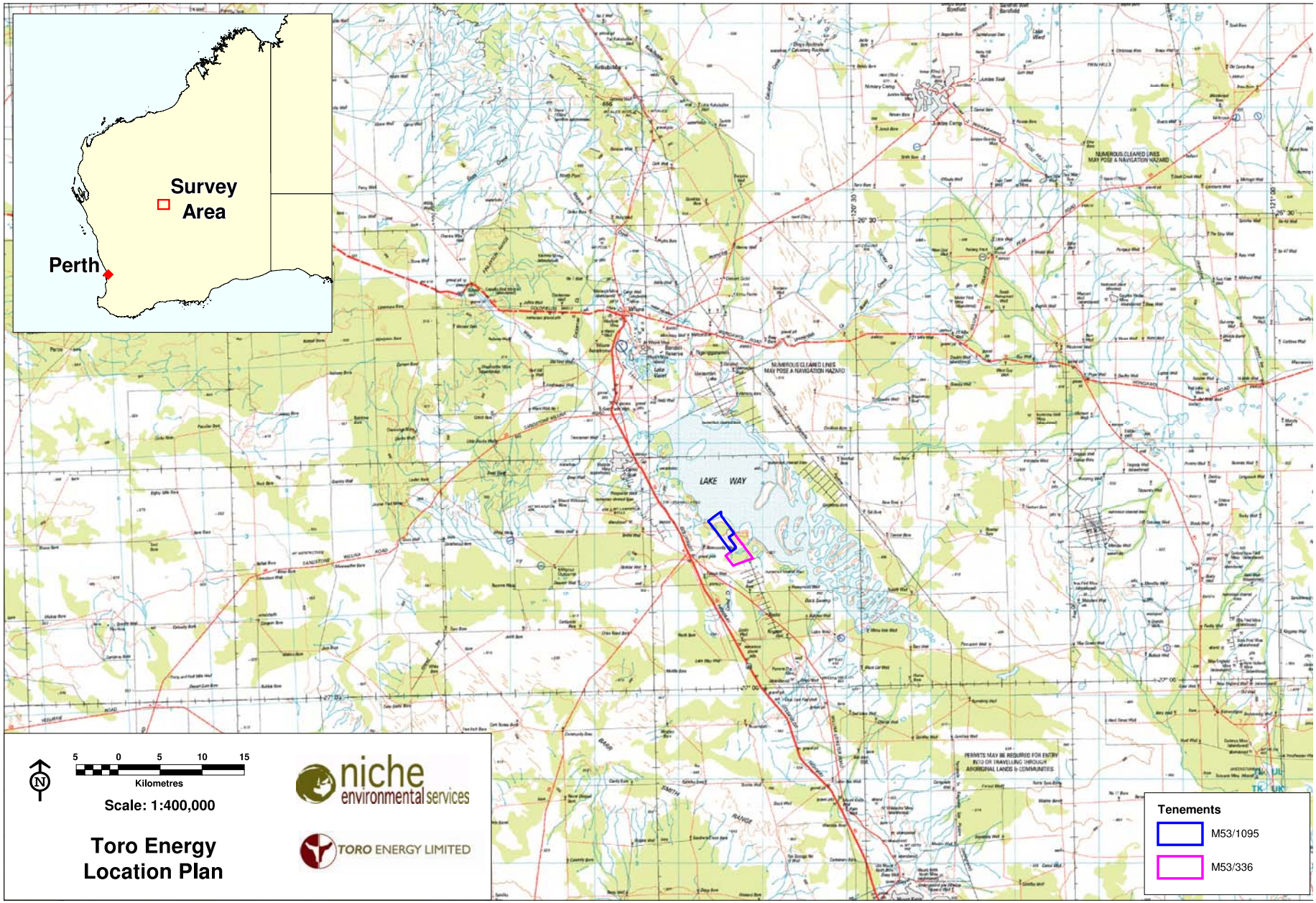

Figure 1 **Map showing the location of the Millipede Project of the Toro Energy Wiluna Uranium Project relative to the Town of Wiluna in Western Australia.**

Figure 2 **Map showing the tenements comprising the Millipede Project.**

3.2.2 Beard Vegetation

Beard (1990) describes the region in which the Toro Wiluna Uranium Project is located as being the Murchison Region within the Austin Botanical District. The region is described as being predominately mulga (*Acacia aneura*) woodland on plains which is reduced to scrub on the hills, with *Eucalyptus* spp and *Triodia basedowii* on sand plains (Beard, 1990). The region is arid, with annual rainfall of 200 mm, received in both summer and winter (Beard, 1990). The geology of the region is Archaean granite with infolded volcanics and greenstones which form the Yilgarn block (Beard, 1990).

Beard (1990) identifies five important soils within the region, being:

- Shallow stony earthy loams on hills and ranges;
- Red earthy sands on upland sandplains, with red sands on occasional dunes;
- Earthy loams overlying red-brown hardpan, often with a surface stone layer, on undulating terrain;
- Shallow acid or neutral red earths in mosaics with the earthy loams on extensive flat and gently sloping plains; and
- Saline soils associated with salt lakes.

Beard (1990) identifies mulga as the dominant vegetation within the Murchison region. Mulga changes form depending on the climate and geology of the area, but the fundamental structure of mulga to 3 m over mid-shrubs to 2 m over an understorey of annuals and grasses that ranges in density depending on rainfall received (Beard, 1990). Variation from mulga is linked to changes in substrate and hydrology, with the following changes noted:

- Saline areas – samphire vegetation;
- Granite hills – *Acacia* species, including *A. aneura, A, grasbyi, A. ramulosa* and *A.quadrimarginea* with an understorey of *Senna* and *Eremophila;*
- Sand plains – *Acacia aneura* and *A. ramulosa* over spinifex in the eastern extent of the Murchison;
- Calcrete – *Acacia sclerosperma, A. aneura* and *Grevillea nematophylla*;
- Drainage lines and rivers – *Eucalyptus camaldulensis* and *Casuarina obesa* with *Acacia aneura.*

The relationship between vegetation and disturbances is addressed by Beard (1990), who noted that areas of mulga appear to regenerate in cycles, with successive droughts increasing mortality and excessive grazing leading to loss of regenerative capacity.

3.2.3 Climate

The Toro Wiluna Uranium Project is located in a region with a climate that is broadly characterised as hot dry summer, cold winter (Commonwealth of Australia, 2010). Rainfall in this region is noted as being highly variable (Commonwealth of Australia, 2010). Mean annual rainfall recorded at the station was 255.6 mm, with a median of 223.6 mm. The highest annual rainfall record at Wiluna was

712.1 mm, recorded in 1900, with the lowest recorded annual rainfall of 48.8 mm in 1910 (Commonwealth of Australia, 2010). Mean monthly temperature recorded at the Wiluna station ranges from a maximum of 37.9˚ C in January to a minimum of 19.4˚ C in July (Commonwealth of Australia, 2010).

Data recorded at the Wiluna Bureau of Meteorology recording station was reviewed prior to surveys to assist with defining survey times. In the 12 months prior to the October 2013 survey, a total of 371.2 mm of rainfall was recorded (**Figure 3**). This was substantially above the long term average of 243.5 mm. In the months preceding the survey, there was abaove average rainfall, including three days of heavy rainfall approximately six weeks before the survey. Mean daily maximum temperature was close to the long term mean (**Figure 3**). Data in relation to the rainfall and temperature prior to other surveys is presented in Niche Environmental Services (2011).

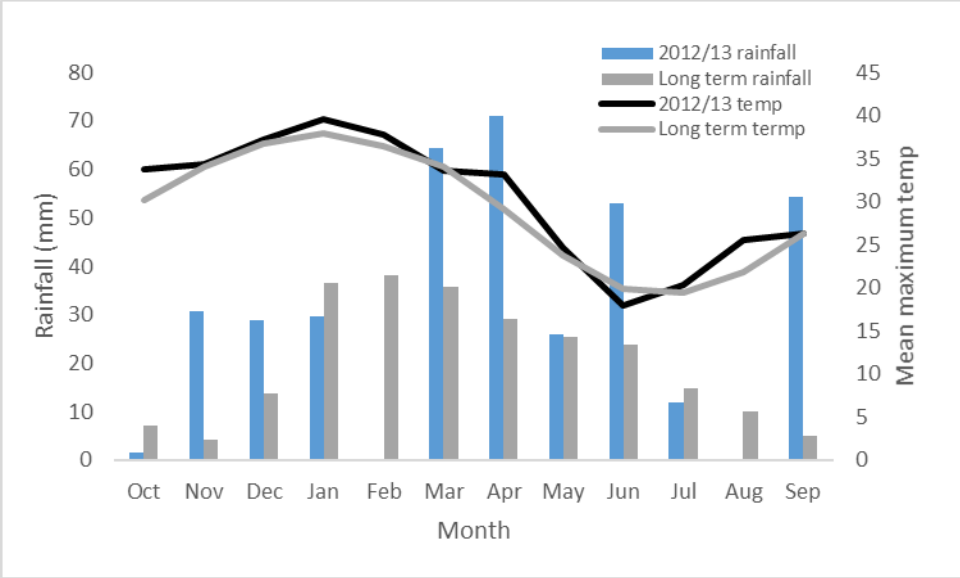

Figure 3 Graph displaying rainfall and mean daily maximum temperature recorded at the Wiluna Bureau of Meteorology recording station in the 12 months preceding the 2013 surveys by Niche Environmental Services. The long-term mean is presented for reference (Data sourced from Commonwealth of Australia, 2013).

4.0 METHODS – DESKTOP REVIEW

4.1 Overview

A desktop review was conducted prior to field surveys. The purpose of the desktop review was to collect information about the site and surrounds that would potentially assist with the design and implementation of the field survey. The desktop review consisted of:

- A search of the Federal Government *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters database. The search was conducted to determine whether there were any flora and vegetation listings of relevance to the Toro project and to

assess whether there were grounds for referral in relation to any of these matters;

- A search of the Western Australian Department of Environment and Conservation (DEC) Threatened (Declared Rare) Flora database, the Western Australian Herbarium (WAHERB) database and the Declared Rare and Priority Flora List for rare and priority flora collected from the survey area and surrounds or potentially occurring within the survey area;
- A search of the DEC Threatened Ecological Communities (TEC) database for listings of Threatened Ecological Communities or Priority Ecological Communities (PEC) recorded at or in the surrounds of the survey area; and
- A review of publicly available reports and publications containing flora, vegetation and ecological information relevant to the survey area.

4.2 Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Database Search

The *Environment Protection and Biodiversity Conservation EPBC Act 1999* is a Federal Act drafted to facilitate a national level of protection for natural assets of conservation significance on Commonwealth, State and private lands. The key features of the legislation are the provision of a means to:

- protect biodiversity by identifying threatening processes and ensuring these are appropriately assessed and managed;
- protect critical habitat;
- ensure compliance and enforcement through auditing and legal processes;
- conduct assessments in addition to state assessments; and
- protect natural assets on Commonwealth lands.

To determine whether there were potential matters of national significance associated with the proposed project, a search of the Protected Matters database was undertaken. The Protected Matters database provides a summary of listings under the provisions of the Act. The proposed disturbances do not occur on Commonwealth lands and as such listings of relevance only to Commonwealth lands were not considered. The search was conducted for the Local Government Area of the Shire of Wiluna.

4.3 Threatened (Declared Rare) and Priority Flora – DEC Database Search

All flora within Western Australia is protected under the provisions of the *Environmental Protection Act 1986.* Under the Act, permission to clear vegetation is required, with a few exemptions for specific reasons. While this level of protection is provided for all flora, additional protection is warranted for declared rare flora (DRF). The declaration of rarity is applied to flora for which adequate searches have been made and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (DEC, 2010a). DRF are gazetted under subsection 2 of section 23F of the Western Australian *Wildlife Conservation Act 1950*. Once a species has been declared as rare, it is illegal to remove, take from

or damage any DRF without Ministerial approval. Priority flora are species for which a level of conservation value is applied below declared rare (refer to **Appendix A** for definitions). There is no Ministerial approval required for disturbances affecting priority flora but these species are still protected under the *Environmental Protection Act 1986.* Impacts to priority flora are considered when assessing the conservation value of an area, especially in the context of clearing of native vegetation.

A search of the DEC *Threatened (Declared Rare) Flora* database and the *Western Australian Herbarium Specimen* database was completed in Decermber 2013, based on the project area.

4.4 Threatened Ecological Communities – DEC Database Search

Within Western Australia, biological assemblages that are considered to be unique, restricted or both can be assigned a status as a Threatened Ecological Community (TEC) or a Priority Ecological Community (PEC). A TEC is gazetted in parliament and Ministerial approval must be sought for any disturbance. There are currently four categories of TEC recognised by the DEC: Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable. Definitions of these are presented in **Appendix B**.

Ecological communities that are not recognised as TECs can be listed as Priority Ecological Communities. There are currently four classes of PEC (**Appendix B**). It is possible that ecological communities can be under threat, but do not meet the TEC criteria. In this instance, these communities may be listed as Priority Ecological Communities. It is possible that communities that are currently only considered to be PECs may be upgraded to TECs should threatening processes continue. In light of this, any assessment of vegetation that will potentially be cleared needs to consider both categories of communities and any potential impacts.

A search of the DEC TEC database was requested by Niche Environmental Services based on a polygon with a northwest corner of -26 12 57.67, 119 49 16.90 and a southeast corner of -27 1 15.38, 120 43 48.23.

5.0 METHODS – FIELD SURVEY

5.1 Timing of surveys

The project area was initially surveyed during regional surveys conducted for the assessment on the Centipede Project. These surveys were conducted during autumn and spring 2010. Additional surveys within the project area were conducted in early October 2013.

5.2 Survey Locations

A total of 30 quadrats were established and surveyed within the project area, of which 18 were established during September 2013, the balance were established during 2009/10. Quadrats

established prior to 2013 were revisited during the 2013 survey. In addition to this, there were quadrats within the Centipede Project Area, located to the east of the Millipede area, and in areas to the west of Millipede that were considered to incorporate vegetation types within the Millipede Project Area. The distribution of the quadrats within the Millipede Project Area and immediate surrounds are mapped in **Figure 4**.

5.3 Quadrat Survey Methods

At each quadrat location, the following was completed:

- A quadrat measuring 30 × 30 m was pegged out using 1 170 mm Waratah Fence Droppers. The cardinal fence dropper was typically located in the northwest corner. The cardinal fence dropper and the fence dropper located diagonally across the quadrat were left in place. In instances where the vegetation unit could not be sampled using a 30 × 30 m quadrat, a quadrat with a 900 m^2 area was used that better fit the vegetation unit.
- A photograph was taken of the quadrat. The photograph was always taken from the cardinal corner. Photographs were taken using either a Samsung ES15 digital camera or a Fujifilm A170 digital camera.
- The location of the survey area was recorded using a Garmin GPSmap 60CSx GPS, with the location recorded in WGS84, UTM.
- All flora present was recorded, with estimates of height and cover made to assist with describing the vegetation. Any species with less than 2 % cover was recorded as a +, all other cover values were recorded as ranges (eg.> 2-5, 5-10 etc.).
- The condition of the vegetation and any disturbances were noted.
- The geographical location of the site was recorded, with slope, topography and soil type recorded.
- The extent and nature of litter cover was recorded.

5.4 Traverse to develop census

Traverses were conducted within vegetation units to develop the census of the flora. All specimens collected were assigned a field number and were pressed to facilitate identification in the herbarium. To ensure accuracy in the development of the census, specimens collected were stored according to vegetation unit, with duplicate specimens collected from different vegetation units when identification in the field was not possible.

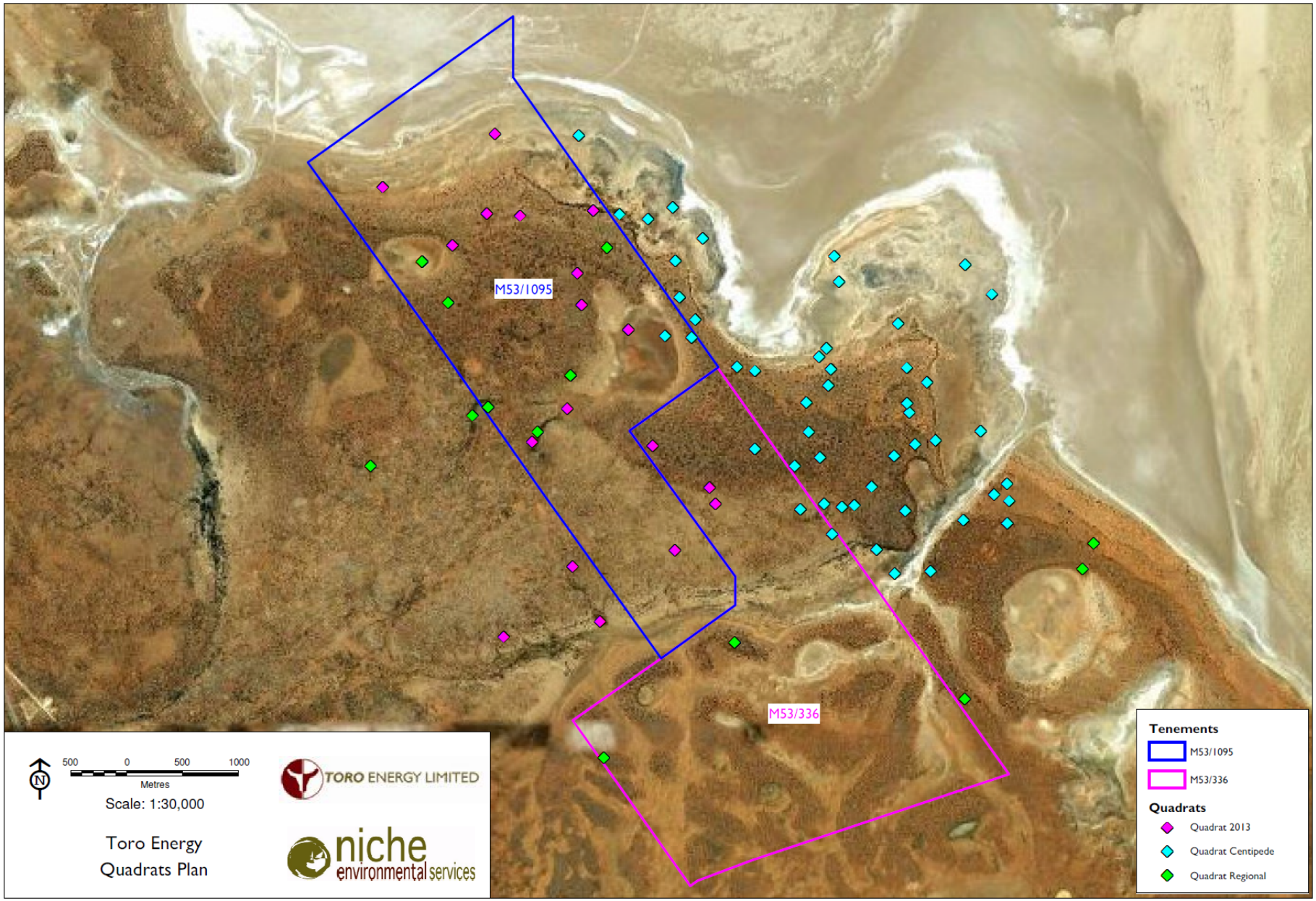

Figure 4 **Map of quadrats surveyed within and adjacent to the Millipede Project**

5.5 Targeted searches

5.5.1 *Eremophila arachnoides* Chinock subsp. *arachnoides*

Targeted searches were conducted within the Millipede Project Area during the completion of targeted searches for the assessment of ecological values associated with the Centipede Project Area. During these searches, the priority 3 (P3) species *Eremophila arachnoides* Chinock subsp. *arachnoides* (P3) was recorded within the Millipede area. The records were made along a series of transects, the length of which was dictated by the extent of potential habitat. The transects were traversed by foot, with all records within 25 m of the transect recorded. This method created a series of essentially contiguous quadrats with a width of 50 m along the length of the transect.

To estimate the population of the species in potential habitat, the area of each transect was calculated. The number of records of the species recorded along the transect was divided by the area of the transect, which yielded a density value. The mean density (± s.d.) was then calculated. This value was used to estimate the potential population of the species within the defined habitat area.

5.5.2 *Stackhousia clementii* Domin.

The priority species, *Stackhousia clementii* Domin (P3) was recorded within a small section of a creek to the west of the Millipede area (Niche, 2011). The habitat requirements for this species appeared to be watercourses, albeit those that were subject to wetting and drying cycles. During the survey works associated with the Millipede Project, targeted searches were conducted in areas in which plants were observed, and involved tracking populations until no plants were observed. Where plants were observed, the location and number of plants was recorded.

5.6 Project personnel

The following people were involved in the completion of surveys:

- Mr. Brett Neasham B.Sc. (Biol) Hons. (Env. Man.) – Project manager, Senior botanist, all surveys.
- Ms Sarah Dalgleish B.Sc. Hons. (Env. Man) – Botanist, autumn 2010 surveys.
- Ms Serena Wright Assoc. Deg. Agribusiness – Environmental technician, autumn 2010 surveys.
- Mr. Russell Barrett (B.Sc.) – Contract botanist, spring 2010 surveys.

5.7 Survey limitations

Niche Environmental Services planned and implemented the surveys detailed in this report in accordance with EPA guidelines and requirements (EPA 2000, 2004). Within the survey guidelines a number of potential limitations to the completeness of surveys are presented. Niche Environmental Services have reviewed these guidelines and provide a response to these as considered relevant to this survey below.

- Competency of botanists – the surveys over the Millipede Project Area were led or completed by the botanist from Niche Environmental Services who had co-ordinated the flora and vegetation surveys for the Toro Energy Centipede and Lake Way Project Areas, the proposed West Creek borefield and supporting regional surveys. Other personnel used in the completion of the surveys were considered to have an appropriate level of competence to contribute to the surveys in their defined roles.
- Scope – the scope for these surveys were clearly defined, being flora and vegetation surveys over the Millipede Project Area.
- Proportion of flora identified – Due to ongoing issues surrounding the resolution of taxonomy for *Tecticornia* species in this region, limited effort was placed in identifying samples of *Tecticornia* collected during the surveys. There were a limited number of samples of other plants for which there was sufficient information to facilitate resolution to genus level, but there was some uncertainty regarding species or infraspecies designation. The specimens for which taxonomy could not be completely resolved were compared against species of conservation significance. None of these specimens with incomplete taxonomic resolution were considered to be known species of conservation significance.
- Timing of surveys – the surveys were conducted in late autumn 2010, spring 2010 and spring 2013. All of the surveys were conducted after rainfall had been received in the region.
- Access to land – there were no access related issues.
- Completeness and further work – the Millipede area has been subject to survey over multiple seasons, with surveys conducted during 2010 and 2013. These surveys have been quadrat-based, including two visits to most quadrats, and have also included traverses to develop the census and targeted searches for flora of conservation significance. The survey work completed to date is considered to be adequate to describe vegetation within the project area, to assess the conservation value of the vegetation, to develop the census of the flora and to complete searches for flora of conservation significance within all areas except the salt lake vegetation dominated by *Tecticornia*.

  Issues associated with *Tecticornia* taxonomy on the edges of Lake Way were identified during the assessment of the Centipede and Lake Way Project Areas of the Toro Wiluna Project. Dr Kelly Shepherd of DPaW completed preliminary identification of *Tecticornia* specimens collected during surveys for the assessments of the Centipede and Lake Way Project Areas, during which it was noted that there was a degree of uncertainty in relation to taxonomy of a number of specimens. One of the conditions attached to the approval of the Centipede and Lake Way projects was the resolution of this taxonomic uncertainity. In light of this condition, it was considered prudent to limit survey work within *Tecticornia* vegetation units on the salt lake edge until taxonomy is better resolved, and it is acknowledged that additional work is required to better define the species within this unit.
- Disturbances – the Miilipede Project Area is located on the Lake Way Pastoral lease, and is adjacent to the Centipede Project Area. The Millipede area is dissected by a well-developed

access track as well as a series of smaller access tracks. The project area also contains a number of drill lines and drill pads. These tracks were associated with removal of vegetation and localised deposition of dust. There was evidence of impacts associated with cattle, including grazing and the formation of cattle tracks.

6.0 METHODS – DATA ANALYSIS AND INTERPRETATION

6.1 Taxonomy

Taxonomic work was completed at the Western Australian Herbarium. Specimens were identified by the use of relevant keys and Herbarium specimens. Nomenclature was based on Florabase (Western Australian Herbarium, 2013). Identification work was completed by the following people:

- Mr. Brett Neasham (Niche Environmental Services) – various specimens, all surveys
- Dr Paul Armstrong (contract botanist) – various specimens, autumn 2010 survey
- Dr Kelly Shepherd (WA Herbarium) – *Tecticornia* specimens, autumn and spring 2010 surveys
- Mr. Rob Davis (WA Herbarium) – *Eremophila* specimens, autumn 2010 survey
- Mr. Russell Barrett (contract botanist) – various specimens, spring 2010 survey

6.2 Vegetation Description and Mapping

The vegetation within the survey area was described using the scale of Muir (1977) (**Appendix C**). The condition of vegetation was described using the scale of Keighery (1994) (**Appendix D**). Vegetation maps presented in the report have been developed based on the information collected during the survey and the interpretation of aerial photography.

7.0 RESULTS AND DISCUSSION – DESKTOP REVIEW

7.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Database Search

There was no flora or vegetation (ecological communities, conservation areas) listed for the database search area (refer 4.2). Based on this, there are not considered to be any reasons for referring the project based on impacts to flora and vegetation.

7.2 Threatened (Declared Rare) and Priority Flora – DEC Database Search

No Threatened (Declared Rare) Flora (T) were listed in the database search (DEC, 2013; search reference 35-1213). A total of 27 priority flora were listed in the database search results, of which six were priority 1 taxa (P1), 17 were priority 3 taxa (P3) and the remaining four were priority 4 taxa (P4) (definitions of the priority codes are provided in **Appendix A**). A summary of these species and brief description of habitat is provided in **Table 1.** A map illustrating the distribution of database records close to Lake Way and the Millipede Project is presented in **Figure 5.**

Table 1 Summary of Threatened (Declared Rare) Flora and Priority Flora records from DEC database search 35-1213, with conservation code and a brief description of habitat.

Species	Cons code[2]	Habitat
Beyeria lapidicola Halford and R.J.F. Hend.	P1	NNE facing steeply inclined mid to upper escarpment of haematite and ban (*sic*)[1]
Bossiaea eremaea	P3	Orange sands. Flats[2]
Calytrix uncinata Craven	P3	White or red sand, sandy clay. Granite or sandstone breakaways, rocky rises[2]
Eremophila arguta Chinook	P1	Loam soils[1]
Eremophila congesta Chinook	P1	Lateritic outcrops in greenstone hills, stony quartzite slopes[2]
Eremophila flaccida subsp. *attenuata* Chinook	P3	Stony clay over quartzite. Hillslopes, ridges[2]
Eremophila pungens Chinook	P4	Sandy loam, clayey sand over laterite. Plains, ridges and breakaways[2]
Euryomrytus inflata Trudgen	P3	Deep red sand. Flat plains[2]
Grevillea inconspicua	P4	Loam, gravel. Along drainage lines on rocky outcrops2
Hemigenia exilis S. Moore	P4	Laterite. Breakaways and slopes[2]
Homalocalyx echinulatus Craven	P3	Laterite. Breakaways, sandstone hills[2]
Maireana prosthecochaeta (F. Muell.) Paul G. Wilson	P3	Laterite. Hills, salty places[2]
Mirbelia stipitata Crisp and J.M. Taylor	P3	Red sandy loam[2]
Olearia arida	P4	Red or yellow sands. Undulating low rises2
Olearia mucronata Lander	P3	Schistose hills, along drainage channels[2]
Paspalidium distans	P3	Loam. River banks
Prostanthera ferricola B. J. Conn & K.A. Sheph.	P3	Shallow red-brown skeletal sandy loam on banded ironstone, laterite, basalt or quartz. Gently inclined mid to upper slopes of hills, rocky crests, outcrops[2]
Ptilotus chrysocomus R.W. Davis	P1	Brown sandy clays. Bases of breakaway, rocky scree slopes[2]
Ptilotus luteolus (Benl & H. Eichler) R.W. Davis	P3	Basalt hill, stony hills, quartz flat at base of breakaway[1]
Sauropus ramosissimus	P3	No habitat data
Sida picklesana	P3	No habitat data
Stackhousia clementii Domin	P3	Skeletal soils. Sandstone hills[2]
Tecticornia sp. Lake Way (P. Armstrong 05/961)	P1	Lake bed within salt lake system[3]
Thryptomene sp. Leinster (B.J. Lepschi & L.A. Craven 4362)	P1	No habitat data
Tribulus adelacanthus R.M. Barker	P3	Midslopes of banded ironstone formations[1]
Xanthoparmelia nashii Elix and J. Johnst.	P3	Granite breakaway[1]

[1] - DEC (2013); [2] – Western Australian Herbarium (2013); and [3] – Niche Environmental Services

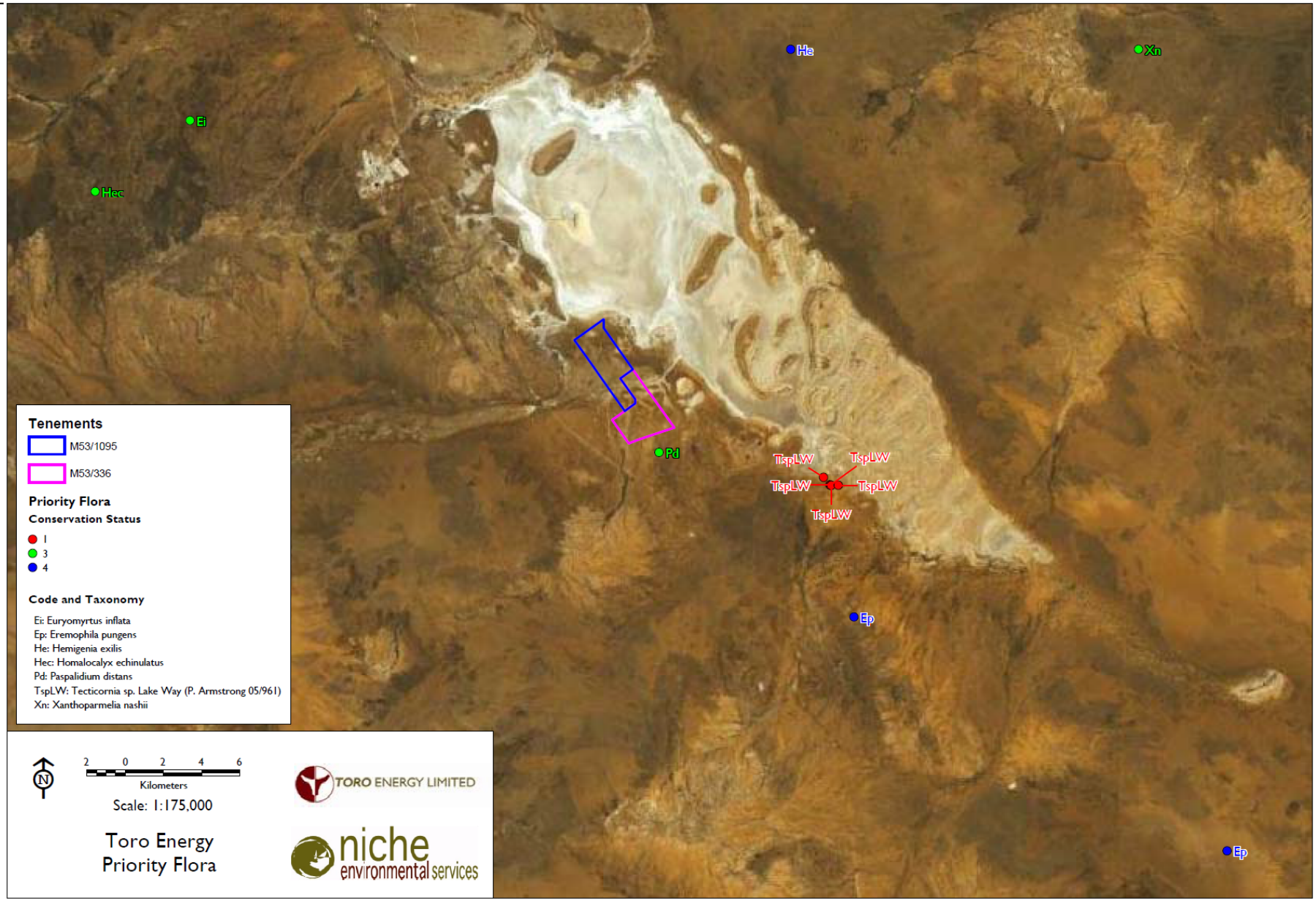

Figure 5 **Map showing DPaW records of Threatened (Declared Rare) and Priority Flora species in close proximity to the Millipede Project.**

7.3 Threatened Ecological Communities – DEC database search

No Threatened Ecological Communities (TECs) as defined by the DEC were identified as occurring within the database search area (reference 17-0510; DEC 2010b). A total of 30 Priority Ecological Communities (PECs) were listed in the database, of which two were flora communities, being:

- Wiluna West vegetation complexes (banded ironstone formation (BIF)) – this is a Priority 1 ecological community located to the northwest of the project. The buffer of this PEC does not intersect the project.
- Montague Range vegetation complexes (BIF) – this is a Priority 1 ecological community located to the southwest of the project. The buffer of this PEC does not intersect the project.

There were no ridges of BIF within the Millipede Project, and given that there is no overlap between the PEC buffers and the project area, no further consideration to these PECs is made within this report.

7.4 Review of Existing Reports

7.4.1 Shepherd *et al.* (2007)

Shepherd *et al.* (2007) have completed an analysis and interpretation of the extent and distribution of vegetation types within Western Australia. The work is generally based on interpretations of aerial photography and uses the vegetation codes developed by Beard at the 1:250,000 scale. This information was used in the preparation of the report to assist with placing the Wiluna project into a broad floristic context. Data used in this report was provided by Mr. Damian Shepherd from the Department of Agriculture and Food, Western Australia (DAFWA). Mr. Shepherd provided data specific to the area within which the project area is located, based on a radius of 50 km from the centre of Wiluna town.

According to the data provided, there are a total of 17 Beard vegetation units within the project area and surrounds (**Table 2**). The dominant vegetation within the search area is characterised by the presence of mulga (*Acacia aneura*), with 12 of the vegetation units containing this species as either a dominant or co-dominant species. Samphire flats, coolibah woodlands, bowgada (*Acacia ramulosa* var. *linophylla*) or bare areas (claypans and salt lakes) form the balance.

The samphire vegetation covered approximately 4 000 ha, most of which would be concentrated around the edges of the Lake Way system. It should be noted that within the local government area (LGA) of the Shire of Wiluna, this vegetation covered over 800 000 ha.

The coolibah woodlands are a more restricted vegetation unit, with just over 7 000 ha in the Shire Wiluna, of which nearly 7 000 ha is within or close to the project area. The coolibah woodlands are

described as being dominated by *Eucalpytus microtheca,* which is an incorrect definition; this species is restricted to the Kimberley and there are no records near Wiluna. This vegetation unit is considered to be the woodlands dominated by *Eucalyptus camaldulensis*. From a functional perspective, there is no difference between the two, with both units hosting phreatophytic species as the dominant canopy species.

The extent of clearing in the project area and surrounds is negligible, with 100 % of the inferred pre-European extent remaining (Shepherd *et al.,* 2007). While clearing is considered to be negligible, the extent of conservation of vegetation is low, as detailed in **Table 2**. The lack of conservation in the region is evident, with eight of the units identified in the Shepherd *et al.* (2007) report having no land in the DEC estate and only three units having more than 5 % in the DEC estate.

7.4.2 CSIRO (1963)

The project is located within an area over which broadscale surveys were completed by Mabbutt *et al.* in 1958 (CSIRO, 1963). In this study, a number of land systems were identified. The land systems corresponded to geographic and floristic patterns observed during the surveys. To assist with placing the project area into the correct land systems, a digital dataset was acquired from the Department of Agriculture and Food, Western Australia (DAFWA). The digital dataset was used to determine the Land Systems and extent within the project areas. The Millipede Project was located on two land systems, the Carnegie and the Cunyu Systems (**Figure 6**).

The Carnegie land system was characterised by Mabbutt *et al.* (1958) as being salt lakes with and surrounding dunes, covering approximately 3 625 km^2 of the CSIRO survey area. The system was divided into nine, incorporating inner lake floors devoid of vegetation, lower margins and tributary plains hosting halophytic vegetation, higher marigns and channels hosting mulga, kopi dunes with eucalypts, dunes of red sands hosting *Acacia* vegetation and fringing units of *Melaleuca* spp. (Mabbutt *et al.,* 1958). The dominant units within the Cunyu system were the lake floors and the dunes, sand banks and higher plains.

The Cunyu land system was broadly catergorised by Mabbutt *et al.* (1958) as being calcrete valley floors comprised of deopsotional surfaces to 8 km wide. The system includes calcrete platforms up to 5 m high, narrow alluvial floors between the higher areas and broader alluvial plains obscuring the calacrete (Mabbutt *et al.,* 1958). A total of six broad units were defined within the Cunyu land system, with calcrete platforms and alluvial plains typically hosting mulga (*Acacia aneura*) and other *Acacia* species over mixed shrubs, grasses and forbs, while saline plains hosted halophytic communities and drainage channesl and marginal zones hosted communities of *Eucalyptus microtheca* (Mabbutt *et al.,* 1958). The Cunyu land system covered approximately 1 553 km^2 of the survey area detailed in CSIRO (1963), of which the calcrete platform is the dominant unit.

Table 2 Summary of vegetation types within a 50 km radius of the town of Wiluna, which incorporates all of the survey areas, with inferred extent from Shepherd *et al.* (2007).

System - Association code	Description	Environmental description	Area (ha)	Extent in reserves (%)*
11	Medium woodland; coolabah (*Eucalyptus microtheca*)	General	6 986	0
18	Low woodland; mulga (*Acacia aneura*)	General	621 623	3.75
19	Low woodland; mulga between sandridges	General	875	0
28	Open low woodland; mulga	General	4 527	0
29	Sparse low woodland; mulga, discontinuous in scattered groups	Wiluna	157 951	10
39	Shrublands; mulga scrub	Wiluna - Granite Hills	102 773	2.4
40	Shrublands; acacia scrub, various species	General	1 116	0.63
107	Hummock grasslands, shrub steppe; mulga and *Eucalyptus kingsmillii* over hard spinifex	Wiluna	494 618	8
125	Bare areas; salt lakes	General	25 167	1.3
188	Shrublands; mulga & *Acacia sclerosperma* scrub	General	3 634	0
202	Shrublands; mulga & *Acacia quadrimarginea* scrub	Wiluna - Granite Hills	31 400	0
204	Succulent steppe with open scrub; scattered mulga & *Acacia sclerosperma* over saltbush & bluebush	Wiluna	51 202	0
389	Succulent steppe with open low woodland; mulga over saltbush	Wiluna	7 884	.2
560	Mosaic: Shrublands; bowgada scrub / Succulent steppe; samphire	General	17 029	0
561	Succulent steppe with low woodland; mulga over saltbush	General	5 098	0
676	Succulent steppe; samphire	Wiluna	4 112	15.5
1 271	Bare areas; claypans	General	3 131	0
Total			**1 539 129**	

*this figure includes the entire LGA of Wiluna.

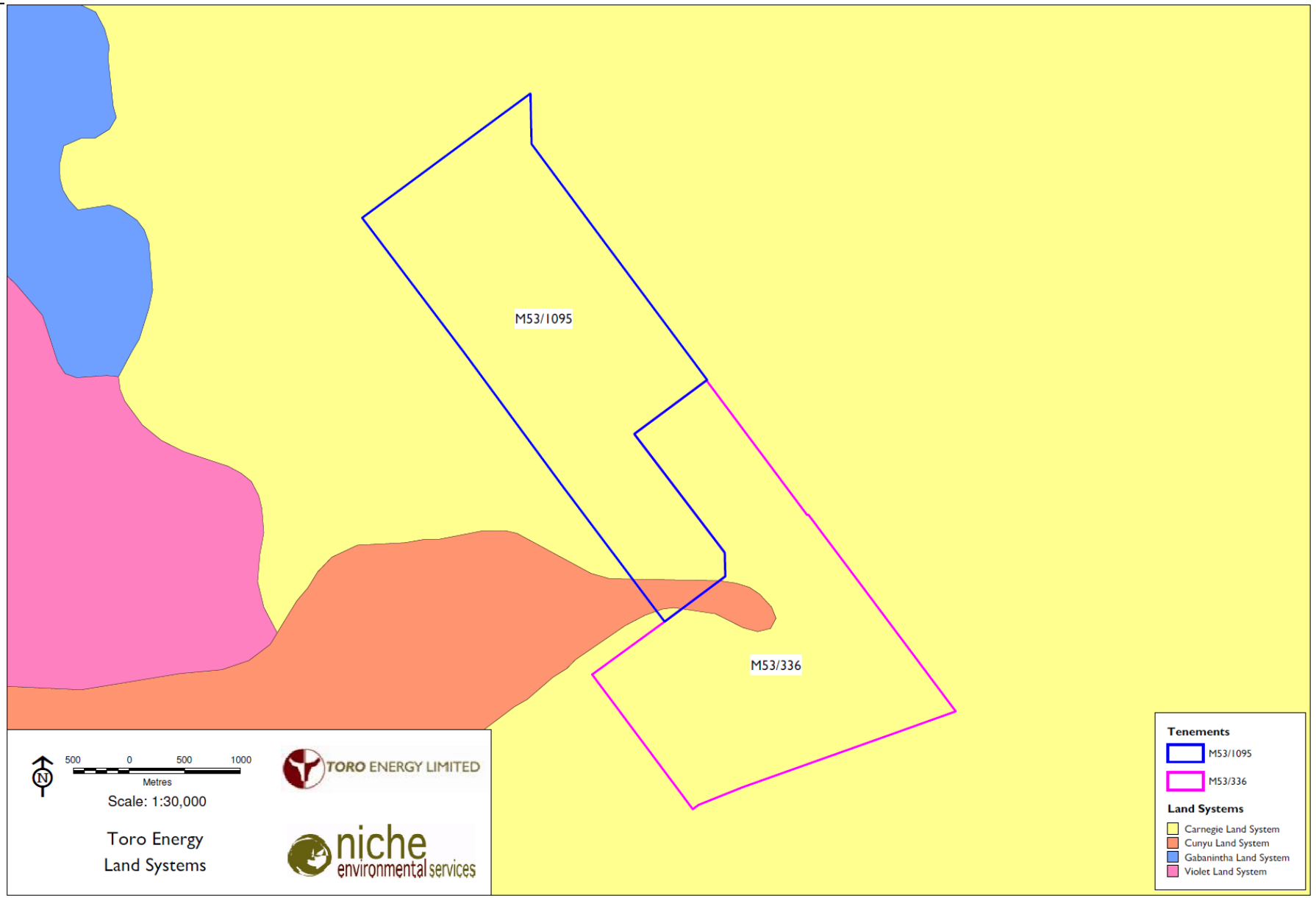

Figure 6 **Map showing land systems on which the Millipede Project is located.**

7.4.3 Outback Ecology (2007)

First pass surveys were conducted over the Centipede and Lake Way project areas by Outback Ecology in 2007. The survey work over the Centipede project area is considered to be of the greatest relevance, as this area is contigious with the Millipede project area. A total of 46 quadrats were surveyed at Centipede, with a total of 132 taxa were recorded during the survey of both the Centipede and Lake Way project areas. This census was noted as being low (Outback Ecology Services, 2007). Of particular note was the comparatively low diversity of annual and ephemeral flora. The low numbers in the census may be a reflection of the prevailing environmental conditions prior to the survey.

The vegetation over the Centipede project areas was described as fitting into four broad groups, being - Playa vegetation; Fringing vegetation; Dune vegetation; and, Plains vegetation. Within these broad groups, there were a total of 11 vegetation units. The fringing vegetation unit, *Melaleuca xerophila* Mid Density Low Forest (Me1) was noted as being an "at risk" vegetation unit. The status of "at risk" does not have any legislative imperative, but may indicate vegetation units that will be scrutinised should any impacts to the vegetation be considered. It was noted that impacts to this association should be avoided or minimized (Outback Ecology, 2007).

No EPBC-related issues were noted in relation to the flora and vegetation for the survey area during the 2007 database search. There were 17 priority taxa noted in the DEC database search, none of which were observed during the survey. One Threatened Ecological Community (TEC), the Wiluna West vegetation complexes on Banded Ironstone Formation. This is no longer a TEC, but is still listed as a Priority 1 ecological community, as detailed in Section 5.1.3 of this report.

The work detailed in Outback Ecology (2007) was not considered to meet the basic assumptions of a Level 2 survey as defined by the EPA (2002; 2004), principally because a second survey was not completed over the area following the season during which the majority of rainfall is received.

7.4.4 Niche Environmental Services (2011)

Niche Environmental Services (Niche) completed a Level 2 survey over the Wiluna Uranium Project, incorporating the Centipede and Lake Way project areas and the proposed borefield. In addition to the surveys in the project areas, regional surveys were completed to develop an understanding of the regional context of the vegetation. The surveys were completed during April – June and September – October 2010

Prior to commencing the field surveys, a desktop review was undertaken. The key findings from the desktop review were:

- No flora and vegetation matters were noted in the *Protected Matters database* search that related to the project area.

- There were 21 priority flora were listed in the DEC database, of which six were priority 1 taxa, 13 were priority 2 taxa and the remaining two were priority 3 taxa. In addition to the species listed in the database search, there were two species listed by the DEC after the review of the scoping document.
- There were two vegetation assoications listed as Priority Ecological Communities (PECs), being: Wiluna West vegetation complexes (banded ironstone formation (BIF)) (Priority 1), and Montague Range vegetation complexes (BIF) (Priority 1), neither of which were within the survey areas.

Of the areas surveyed by Niche in 2010, the Centipede project area and regional survey quadrats located to the west of the Centipede project area, the area detailed in this report as the Millipede project area, are the most relevant. Within the Centipede survey area, there were five clearly defined zones of vegetation, being:

- *Tecticornia* spp. vegetation on the playa, which was the main vegetation type within the Centipede area;
- Fringing vegetation dominated by *Melaleuca xerophila*, which was distributed as a belt along the interzone between the playa and the dune system;
- A foredune system, comprised of low sand ridges hosting either *Callitris columellaris* and *Acacia ayersiana* over spinifex*;*
- A rear dune system comprised of *Acacia* species and mallee eucalypts over spinifex; and
- Calcrete platform comprised of *Acacia* species.

The *Tecticornia* vegetation units were considered to have potential conservation significance, largely due to matters relating to unresolved taxonomy. The balance of the vegetation within the Centipede area was not noted as having a high amount of potential conservation significance. A number of threating processes were identified during the surveys, with varying amounts of impacts noted. The key threatening processes noted were overgrazing by cattle, grazing by camels and rabbits, track proliferation, fire and drought. The effects of the threatening processes were evident in the survey areas, especially with respect to grazing, track proliferation and drought.

A total of 428 species, including subspecies and variants, from 57 families and 161 genera were recorded durng the Lake Way, Centipede, West Creek Borefield and regional surveys. This figure does not include *Tecticornia* specimens, as these are still undergoing taxonomic work. The flora was dominated by the families Asteraceae, with 51 species from 29 genera, Chenopodiaceae, with 47 species from nine genera and Fabaceae, with 44 species from seven genera. There were 24 range extensions recorded during the surveys and four species for which there was some variation to known collections. The census of the flora was considered to be comprehensive, with a high number of annual taxa recorded during the surveys

One priority species, *Eremophila arachnoides* Chinock subsp. *arachnoides* (P3), was recorded to the within and to the west of the Centipede area, with a total of 5 440 plants recorded. It was estimated that 130 plants, representing approximately 2.4 % of the population, will be removed to facilitate the development of the Centipede project. Substantial populations of this species were recorded to the north of Lake Way and approximately 100 km north of the town of Wiluna. In addition to this there were between 500 – 1 000 individual *Stackhousia clementii* Domin (P3) observed in an epheremal creekline to the west of the Centipede survey. There are no plans to clear from within the areas where these species were recorded.

The environmental weed *Acetosa vesicaria* (ruby dock) was recorded in the Centipede project area, in one section of the proposed borefield and in other locations not within, but very close to Toro tenements. Weed management strategies have been put in place by Toro to address this.

8.0 RESULTS and DISCUSSION - VEGETATION

8.1 Site description

The Millipede project covered approximately 1177 4 ha, of which approximately 53 ha was unvegetated salt lake. Of the remaining 1124 ha, approximately 725 ha falls within the zone in which project-related impacts are planned. The remaining area, located in the southern sections of M5/336, will not be impacted by the proposed development and were not surveyed or mapped (**Figure 7**). The eastern boundary of the Millipede project area abuts the western edge of the Centipede project area (refer Niche Environmental Services, 2011 for mapping and descriptions) while the northern boundary terminates on the salt lake. The southern and western boundaries are contiguous with native vegetation not likely to be impacted by any of the activities proposed by Toro. Within the Millipede survey area, there were five clearly defined zones of vegetation, being:

- *Tecticornia* spp. vegetation on the playa;
- Fringing vegetation, which was distributed as a belt along the interzone between the playa and the dune system;
- A dune system, comprised of a foredune of *Acacia* species over spinifex, and a rear dune system comprised of *Acacia* species and mallee eucalypts over spinifex;
- Claypans hosting a mix of halophytic vegetation; and
- Calcrete platform, which hosted vegetation dominated by *Acacia* species.

8.2 Vegetation descriptions and condition assessment

A total of 10 vegetation units were described and delineated within the Millipede survey area. A summary of the vegetation units is presented below. The distribution of the vegetation is presented in **Figure 7**. An image of each vegetation unit is presented in **Appendix E.**

Figure 7 **Map showing vegetation units defined and delineated within the Millipede Project.**

niche environmental services

8.2.1 Playa vegetation

The playa vegetation was located on the north and south of the Millipede survey area. The playa vegetation unit was characterised by the dominance of halophytic species, usually within the family Chenopodiaceae. There was only one vegetation unit identified on this substrate, which was noted as being essentially mosaic, with subtle changes in species presence and density noted. It is proposed that changes in species within the unit may have been due to changes in underlying hydrology.

sl – Low Heath D of *Tecticornia* species.

This vegetation unit was defined as a Low Heath D of *Tecticornia* species to 0.5 m with occasional pockets to 1 m. The vegetation was generally uniform in height and density, with some changes in species composition noted across the surveyed area. The unit was located on the lake edge on heavy clays, light orange in colour with salt crusts in the north of the survey area, and on light orange clays in Abercrombie creek, located on the south of the survey area. There were pockets of *Lawrencia helmsii* in some areas, but these were not extensive enough to be mapped as separate units. The vegetation within this unit was as assessed as being in good to very good condition. The vegetation had clearly been affected by exploration activity, with a number of tracks and drill lines located within the area. There was also evidence of drought stress, although the scale of this will be affected by seasonal rainfall patterns. An image of this unit is presented as **Plate 1** in **Appendix E**.

8.2.2 Fringing vegetation

The fringing vegetation was located on the edge of the salt lake system and served to demarcate the playa vegetation from the dune or calcrete vegetation. The vegetation existed as a narrow band located on the north and south of the survey area, immediately adjacent to the salt lake vegetation. This unit was generally approximately 10 m wide, although in some areas it was noted as being 30 m wide. There was one vegetation unit within fringing vegetation zone.

fr – fringing Closed Low Forest of *Melaleuca xerophila*

This unit was dominated by *Melaleuca xerophila* to 4 m, forming a closed forest to a maximum thickness of 30 m, although it most sections it was generally no thicker than 10 m. The unit was noted as generally being on the same soil as the dunes, which were orange to red sands, but was also noted as being on light orange clays or calcrete in some areas. This unit was species poor, with few other species contributing to the structure. In some areas *Muellerolimon salicorniaceum* was a dominant understorey species while in other pockets *Tecticornia* species were noted. There were some instances where *Acacia ayersiana* was noted as a co-dominant species, but this was generally a reflection on intergrading, rather than characterising a subunit. This vegetation unit was noted as being in good to very good condition. The vegetation had been affected by clearing for exploration and track development, but the impacts of this were limited in scale and extent. An image of this unit is presented as **Plate 2** in **Appendix E**.

8.2.3 Dune vegetation

The dune complexes were located between the playa and fringing vegetation and the calcrete platform, and were characterized by a variable topography, with some sections being characterised by a steep slope terminating in a high, narrow peak while other areas were noted as having a gentler slope and a lower peak. Within the dunes, there was a distinction between the foredune vegetation, which faced toward the salt lake, and the dune vegetation, which faced toward the calcrete platform. There was one vegetation unit on the foredune and one on the dune.

fd – Open Low Woodland A of *Acacia ayersiana*

This unit was an Open Low Woodland A of *Acacia ayersiana* to a height of 10 m with a sparse midstorey over a hummock of *Triodia melvillei.* This vegetation unit was assessed as being in very good condition. There were a limited number of tracks in this vegetation unit, with damage from this localised. There was also evidence of grazing by cattle. An image of this unit is presented as **Plate 3** in **Appendix E**.

d – Low Woodland A of *Eucalyptus eremicola* subsp. *peeneri* and *Acacia ayersiana*

This unit was defined as being a Low Woodland A of *Eucalyptus eremicola* subsp. *peeneri* and *Acacia ayersiana* to a height of 10 m on red sands in shallow dunes. The unit contained *A. aneura* var. *aneura* and *Grevillea sarissa* subsp. *succincta* as the dominant midstorey species, typically growing to a maximum height of 3-4 m. The understorey was a mid-dense hummock of *Triodia melvillei.* There were a series of small claypans within this unit, but these were largely devoid of vegetation. The condition of this vegetation was assessed as being good to very good. There were a number of exploration tracks located within this unit, which had resulted in localised damage to the vegetation. There was also some evidence of grazing by cattle. An image of this unit is presented as **Plate 4** in **Appendix E**.

8.2.4 Calcrete platform vegetation

The calcrete platform was a major feature of the Millipede project area and was located behind the dune systems. The platform was characterised by a shallow topsoil of orange to red clays, which was absent in some areas, overlain on calcrete. The platform was essentially flat, with areas of very minor relief adjacent to dunes or near drainage lines. There were four vegetation units defined and delineated on the calcrete platform.

ca1 – Low Woodland B of *Acacia* species

This vegetation unit was defined as being a Low Woodland B of *Acacia* species, generally to a height of 3 m, with occasional individuals to 5 m. The vegetation contained *Acacia ayersiana, A. tetragonophylla, A. burkittii* and *Acacia aneura* var. *aneura.* The understorey contained *Rhagodia ?drummondii, Eremophila longifolia* and the priority 3 species *E. arachnoides* subsp. *arachnoides.* The condition of this vegetation ranged from good to degraded. The unit had been dissected by the main track into the Centipede Project, which is immediately to the west of the Millipede Project. In

addition to this, there were a number of exploration tracks and drill sites within this unit. The vegetation was also noted as being grazed by cattle. An image of this unit is presented as **Plate 5** in **Appendix E**.

ca2 – caOLW – Open Scrub of mixed species

The structure was heavily impacted, and in many areas was reduced to an understorey of *Eremophea spinosa, Sclerolaena* and *Maireana* species with occasional *Acacia victoriae, Cratystylis spinescens, Maireana pyramidata* forming a sparse upperstorey. The vegetation in this unit was assessed as being in poor to degraded condition. There was clear evidence of widespread disturbance in this unit, with a number of tracks dissecting the unit. In addition to this, the areas immediately adjacent to the claypan were effectively free of perennial vegetation. An image of this unit is presented as **Plate 6** in **Appendix E**.

ca3 - caOLWAcspp

This vegetation unit was located on shallow red clays over calcrete, with the thickness of the clays increasing closer to the dune systems against which it abutted on one side, and the calcrete becoming more exposed in the areas adjacent to the calcrete platform. The vegetation in this unit was comprised of *Acacia aneura* and *A. ayersiana* to 5 m over a midstorey dominated by *A. tetragonophylla, Senna artemisioides* and *Eremophila arachnoides* subsp. *arachnoides.* The vegetation in this unit was assessed as being in good condition, with obvious damage due to the presence of access tracks and drill pads, as well as from grazing by cattle. An image of this unit is presented as **Plate 7** in **Appendix E**.

dl – Low Woodland of Acacia species on shallow, ephemeral drainage line.

This vegetation unit was defined by an overstorey to 8 m of *Pittosporum phylliraeoides, Acacia macranuera* and *A. tetragonophylla* over a comparatively dense mid and understorey. While the density of vegetation increased in the drainage line, there were no substantial changes to species composition. The drainage line vegetation was noted as being in good to very good condition, with the main disturbances due to grazing by cattle and low levels of damage from vehicles. An image of this unit is presented as **Plate 8** in **Appendix E**.

8.2.5 Claypan vegetation

There were two vegetated claypans within the Millipede project area, both of which were located in depressions behind the dune systems. There were two different vegetation units recorded in the claypans.

cp1 – Low Heath D of *Tecticornia* species

This vegetation unit was comprised of halophytic species on soils of white-red clay. Key species within this unit were *Tecticornia halocnemoides* subsp. *halocnemoides, T. indica* subsp. *leiostachya* and *T. pterygosperma* growing to 0.5 m, with very occasional *Senna artemisioides* to 1 m. It was

noted that there had been previous records of *Acetosa vesicaria* (ruby dock) in this location (Niche Environmental Services, 2011); however, none were observed in 2013. The vegetation in this unit was assessed as being in good condition, although it was noted that there was widespread evidence of drought stress in this claypan. In addition to this, there was evidence of damage due to cattle. An image of this unit is presented as **Plate 9** in **Appendix E**.

cp2 – Low Heath D of *Tecticornia* species

This vegetation unit was comprised of halophytic vegetation to 0.5 m on soils of red clay, with *Tecticornia indica* subsp. *bidens* and *T. indica* subsp. *leiostachya* the dominant species. The vegetation in this unit was assessed as being in very good condition. There was some evidence of disturbances due to cattle, but these were considered to be comparatively minor. An image of this unit is presented as **Plate 10** in **Appendix E**.

8.3 Regional context

Regional surveys were conducted during the assessment of ecological values associated with the proposed development of the Lake Way and Centipede Project areas (Niche Environmental Services, 2011). These surveys were conducted in vegetation immediately adjacent to the project areas, including areas that are now within the tenements comprising the Millipede Project, as well as in the southern, western and eastern vegetation near Lake Way (Niche Environmental Services, 2011). Regional surveys were also conducted adjacent to salt lakes in the surrounding area (Niche Environmental Services, 2011). Key findings from these surveys, as they relate to the Millipede Project, were:

- The fringing Closed Forest of *Melaleuca xerophila,* was recorded in a number of areas in the south of Lake Way, as well as adjacent to other lake systems in the region. While there may be significant and highly localised impacts to this unit within the Millipede Project, these are unlikely to lead to a reduction in the distribution of this unit either adjacent to Lake Way or in the broader region, in such a manner that its threatening processes profile would be altered.
- Vegetation recorded on the calcrete platform within the Millipede Project was found in small patches on the west of Lake Way. There were structurally similar vegetation units observed near Lake King, approximately 100 km to the north, and near Lake Miranda, to the south of Lake Way. The calcrete vegetation near Lake King was the most similar, containing a similar suite of species, including a large number of the Priority 3 species *Eremophila arachnoides* subsp. *arachnoides.*
- The surveys of other *Tecticornia* vegetation units has covered a number of salt lake systems, small and large, located to the south, east and north of the Lake Way system. There are unresolved taxonomic issues in relation to *Tecticornia* species, as well as a currently poorly developed understanding of the significance and robustness of these vegetation units. A condition arising in relation to the assessment of the Lake Way and Centipede Projects was that futher research was needed to advance the understanding of the taxonomy and ecology

of these systems. As such, it is not currently possible to adequately discuss the regional context of *Tecticornia* vegetation.

- Dune vegetation with both structural and species similarity to the dune systems in the Millipede area was recorded during the regional surveys near Lake Ward and Lake King. There was also vegetation recorded on the east of Lake Way that was structurally similar, although not on the same type of dune structure. Where dune vegetation was observed, it was noted as being comparatively widespread.
- Claypan vegetation units similar to those found in the Millipede Project were not observed during regional surveys.

8.4 Conservation Significance of Vegetation

To determine whether vegetation was considered to have conservation significance, an assessment was made against the following factors:

- Presence of flora of conservation significance;
- Presence of new flora records;
- Vegetation unit potentially restricted in distribution;
- Vegetation containing a unique assemblage of species; and/or
- Identified by a recognised authority as being a unit with conservation significance.

The vegetation unit ca1, the dominant vegetation unit on the calcrete platform within the Millipede Project, was noted as being habitat for the priority 3 species *Eremophila arachnoides* subsp. *arachnoides.* Targeted searches were conducted over this area during surveys for the Centipede assessment, the result of which was the identification of a substantial population of this species (refer Section 9.2.1 in this report for summary). Based on the numbers recorded in this unit, it was proposed that this vegetation would be considered to have conservation significance. It was noted that substantial numbers of this species were recorded to the north of the Lake Way Project and to the south of Lake King, with all records made on similar vegetation (Niche Environmental Services, 2011). Any assessment of the significance of this vegetation unit and associated impacts to this species should be considered in the context of the regional populations.

The *Tecticornia* species vegetation units recorded on the playa were identified as having conservation significance during assessments of the Lake Way and Centipede Projects (Niche Environmental Services, 2011). This position was based on guidance from Dr Kelly Shepherd from DPAW, who indicated that taxonomy for this group of species was poorly understood, and as such, there was potential for new species to be present. In addition to this, it was asserted by Dr Shepherd that the scale of impacts associated with the proposed development of the resource would be significant at the local and regional scale, primarily due the focus on removing this vegetation unit to access the ore.

In addition to the *Tecticornia* related matters, the salt lake vegetation in the southern sections of the project area was noted as hosting the Priority 3 species *Stackhousia clementii.* During the surveys completed for the initial assessment of the Wiluna Project and the surveys documented in this report, three distinct habitats with populations of *S. clementii* have been identified – within the bed of West Creek and to the west of the Millipede project (Niche Environmental Services, 2011) and the salt lake heath. Of these three, only the latter is likely to be impacted by the proposed development of the resource.

8.5 Threatening Processes

During the completion of the surveys documented in this report, it was noted that there were threatening processes that were potentially having an impact on the condition of vegetation and the diversity of flora in the project area and surrounds. While it is acknowledged that mining is a threatening process, the following summary relates to existing threatening processes beyond this. The key threatening processes noted were:

- Track proliferation – the Millipede Project contained a well-developed track that serves to facilitate access from Goldfields Hwy to the Toro Centipede Project and onto the Lake Way patoral lease. In addition to this, there were a number of drill line access tracks and minor access tracks that ran off the main access tracks. These areas were associated with the loss of vegetation in areas cleared for vehicle movement, as well as damage to vegetation through deviation from tracks for turning vehicles and avoidance of flooded sections of tracks after rainfall events. In addition to damage due to vehicle movement, there was evidence of dust deposition as a result of vehicle movement during dry conditions.
- Overgrazing by cattle – the impacts of cattle on vegetation was noted within the project area, although the scale of the impacts observed during the surveys appears to have reduced due to recent rainfall events, with the herb layer regenerating, particularly grasses such as *Eragrostis eriopoda*. This capacity to recover may be reduced with increasing disturbance in the area, for example from clearing for tracks or drill pads, or with exacerbation of natural climatic sequences due to global warming. Impacts associated with cattle will need review over time to provide for the longer term viability of the vegetation.
- Grazing by rabbits – as with the other grazing pressure, grazing by rabbits damages or destroys herbaceous species and recruits of perennial species. The combination of grazing pressures by cattle and rabbits and impacts associated with track proliferation has the potential to significantly threaten the vegetation in the project areas and surrounds. Over time, the combined effects of these introduced disturbances may lead to loss of suites of species and may lead to the complete loss of recuperative capacity in the vegetation, with the concomitant loss of seedbank recharge due to lack of individuals reaching reproductive maturity magnifying the problem.
- Fire – fire may not in isolation present as a threatening process, provided fire frequency and intensity is consistent with existing natural patterns. In instances where fire frequencies change, especially with an increase in frequency, this may result in structural changes to

vegetation. The effects of changes to fire frequency and intensity may also magnify the effects associated with excessive grazing. It is noted that there was no evidence of recent fire events in the area.

- Drought – rainfall in this region can be sporadic, with extended periods of limited or no rainfall interspersed with rainfall episodes of varying scale and intensity. Vegetation in the region is adapted to this pattern, but with the onset of global warming, this pattern may be altered, increasing stress on vegetation. This may be further amplified by alterations to local hydrology associated with extractive processes. Baseline information in relation to the extent of drought-related or other forms of hydrology-related stress should be collected prior to any significant activities in the area.

8.6 Groundwater-dependent vegetation

A groundwater-dependent ecosystem (GDE) is an ecosystem that requires access to groundwater so that ecological structure and function can be maintained (Murray *et al.,* 2006). Within the Millipede Project, the main form of GDEs considered to be present were those defined by Eamus *et al.* (2006) as being either ecosystems dependent on surface expressions of groundwater or ecosystems dependent on subsurface groundwater. A summary of the key characteristics of these is presented in **Table 3**.

The dependency on groundwater of a species within a GDE can be defined as facultative and obligate (Eamus *et al.,* 2006). A GDE is considered to be obligate if, at the species level, the presence of a species is dependent upon continuous, seasonal or episodic access to groundwater (Eamus *et al.,* 2006). A GDE is considered to be facultative if a species uses groundwater when it is available, but does not demonstrate any loss of vegetative cover in the absence of groundwater (O'Grady *et al.,* 2006). Defining whether a system is facultative or obligate is considered to be relevant to understanding how changes in groundwater access will impact the vegetation. This assessment has not been undertaken for the groundwater-dependent vegetation (GDV) within the survey areas. This may need to be addressed to provide a better understanding of vegetation interactions with groundwater.

The vegetation and landscape within the survey areas was reviewed in the context of the criteria listed in **Table 3**. There was no evidence of surface flows, wetlands or swamps in the survey areas observed during the surveys, although the clay pans may be subject to irregular inundation after periods of significant rainfall, leading to filling from both rainfall and inflow from the surrounding landscape. Key features of vegetation within the Millipede Project that may accessing groundwater were:

- The groundwater or capillary fringe above the water table is likely to be within the rooting depth of any of the vegetation;
- A proportion of the vegetation remains green and is likely to be physiologically active during extended dry periods;

- The vegetation associated with the subsurface groundwater is different, in terms of species composition and phenology, to the surrounding vegetation; and
- The annual use of water by vegetation is considered to be significantly greater than the annual rainfall.

Inferred GDEs within the Millipede Project are presented in **Figure 8**. No direct assessment of the hydrological requirements of these units, or species within, has been undertaken. Therefore, it is recommended that a detailed assessment should be completed prior to commencing any activities that may directly impact on these units or lead to alterations in local or regional hydrology.

Table 3 Criteria for determining groundwater dependence in vegetation (adapted from Eamus, 2009).

Surface expression of groundwater	Subsurface expression of groundwater
Does a river flow all year, or a wetland or swamp remain wet all year despite prolonged periods of zero surface flows (that is, zero or very low rainfall)?	Are roots able to reach the water table? If roots can reach a source of fresh water it is generally true that this water will be absorbed by the roots and transpired by the canopy.
Within an estuary, does the salinity drop below that of seawater in the absence of surface water inputs (e.g. tributaries or stormwater)?	During extended dry periods, does a significant proportion of the vegetation remain green and physiologically active? The green region might be using groundwater to maintain its physiological activity.
Does the volume of flow in a stream or river increase downstream in the absence of inflow from a tributary?	Are large changes in LAI apparent at some locations but not others within a small geographical range? The area not showing a large change in LAI might be accessing groundwater while the area that does show large intra-annual changes in LAI is probably not.
Is groundwater discharged (e.g. a spring) to the surface for significant periods of time each year? If such a resource is present, some species present are likely to be adapted to be using it.	Is the vegetation associated with the surface discharge of groundwater different (in terms of species composition, phenological pattern, LAI or vegetation structure) from vegetation close by but which is not associated (i.e. not accessing) this groundwater?
Is the vegetation associated with the surface discharge of groundwater different (in terms of species composition, phenological pattern, LAI or vegetation structure) from vegetation nearby that is not associated with this groundwater?	For sites that are not receiving significant amounts of lateral surface and sub-surface flows, is the annual rate of water use by the vegetation significantly larger than the annual rainfall at the site?
Is the annual rate of water use by the vegetation significantly larger than annual rainfall at the site, and the site is not a run-on site?	Are plant water relations (especially pre-dawn and midday water potentials and transpiration rates) indicative of less water stress (potentials closer to zero; transpiration rate larger) than vegetation located nearby but upslope? The best time to measure this is during rainless periods.
Are plant water relations (especially pre-dawn and midday water potentials and transpiration rates) indicative of less water stress (potentials close to zero; transpiration rate larger) than vegetation located nearby but not accessing the groundwater discharged at the surface?	Are seasonal changes in groundwater depth larger than can be accounted for by the sum of lateral flows and percolation to depth (that is, a significant discharge path for groundwater)?
Is occasional (or habitual) groundwater release at the surface associated with key developmental stages of the vegetation (such as flowering, germination, seedling establishment)?	
Can small (typically less than 20 mm per day) fluctuations in the depth to groundwater be seen in the aquifer with a diurnal periodicity?	

Figure 8 **Map showing inferred Groundwater Dependent Ecosystems within the Millipede Project.**

9.0 RESULTS and DISCUSSION - FLORA

9.1 Summary of Flora

During the surveys within the Millipede Project and immediate surrounds, a total of 185 species, including subspecies and variants, were recorded. This figure does not include collections of *Tecticornia* species, for which regional taxonomic work is still ongoing. The 185 species were from 100 genera within 40 families. The flora was dominated by the following families; Chenopodiaceae, with 34 species from 10; Poaceae, with 18 species from 10 genera; Asteraceae, with 14 species from 4 genera; and, Amaranthaceae, with 10 species from 2 genera. A summary of the flora is presented in **Appendix F**. Two priority species were recorded during the surveys; *Eremophila arachnoides* Chinock subsp. *arachnoides* (Scrophulariaceae) (P3); and *Stackhousia clementii* Domin (Celastraceae) (P3). Further details in relation to priority flora are presented in the following section. There were two weed species recorded during the most recent surveys of the Millipede Project, but it was noted that records of *Acetosa vesicaria* were made within or adjacent to the area in previous surveys.

The census of the flora from the survey areas was considered to be comprehensive. The collection of 185 species, which does not include *Tecticornia* species, was considered to be a high number, particularly in the context of the extent of disturbance at the site. The census was comprised of a number of annual taxa, which would support the assertion that the surveys were correctly timed. The number of specimens collected during the survey for which taxonomy could not be resolved was low, relative to the number of specimens collected.

9.2 Targeted Search Results

9.2.1 *Eremophila arachnoides* Chinook subsp. *arachnoides*

Targeted searches for Eremophila arachnoides subsp arachnoides were completed as a component of the assessment of ecological values associated with the Centipede Project. The targeted searches occurred within the area to the west of the Centipede survey area, incorporating the area that now includes the Millipede Project (**Figure 9**). A total of 8 780 linear metres of transects was traversed, covering an area of 43.9 ha. The mean density of records over this area was 22.67 (± 16.4) plants per hectare. The high variance was the product of two transects yielding very high densities of 55.2 and 40 plants per hectare. The habitat for this species was identified as being acacia woodland on calcrete, with the density dropping rapidly as the calcrete became overlain with shallow clays. The estimate of plants within the habitat in and adjacent to the Millipede Project was 5 440 (±3 936). Additional information in relation to the regional distribution of this species is detailed in the report pertaining to the other areas within the Toro Wiluna Project (Niche Environmental Services, 2011).

9.2.3 *Stackhousia clementii* Domin.

There were nine records of the Priority 3 species *Stackhousia clementii* Domin. made during targeted searches for this species during 2013, all located within Abercrombie Creek (**Figure 10**). There were

estimated to be greater than 300 individual plants recorded at the nine sites. During previous surveys, approximately 500 – 1000 plants were recorded in a seasonal creek line to the west of the Millipede project (Niche, 2011). The plants recorded in Abercrombie Creek are located over the ore body, and as such, these plants are likely to be impacted by the proposed development. There are currently no indications that there is a resource and there are no plans to develop any mining infrastructure associated with the Toro Energy Wiluna Project in the seasonal creek line in which the 500 – 1000 plants were recorded. Based on this, the proposed development will not result in the loss of this species from the area. In addition to this, all of the records of this species made during the surveys associated with the Toro Wiluna Project were all new, which supports the assertion that this species is potentially more common in the area than is currently documented.

9.3 Alien Taxa

There were scattered records of alien taxa made during 2013 surveys, although none of these were species that would be considered to pose significant environmental threats. It was noted that during previous surveys in the area, there were records of the invasive weed species *Acetosa vesicaria* made within the Centipede Project and a claypan within what is now the Millipede Project (Niche Environmental Services, 2011). Toro Energy have undertaken an intensive management program to address this species, which appears to have been successful to date. It is recommended that Toro continue to monitor for the presence of this species within the project and surrounding vegetation.

Figure 9 **Map showing location of transects used for searches for *Eremophila arachnoides* subsp. *arachnoides*.**

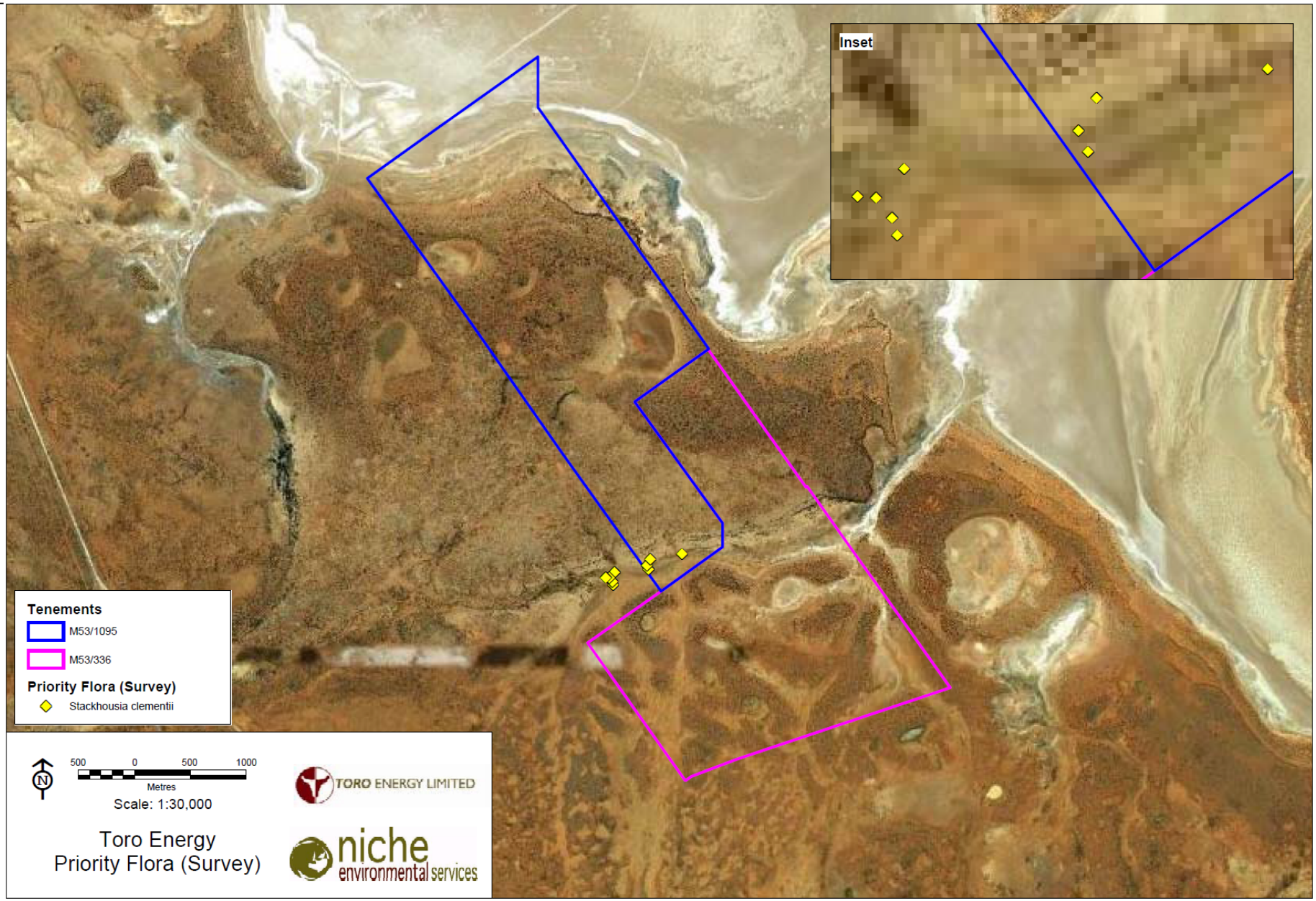

Figure 10 **Map showing locations at which *Stackhousia clementii* was recorded in 2013.**

10.0 CONCLUSION AND RECOMMENDATIONS

The surveys as detailed in this report were conducted to comply with the requirements of a Level 2 survey as detailed in *Guidance Statement No. 51* (EPA, 2004). The Millipede Project has been surveyed as a component of regional surveys completed in relation to the Centipede Project of the Toro Wiluna Uranium Project, as detailed in Niche Environmental Services (2011) and during spring 2013. The survey effort has been adequate to assess the diversity of flora, presence of priority flora and the type of vegetation within the project area. Data collected during previous surveys assisted with placing vegetation in the Millipede Project into a regional context. Based on this, there is considered to be sufficient information available to discuss the impacts associated with the project, notwithstanding acknowledged issues with *Tecticornia* species vegetation.

Vegetation within the Millipede Project had been impacted by activities associated with the ongoing operation of the Lake Way Pastoral Lease, investigations associated with the development of the Centipede Project and exploration within the Millipede Project. Key amongst these impacts were the main access tracks through the project tenements, smaller access tracks and drill pads. These tracks had resulted in the loss of vegetation and the deposition of dust on vegetation adjacent to the tracks.

The vegetation within the Millipede Project had also been impacted by grazing by cattle, although it was noted that the effects of this were subject to effects associated with rainfall events. The surveys detailed in this report were conducted after rainfall, which had resulted in the rejuvenation of the herbaceous understorey and normally heavily-grazed midstorey species. While there was evidence of some rejuvenation on the calcrete and dunes, the volume of rainfall did not appear to be of a significant enough volume to promote significant improvements in claypan and salt lake vegetation units. It is recommended that additional investigations in relation to the hydrological requirements of these units is completed prior to commencing any meaningful development.

Information gathered during regional surveys was used to assist with placing the vegetation and flora in the proposed disturbance areas into context. The dunes, plains and calcrete vegetation found within the project survey areas was found to be similar to vegetation found during regional surveys. The findings of taxonomic work in relation to *Tecticornia* species is required to make definitive assertions, but based on assessments of structural form and inferences in relation to substrate and hydrology, there appears to be an underlying difference between *Tecticornia* communities in the project survey areas and surrounds. While the claypan vegetation units within the Millipede Project were noted as being discrete landforms, they bore a strong structural and floristic similarity to extensive areas located to the south of the Millipede Project, and as such, are not of high conservation value. Cultural matters in relation to these landforms fall outside of the scope of this report, but they may require consideration.

The census of the flora within the Millipede Project yielded 185 species, excluding *Tecticornia* species. While this was substantially lower that the census of 428 species recorded in surveys over the other components of the Toro Wiluna Project (Niche Environmental Services, 2011), the survey area was also substantially smaller. Key findings of the census related to records of the priority species *Eremophila arachnoides* subsp.*arachnoides* and *Stackhousia clementii.* In particular, *E. arachnoides* subsp. *arachnoides* populations within the Millipede Project will potentially be significantly impacted by the proposed development. It is noted that while this has a localised impact, the regional extent of this species is greater than previously known (Niche Environmental Services, 2011). The proposed impacts associated with this project are unlikely to result in a significant change to the threatening processes profiles of either of these species.

Key further research required in relation to the flora and vegetation within the Millipede Project relates to the groundwater requirements of identified GDEs within the area, and the taxonomy of *Tecticornia* species. It is noted that both of these issues were raised in relation to the completed assessment of other components of the Toro Wiluna Uranium Project. It is proposed that investigations into these matters, as detailed in relevant approvals documents, can be readily expanded to include the areas within the Millipede Project. Vegetation to the south of Abercrombie Creek was identified during the surveys as having the potential to be suitable as a source of seed for rehabilitation, as well as areas to be considered for offsets. Detailed surveys of these areas have not been undertaken, but initial first pass surveys have delineated salt lake heath, foredune and dune vegetation units that are comparable to those within the project footprint.

11.0 REFERENCES

Beard, J.S. (1990) *Plant Life of Western Australia*. Kangaroo Press, Kenthurst, NSW

Commonwealth of Australia (2013) *Bureau of Meteorology Australian Climate Averages.* [Online]. Available: *http://www.bom.gov.au/climate* [URL accessed November, 2013].

Cowan (2001). Murchison 1 (MUR1 – East Murchison subregion) In May, J. & McKenzie, N. (Eds) *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002.* Department of CALM (CALM, now DEC) pp 466 – 479. URL: www.naturbase.net/pdf/science/bio_audit/murchison01_p466-479.pdf (Accessed: July, 2010)

Department of Parks and Wildlife (formerly DEC) (2013a). Declared Rare and Priority Flora List for Western Australia; search 21-0510

Department of Parks and Wildlife (formerly DEC) (2013b). Threatened Ecological Community listings; search 32-0510

Eamus, D., Froend, R., Loomes, R., Hose, G. and Murray, B. (2006) A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Aust. J. Bot.* **54**, 97-114

Eamus, D. (2009) *Identifying groundwater dependent ecosystems. A guide for land and water managers.* Land and Water Australia, Canberra

English, V. and Blyth, J. (1997). *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province* ANCA National Reserves System Cooperative Programme: Project Number N702. Final Report, May 1997.

EPA (2002). Environmental Protection Authority. Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No 3. March 2003.

EPA (2004). Environmental Protection Authority. Guidance for the Assessment of Environmental Factors. Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No 51. June, 2004.

Keighery, B. (1994). *Bushland Plant Survey – A guide to Plant Community Survey for the Community*, Wildflower Society of WA (Inc.)

Mabbutt, J. A. & CSIRO. (1963) *General report on lands of the Wiluna-Meekatharra area, Western Australia, 1958 / comprising papers by J.A. Mabbutt ... [et al.]* CSIRO, Melbourne

Muir, B.G (1977) Biological Survey of the Western Australian Wheatbelt. Pt. 2. Vegetation and habitat of the Bendering Reserve. *Rec. West. Aust. Mus.* Supp. **3.**

Murray, B.R., Hose, G.C., Eamus, D. and Licari, D. (2006) Valuation of groundwater-dependent ecosystems: a functional methodology incorporating ecosystem services. *Aust. J. Bot.* **54**, 221-229

Outback Ecology Services (2007) *Lake Way and Centipede Baseline Vegetation and Flora Survey.* Unpublished report prepared for Toro Energy Ltd.

Pringle, H.J.R, Van Vreeswyk, A.M.E. and Gilligan, S.A. (1994) An inventory and condition survey of the north-eastern Goldfields, Western Australia. *Dept. of Agric. West. Aust. Technical Bulletin* **87**

Shepherd, D., Beeston, G., and Hopkins, A. (2007). *Native Vegetation in Western Australia; Extent, Type and Status. Resource Management Technical Report No. 249.* Department of Agriculture, Government of Western Australia.

Thackway, R., and Creswell, I. (eds) (1995) *An Interim Biogeographical Regionalisation of Australia.* Australian Nature Conservation Agency (now DEWHA), Canberra.

Western Australian Herbarium (2013). FloraBase — The Western Australian Flora. Department of Environment and Conservation. http://florabase.calm.wa.gov.au/

Appendix A

Definitions of Threatened (Declared Rare) and Priority Flora

Definition of Declared Rare and Priority Flora Species (DPaW, 2013)

Code	Category Description
T	*Threatened – (Declard Rare Flora – Extant)* Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the Wildlife Conservation Act, 1950). Threatened Flora (Schedule 1) are further ranked by the DEC according to their level of threat using IUCN Red List Criteria: CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild EN: Endangered – considered to be facing a very high risk of extinction in the wild VU: Vulnerable – considered to be facing a high risk of extinction in the wild
X	*X: Presumed Extinct Flora (Declared Rare Flora — Extinct)* Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950)
Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation Dependent species are placed in Priority 5.	
P1	*Priority One – Poorly-known Species* Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	*Priority Two – Poorly Known Species* Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	*Priority Three – Poorly Known Species* Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	*Priority Four – Rare, Near Threatened and other species in need of monitoring* a. Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. b. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	*Priority Five – Conservation-dependent species* Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix B

Threatened and Priority Ecological Community Definitions

Threatened Ecological Community Classifications and Descriptions (DPaW, 2013)

Category	Category Description
Presumably 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 completely 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 forseeable 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) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or** B) All occurrences within the last 50 years have been destroyed.
Critically endangered (CR)	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 is determined on the basis of the best available information, by it meeting ANY ONE OR MORE of the following criteria (A, D, or G): **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 (B or C):** B) 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); C) 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. **D) Current distribution is limited, and one or more of the following apply (E or F):** E) 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); F) 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. G) **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	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 (A, D or H): **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 (B or C):** B) 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); C) Modification throughout its range is continuing such that in the short term future (within approximately 20 years). **D) Current distribution is limited, and one or more of the following apply (E, F or G):** E) 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); F) There are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; G) There may be many occurrences but the total area is small and/or isolated and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. **H) 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	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 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 to move into a category of higher threat in the medium to long-term future because of existing or impending threatening processes.

Priority Ecological Community Classifications and Descriptions (DPaW, 2013)

Category	Category Description
Priority One	Poorly-known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100 ha). Occurrences are believed to be under threat due to limited extent, or being on lands under which immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. 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 occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200 ha). At least some occurrences are not believed to be under immediate 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 Communities that are known from several to many occurrences, a significance number or area of which are not under threat of habitat destruction or degradation; or Communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat; or, Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, 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.
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. 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. 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. 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.

Appendix C

Classification of Vegetation Structural Formation and Height Classes

LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE 70% - 100%	**MID DENSE 30% - 70%**	**SPARSE 10% - 30%**	**VERY SPARSE 2% - 10%**
Trees > 30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15m	Dense Low Forest A	Low Forest A	Low woodland A	Open Low Woodland A
Trees < 5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee Tree Form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee Shrub Form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 – 1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 – 0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat Plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock Grass	Dense Hummock Grass	Mid-dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass >0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5m	Dense Low Grass	Low Gras	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

Appendix D
Vegetation Condition Scale

Code	Description
Pristine	Pristine or nearly so. No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Appendix E
Vegetation Photographs

Plate 1 – Photograph of sl - Low Heath D of *Tecticornia* species.

Plate 2 – Photograph of fr – fringing Closed Low Forest of *Melaleuca xerophila*

Plate 3 – Photograph of fd – Open Low Woodland A of *Acacia ayersiana*

Plate 4 – Photograph of d – Low Woodland A of *Eucalyptus eremicola* subsp. *peeneri* and *Acacia ayersiana*

Plate 5 – Photograph of ca1 – Low Woodland B of *Acacia* species

Plate 6 – Photograph of ca2 – caOLW – Open Scrub of mixed species

Plate 7 – Photograph of ca3 – caOLWAcspp

Plate 8 – Photogrpah of dl – Low Woodland of Acacia species on shallow, ephemeral drainage line

Plate 9 – Photograph of cp1 – Low Heath D of *Tecticornia* species

Plate 10 – Photograph of cp2 – Low Heath D of *Tecticornia* species

Appendix F
Species List

Family	Genus	species
Aizoaceae	*Disphyma*	*crassifolium*
Aizoaceae	*Gunniopsis*	*rodwayi*
Aizoaceae	*Trianthema*	*triquetra*
Amaranthaceae	*Alternanthera*	*nodiflora*
Amaranthaceae	*Ptilotus*	*schwartzii*
Amaranthaceae	*Ptilotus*	*polystachyus*
Amaranthaceae	*Ptilotus*	*obovatus*
Amaranthaceae	*Ptilotus*	*nobilis*
Amaranthaceae	*Ptilotus*	*helipteroides*
Amaranthaceae	*Ptilotus*	*exaltatus*
Amaranthaceae	*Ptilotus*	*divaricatus*
Amaranthaceae	*Ptilotus*	*aervoides*
Amaranthaceae	*Ptilotus*	*macrocephalus*
Apiaceae	*Daucus*	*glochidiatus*
Apocynaceae	*Marsdenia*	*australis*
Apocynaceae	*Rhyncharrhena*	*linearis*
Asparagaceae	*Thysanotus*	sp. Eremeaen
Asteraceae	*Brachyscome*	*ciliaris*
Asteraceae	*Calotis*	*multicaulis*
Asteraceae	*Calotis*	*hispidula*
Asteraceae	*Chrysocephalum*	*apiculatum*
Asteraceae	*Gnephosis*	*tenuissima*
Asteraceae	*Myriocephalus*	*guerinae*
Asteraceae	*Olearia*	*pimelioides*
Asteraceae	*Pluchea*	*dentex*
Asteraceae	*Podolepis*	*capillaris*
Asteraceae	*Rhodanthe*	*streriliscens*
Asteraceae	*Rhodanthe*	*citrina*

Family	Genus	species
Asteraceae	*Rhodanthe*	*charsleyae*
Asteraceae	*Sonchus*	*oleraceus*
Asteraceae	*Streptoglossa*	*cylindriceps*
Asteraceae	*Waitzia*	*acuminata*
Boraginaceae	*Halgania*	*cyanea*
Brassicaceae	*Lepidium*	*muelleri-ferdinandii*
Brassicaceae	*Menkea*	*sphaerocarpa*
Brassicaceae	*Stenopetalum*	*anfractifolium*
Brassicaceae	*Stenopetalum*	*filifolium*
Campanulaceae	*Lobelia*	*heterophylla*
Campanulaceae	*Wahlenbergia*	*tumidifructa*
Chenopodiaceae	*Atriplex*	*codonocarpa*
Chenopodiaceae	*Atriplex*	*amnicola*
Chenopodiaceae	*Dissocarpus*	*paradoxus*
Chenopodiaceae	*Dysphania*	*melanocarpa* forma. *melanocarpa*
Chenopodiaceae	*Dysphania*	*melanocarpa*
Chenopodiaceae	*Enchylaena*	*tomentosa*
Chenopodiaceae	*Eremophea*	*spinosa*
Chenopodiaceae	*Maireana*	*triptera*
Chenopodiaceae	*Maireana*	*trichoptera*
Chenopodiaceae	*Maireana*	*thesioides*
Chenopodiaceae	*Maireana*	sp. (sterile)
Chenopodiaceae	*Maireana*	*pyramidata*
Chenopodiaceae	*Maireana*	*georgei*
Chenopodiaceae	*Maireana*	*erioclada*
Chenopodiaceae	*Maireana*	*amoena*
Chenopodiaceae	*Maireana*	*planifolia*
Chenopodiaceae	*Rhagodia*	*drummondii*
Chenopodiaceae	*Rhagodia*	*eremaea*

Family	*Genus*	*species*
Chenopodiaceae	*Sclerolaena*	*sp. (sterile)*
Chenopodiaceae	*Sclerolaena*	*obliquicuspis*
Chenopodiaceae	*Sclerolaena*	*lanicuspis*
Chenopodiaceae	*Sclerolaena*	*deserticola*
Chenopodiaceae	*Sclerolaena*	*densiflora*
Chenopodiaceae	*Sclerolaena*	*cuneata*
Chenopodiaceae	*Scleroleana*	*fusiformis*
Chenopodiaceae	*Scleroleana*	*eurotioides*
Chenopodiaceae	*Scleroleana*	*eriacantha*
Chenopodiaceae	*Scleroleana*	*diacantha*
Chenopodiaceae	*Scleroleana*	*bicornis*
Chenopodiaceae	*Tecticornia*	*pterygosperma*
Chenopodiaceae	*Tecticornia*	*indica subsp. leiostachya*
Chenopodiaceae	*Tecticornia*	*indica subsp. bidens*
Chenopodiaceae	*Tecticornia*	*halocnemoides subsp. halocnemoides*
Colchicaceae	*Wurmbea*	*deserticola*
Convolvulaceae	*Cuscuta*	*planiflora*
Convolvulaceae	*Duperreya*	*commixta*
Elatinaceae	*Bergia*	*perennis*
Euphorbiaceae	*Euphorbia*	*drummondii*
Euphorbiaceae	*Euphorbia*	*australis*
Euphorbiaceae	*Monotaxis*	*luteiflora*
Fabaceae	*Acacia*	*tetragonophylla*
Fabaceae	*Acacia*	*pruinocarpa*
Fabaceae	*Acacia*	*macraneura*
Fabaceae	*Acacia*	*ligulata*
Fabaceae	*Acacia*	*ayersiana*
Fabaceae	*Acacia*	*aneura*
Fabaceae	*Acacia*	*acuminata*

Family	*Genus*	*species*
Fabaceae	*Indigofera*	*sp (sterile)*
Fabaceae	*Senna*	*pleurocarpa*
Fabaceae	*Senna*	*artemisioides*
Fabaceae	*Senna*	*artemisioides subsp. filifolia*
Fabaceae	*Senna*	*artemisioides subsp. helmsii*
Fabaceae	*Senna*	*artemisioides subsp. x sturtii*
Fabaceae	*Swainsona*	*leeana*
Frankeniaceae	*Frankenia*	*setosa*
Frankeniaceae	*Frankenia*	*pauciflora*
Frankeniaceae	*Frankenia*	*cinerea*
Geraniaceae	*Erodium*	*crinitum*
Goodeniaceae	*Brunonia*	*australis*
Goodeniaceae	*Goodenia*	*havilandii*
Goodeniaceae	*Goodenia*	*macroplectra*
Goodeniaceae	*Scaevola*	*tomentosa*
Goodeniaceae	*Scaevola*	*spinescens*
Goodeniaceae	*Scaevola*	*collaris*
Goodeniaceae	*Velleia*	*rosea*
Goodeniaceae	*Velleia*	*connata*
Haloragaceae	*Haloragis*	*trigonocarpa*
Hemerocallidaceae	*Dianella*	*revoluta*
Malvaceae	*Abutilon*	*cryptopetalum*
Malvaceae	*Abutilon*	*oxycarpum*
Malvaceae	*Alyogyne*	*pinoniana*
Malvaceae	*Androcalva*	*luteiflora*
Malvaceae	*Lawrencia*	*glomerata*
Malvaceae	*Lawrencia*	*densiflora*
Malvaceae	*Lawrencia*	*helmsii*
Malvaceae	*Sida*	*sp. Dark Green Fruits (S. van Leeuwen2260)*

Family	Genus	species
		sp. verrucose glands (F.H. Mollemans
Malvaceae	*Sida*	2423)
Malvaceae	*Sida*	*calyxhymenia*
Malvaceae	*Sida*	*ammophila*
Marsileaceae	*Marsilea*	*hirsuta*
Myrtaceae	*Eucalyptus*	*kingsmillii* subsp. *kingsmillii*
Myrtaceae	*Eucalyptus*	*eremicola* subsp. *peeneri*
Myrtaceae	*Melaleuca*	*uncinata*
Myrtaceae	*Melaleuca*	*xerophila*
Nyctaginaceae	*Boerhavia*	*coccinea*
Phyllanthaceae	*Poranthera*	*microphylla*
Pittosporaceae	*Pittosproum*	sp (sterile)
Plantaginaceae	*Plantago*	*drummondii*
Plumbaginaceae	*Muellerolimon*	*salicorniaceum*
Poaceae	*Aristida*	*holathera* var. *holathera*
Poaceae	*Aristida*	*contorta*
Poaceae	*Austrostipa*	*elegantissima*
Poaceae	*Dactyloctenium*	*radulans*
Poaceae	*Dicanthium*	*sericeum*
Poaceae	*Enneapogon*	*caerulescens*
Poaceae	*Eragrostis*	*falcata*
Poaceae	*Eragrostis*	*dielsii*
Poaceae	*Eragrostis*	*eriopoda*
Poaceae	*Eriachne*	*mucronata*
Poaceae	*Lachnagrostis*	*filiformis*
Poaceae	*Monacather*	*paradoxus*
Poaceae	*Paractaenum*	*novae-hollandiae*
Poaceae	*Thyridolepis*	*mitchelliana*
Poaceae	*Tragus*	*australianus*
Poaceae	*Triodia*	*?melvillei*

Family	Genus	species
Poaceae	*Yakirra*	*australiensis*
Portulaceae	*Calandrinia*	*eremaea*
Portulaceae	*Calandrinia*	*polyandra*
Portulaceae	*Portulaca*	*?oleraceae*
Primulaceae	*Lysimachia*	*arvensis*
Primulaceae	*Samolus*	*repens*
Proteaceae	*Grevillea*	*stenobotrya*
Proteaceae	*Grevillea*	*sarissa* subsp. *succincta*
Proteaceae	*Grevillea*	*sarissa* subsp. *sarissa*
Proteaceae	*Grevillea*	*nematophylla*
Proteaceae	*Hakea*	*minyma*
Proteaceae	*Hakea*	*francisiana*
Pteridaceae	*Cheilanthes*	*sieberi*
Santalaceae	*Santalum*	*acuminatum*
Santalaceae	*Santalum*	*spicatum*
Scrophulariaceae	*Eremophila*	sp (sterile)
Scrophulariaceae	*Eremophila*	*longifolia*
Scrophulariaceae	*Eremophila*	*latrobei*
Scrophulariaceae	*Eremophila*	*georgei*
Scrophulariaceae	*Eremophila*	*compacta* subsp. *compacta*
Scrophulariaceae	*Eremophila*	*arachnoides* subsp. *arachnoides*
Scrophulariaceae	*Eremophila*	*alternifolia*
Scrophulariaceae	*Eremophila*	*forestii* subsp. *forestii*
Solanaceae	*Duboisia*	*hopwoodii*
Solanaceae	*Nicotiana*	*rosulata*
Solanaceae	*Nicotiana*	*simulans*
Solanaceae	*Solanum*	*centrale*
Solanaceae	*Solanum*	*lasiophylum*
Solanaceae	*Solanum*	*nummularium*

Family	*Genus*	*species*
Thymeleaceae	*Pimelea*	*microcephala subsp. microcephala*
Zygophyllaceae	*Tribulus*	*occidentalis*
Zygophyllaceae	*Tribulus*	*asterocarpus*
Zygophyllaceae	*Tribulus*	*terrestris*
Zygophyllaceae	*Zygophyllum*	*eichleri*
Zygophyllaceae	*Zygophyllum*	*compressum*
Zygophyllaceae	*Zygophyllum*	*aurantiacum*
Zygophyllaceae	*Zygophyllum*	*eremaeum*
Zygophyllaceae	*Zygophyllum*	*simile*

Appendix G
Quadrat Summaries

Quadrat Number	**M01**
Coordinates (WGS84)	51 J 235973 7029517
Plot size	30 x 30
Topography	Flat (Clay Pan)
Soil	White - red clay
Exposed rock type	Nil
Condition	Good - Very Good
Disturbance details	Rabbits, cattle, vehicle tracks, exploration sites, environmental stress
Trees	
Shrubs >2m	
Shrubs 1-2m	*Senna artemisioides*
Shrubs <1m	*Tecticornia pterygosperma, Tecticornia indica* subsp*. leiostachya* *Tecticornia halocnemoides* subsp*. halocnemoides, Frankenia cinerea*
Grasses	*Eragrostis falcata*
Herbs/creepers	*Myriocephalus guerinae, Dysphania melanocarpa* forma *melanocarpa* *Lawrencia densiflora, Sclerolaena cuneata, Sclerolaena obliquicuspis*

Quadrat Number	**M02**
Coordinates (WGS84)	51J 236355 7027884
Plot size	30 x 30
Topography	Flat
Soil	Light orange clay
Exposed rock type	Calcrete
Condition	Good - Very Good
Disturbance details	Rabbits, cattle, vehicle tracks
Trees	*Acacia ayersiana, Acacia aneura*
Shrubs >2m	*Acacia macraneura*
Shrubs 1-2m	*Eremophila arachnoides subsp. Arachnoides, Eremophila falcata*
Shrubs <1m	*Senna artemisioides, Ptilotus obovatus*
Hummock grasses	
Grasses	*Eragrostis dielsii, Eragrostis falcata*
Herbs/creepers	*Sclerolaena obliquicuspis, Zygophyllum aurantiacum*

Quadrat Number	**M03**
Coordinates (WGS84)	51 J 235891 7029215
Plot size	30 x 30
Topography	Flat (Abercrombie Creek)
Soil	Red orange clay
Exposed rock type	None
Condition	Good
Disturbance details	Rabbits, cattle, vehicle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Scaevola spinescens, Solanum lasiophyllum, Rhagodia eremaea, Atriplex codonocarpa, Frankenia setosa, Tecticornia indica* subsp. *bidens, Atriplex amnicola, Sclerolaena bicornis, Sclerolaena eriacantha, Sclerolaena cuneata, Maireana erioclada, Sida calyxhymenia*
Hummock grasses	
Grasses	*Eragrostis dielsii*
Herbs/creepers	*Nicotiana rosulata, Zygophyllum aurantiacum, Calotis multicaulis Streptoglossa cylindriceps, Euphoriba drummondii, Stenopetalum anfractifolium, Ptilotus helipteroides*

NOTE: SPECIES LIST IS INCOMPLETE DUE TO ONGOING ISSUES RELATING TO TECTICORNIA TAXONOMY

Quadrat Number	**M04**
Coordinates (WGS84)	51 J 236173 7028657
Plot size	30 x 30
Topography	Flat
Soil	Red sand-clay
Exposed rock type	None
Condition	Very Good
Disturbance details	Cattle, rabbits, tracks
Trees	*Eucalyptus eremicola subsp. peeneri, Acacia ayersiana*
Shrubs >2m	*Acacia tetragonophylla, Acacia jennerae, Acacia aneura*
Shrubs 1-2m	
Shrubs <1m	*Eremophila forestii, Maireana pyramidata, Ptilotus obovatus*
Hummock grasses	*Triodia basedowii, Triodia melvillei*
Grasses	*Eragrostis eriopoda*
Herbs/creepers	*Ptilotus polystachya*

Quadrat Number	**M05**
Coordinates (WGS84)	51 J 235693 7030399
Plot size	30 x 30
Topography	Flat to gently sloping
Soil	Orange - red clay
Exposed rock type	None
Condition	Good - Very good
Disturbance details	Tracks, cattle, rabbits
Trees	*Melaleuca xerophila*
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Muellerolimon salicorniaceum, Atriplex codonocarpa, Enchylaena tomentosa*
Hummock grasses	
Grasses	
Herbs/creepers	*Eremophea spinosa, Sclerolaena bicornis*

Quadrat Number	**M06**
Coordinates (WGS84)	51 J 234947 7030952
Plot size	30 x 30
Topography	Flat
Soil	Orange clay
Exposed rock type	None
Condition	Very good
Disturbance details	Cattle, tracks, rabbits
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Lawrencia helmsii, Frankenia cinerea*
Hummock grasses	
Grasses	*Eragrostis dielsii, Eragrostis falcata*
Herbs/creepers	*Gunniopsis rodwayi, Scaevola collaris, Zygophyllum aurantiacum Maireana amoena*

Quadrat Number	**M07**
Coordinates (WGS84)	51 J 234117 7030541
Plot size	30 x 30
Topography	Flat
Soil	Orange clay
Exposed rock type	None
Condition	Very good
Disturbance details	Tracks, cattle, rabbits
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Atriplex codonocarpa, Tecticornia halocnemoides* subsp. *halocnemoides, Frankenia cinerea, Maireana pyramidata*
Hummock grasses	
Grasses	*Eragrostis dielsii, Eragrostis falcata*
Herbs/creepers	*Salsola tragus, Podolepis capillaris, Sclerolaena cuneata, Maireana* sp. (sterile)

NOTE: SPECIES LIST IS INCOMPLETE DUE TO ONGOING ISSUES RELATING TO TECTICORNIA TAXONOMY

Quadrat Number	**M08**
Coordinates (WGS84)	51 J 234899 7030359
Plot size	30 x 30
Topography	Flat to gently sloping
Soil	Red clay
Exposed rock type	None
Condition	Very good
Disturbance details	Cattle, rabbits, tracks
Trees	*Acacia ayersiana*
Shrubs >2m	*Acacia macraneura*
Shrubs 1-2m	*Senna artemisioides*
Shrubs <1m	*Alyogyne pinoniana, Solanum lasiophyllum, Ptilotus obovatus, Maireana pyramidata, Scaevola spinescens*
Hummock grasses	*Triodia basedowii, Triodia melvillei*
Grasses	*Eragrostis eriopoda, Aristida holathera* var. *holathera, Monacather paradoxus*
Herbs/creepers	*Ptilotus polystachya, Salsola tragus*

Quadrat Number	**M09**
Coordinates (WGS84)	51 J 235620 7029695
Plot size	30 x 30
Topography	Flat to very gently sloping
Soil	Red clay/loam
Exposed rock type	None
Condition	Very good
Disturbance details	Cattle, rabbits, tracks
Trees	*Acacia ayersiana, Hakea francissiana*
Shrubs >2m	*Acacia jennerae, Acacia macraneura*
Shrubs 1-2m	*Alyogyne pinoniana, Senna artemisioides, Hakea minyma*
Shrubs <1m	*Solanum lasiophyllum, Ptilotus obovatus, Olearia pimelioides, Rhagodia eremaea, Scaevola spinescens, Pimelea microcephala subsp. microcephala, Ptilotus macrocephalus*
Hummock grasses	*Triodia melvillei*
Grasses	*Eragrostis eriopoda, Monocather paradoxus*
Herbs/creepers	*Ptilotus nobilis, Ptilotus polystachyus, Zygophyllum aurantiacum, Maireana georgei*

Quadrat Number	**M10**
Coordinates (WGS84)	51 J 235147 7030349
Plot size	30 x 30
Topography	Flat
Soil	Red clay
Exposed rock type	None
Condition	Good - very good
Disturbance details	Cattle, rabbits, vehicle tracks
Trees	
Shrubs >2m	
Shrubs 1-2m	
Shrubs <1m	*Solanum lasiophyllum, Solanum nummularium, Ptilotus obovatus Frankenia cinerea, Frankenia setosa*
Hummock grasses	
Grasses	*Eragrostis eriopoda*
Herbs/creepers	*Sclerolaena bicornis, Sclerolaena fusiformis, Gnephosis tenuissima Ptilotus aervoides*

Quadrat Number	**M11**
Coordinates (WGS84)	51J 235584 7029932
Plot size	30 x 30
Topography	Flat
Soil	Red clay
Exposed rock type	None
Condition	Very good
Disturbance details	Cattle, rabbits, vehicle tracks
Trees	
Shrubs >2m	*Acacia tetragonophylla, Senna artemisioides, Acacia ayersiana*
Shrubs 1-2m	
Shrubs <1m	*Maireana triptera, Rhagodia* sp. (sterile), *Sclerolaena eurotioides, Maireana georgei, Atriplex codonocarpa, Sclerolaena bicornis*
Hummock grasses	
Grasses	
Herbs/creepers	

Quadrat Number	**M12**
Coordinates (WGS84)	51J 23650 7028236
Plot size	30 x 30
Topography	Flat
Soil	Red clay
Exposed rock type	Calcrete
Condition	Good - Very good
Disturbance details	Cattle, rabbits, vehicle tracks
Trees	
Shrubs >2m	*Eremophila arachnoides* subsp. *arachnoides, Acacia macraneura*
Shrubs 1-2m	
Shrubs <1m	*Senna artemisioides, Sclerolaena obliquicuspis, Sclerolaena lanicuspis*
Hummock grasses	
Grasses	*Eragrostis dielsii*
Herbs/creepers	*Zygophyllum aurantiacum*

Quadrat Number	**M13**
Coordinates (WGS84)	51J 235808 7027341
Plot size	30 x 30
Topography	Flat
Soil	Red clay
Exposed rock type	None
Condition	Good - Very good
Disturbance details	Cattle, rabbits, vehicle tracks
Trees	*Melaleuca xerophila, Melaeluca interioris*
Shrubs >2m	*Acacia tetragonophylla, Senna artemisioides, Acacia ayersiana, Acacia aneura*
Shrubs 1-2m	*Maireana pyramidata*
Shrubs <1m	*Muellerolimon salicorniaceum, Dissocarpus paradoxus, Scaevola spinescens, Solanum lasiophyllum, Ptilotus obovatus, Salsola tragus, Sida* sp. verrucose glands, *Maireana georgi, Atriplex amnicola, Enchylaena tomentosa, Sclerolaena diacantha, Slcerolana diacantha, Sclerolaena bicornis*
Hummock grasses	
Grasses	
Herbs/creepers	*Nicotiana rosulata, Ptilotus nobilis, Eremophea spinosa*

Quadrat Number	**M14**
Coordinates (WGS84)	51J 235593 7027748
Plot size	30 x 30
Topography	Flat
Soil	Red clay
Exposed rock type	Calcrete
Condition	Good - Very good
Disturbance details	Cattle, rabbits, vehicle tracks
Trees	
Shrubs >2m	*Gervillea stenobotrya, Acacia burkittii, Acacia aneura*
Shrubs 1-2m	*Senna artemisioides*
Shrubs <1m	*Ptilotus obovatus, Salsola tragus, Eremophila alternifolia, Sida calyxhymenia, Abutilon sp.*
Hummock grasses	
Grasses	*Dicanthium sericeum, Aristida contorta,*
Herbs/creepers	*Euphorbia australis, Calotis multicaulis, Waitzia acuminata, Ptilotus schwartzii, Sclerolaena eurotiodes, Eremophea spinosa, Ptilotus aervoides, Sclerolaena bicornis, Velleia rosea, Tribulus asterocarpus*

Quadrat Number	**M15**
Coordinates (WGS84)	51J 234647 7030118
Plot size	30 x 30
Topography	Flat
Soil	Red clay
Exposed rock type	None
Condition	Very good
Disturbance details	Cattle, rabbits, vehicle tracks
Trees	*Acacia ayersiana*
Shrubs >2m	*Grevillea nematophylla*
Shrubs 1-2m	
Shrubs <1m	*Pimelea microcephala* subsp. *microcephala, Eremophila georgei, Alyogyne pinoniana, Solanum lasiophyllum, Ptilotus obovatus, Maireana pyramidata*
Hummock grasses	
Grasses	*Triodia basedowii*
Herbs/creepers	*Waitzia acuminata, Zygophyllum aurantiacum*

For all other quadrat summaries, refer to previous reports for the Centipede Project Area and corresponding regional surveys.