FLORA & VEGETATION ASSESSMENT

MUCHEA SILICA SAND PROJECT, WA

Prepared By

Mattiske Consulting Pty Ltd

Prepared For

VRX Silica Limited

Date

March 2022




DOCUMENT STATUS				
DOCUMENT REFERENCE: VRX2104/001/22				
VERSION	**TYPE**	**AUTHOR/S**	**REVIEWER/S**	**DATE DISTRIBUTED**
V1	Internal review	LAC/SBR	E.M. Mattiske	-
V2	Draft for client	LAC/SBR	E.M. Mattiske	24/03/2022

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LIST OF ABBREVIATIONS

BAM Act:	*Biosecurity and Agriculture Management Act 2007* (WA)
BC Act:	*Biodiversity Conservation Act 2016* (WA)
BOM	Bureau of Meteorology
DAWE	Department of Agriculture, Water and Environment (Commonwealth)
DBCA:	Department of Biodiversity, Conservation and Attractions (WA)
EP Act:	*Environmental Protection Act 1986* (WA)
EPA:	Environmental Protection Authority (WA)
EPBC Act:	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FCT:	Floristic Community Type
IBRA:	Interim Biogeographical Regionalisation for Australia
Muchea Project:	Muchea Silica Sands Project
NVIS:	National Vegetation Information system
PEC:	Priority Ecological Community
PRIMER:	Plymouth Routines in Multivariate Ecological Research
SIMPER:	Similarity percentages
SIMPROF:	Similarity profile
SVT:	Site-Vegetation Type
TEC:	Threatened Ecological Community
WAH:	Western Australian Herbarium (PERTH)
WAOL:	Western Australian Organism List

EXECUTIVE SUMMARY

Mattiske Consulting Pty Ltd was commissioned in July 2021 by VRX Silica Ltd to undertake a flora and vegetation survey of an area in the north of the Muchea Project, northwest of Muchea WA and the Timaru Road Reserve. This was an addition to an area previously surveyed in spring 2018. The survey area is located within the Bassendean Dune System on the eastern side of the Gnangara Mound within *Banksia* woodlands. The exploration mining tenement E70/4886 covers approximately 5850 ha of primarily native vegetation, of which 1099.04 ha (18.8 %) has now been mapped. A total of 68 sites were mapped using vegetation quadrats, and data analysed statistically to assist in defining vegetation communities.

A total of 225 vascular plant taxa which are representative of 103 plant genera and 42 plant families were recorded within the survey area. The majority of taxa recorded were representative of the Myrtaceae (33 taxa), Fabaceae (24 taxa), Stylidiaceae (17 taxa) and Ericaceae (14 taxa) families. Eight taxa were identified as introduced species. Annuals accounted for 22 taxa (9.8 %), and of these 27.3 % were introduced. No listed Threatened or Priority Flora species were recorded within the survey area. Analysis indicates that approximately 74 % of the flora species potentially present within the survey area have been recorded.

Eight vegetation communities were delineated and mapped across the survey area. Seven of these communities are located on dunes and flats and are characterized by a canopy of *Banksia attenuata* and *Banksia menziesii*, and an understory of sclerophyllous shrubs, whilst the eighth community is located in low, damp areas and has an overstorey dominated by *Melaleuca preissiana*.

Statistical analysis and inference based on the presence and coverage of key species and topography were used to align the eight vegetation communities with both the Floristic Community Types for the Swan Coastal Plain of Gibson et al. (1994) and the Site-Vegetation Types of Mattiske Consulting Pty Ltd (2002) for the Gnangara Mound. The seven communities (A, B, F, G, H, J and K) situated in the drier dune areas are floristically similar to Floristic Community Type 23b 'Northern *Banksia attenuata-Banksia menziesii* woodlands' and community M was most similar to Floristic Community Type 21c 'Low lying *Banksia attenuata* woodlands or shrublands'.

One Threatened and two Priority Ecological Communities are inferred to exist within the Muchea Project. The Threatened Ecological Community '*Banksia* woodlands of the Swan Coastal Plain' is listed as Endangered at a Federal level and as a Priority Ecological Community ranked Priority 3 for Western Australia. Both the priority 3 Priority Ecological Communities 'SCP *Banksia attenuata-Banksia menziesii* woodlands' and 'Low lying *Banksia attenuata* woodlands or shrublands' defined from the Floristic Community Types 23b and 21c respectively. Both of these Priority Ecological Communities are included in the federally listed Threatened Ecological Community '*Banksia* woodlands of the Swan Coastal Plain'.

The condition of the vegetation in the survey area was primarily in Excellent or Pristine condition (Keighery 1994). The surveyed area showed few signs of disturbance, with the only disturbance due to vehicle tracks, fire and firebreaks. Eight introduced taxa were recorded in this survey. The condition of the Timaru Road Reserve was Completely Degraded.

The local impact of the proposed project can be estimated by noting that clearing the survey area would result in 0.7 % of the vegetation remaining on the Gnangara Mound being impacted. Regionally, impacts can be estimated by considering that 0.76 %, 0.53 % and 0.13 % of the pre-European vegetation associations 949.2, 1014.1 and 1018.1 (as a proportion of that remaining in the Swan Coastal Plain IBRA region) and 0.33 % of the Threatened Ecological Community 'Banksia woodlands of the Swan Coastal Plain' would be removed in the course of the proposed project. These impacts are not insignificant given the substantial decline in areal extent, fragmentation, and the ongoing threats to *Banksia* woodlands in the region.

1. INTRODUCTION

Mattiske Consulting Pty Ltd (Mattiske) was commissioned in July 2021 by VRX Silica Ltd (VRX) to undertake a flora and vegetation survey of the Muchea Silica Sands Project (Muchea Project) northwest of Muchea, WA and the road reserve area of Timaru Road, Muchea, WA (Mattiske 2021). This survey was combined with desktop and flora and vegetation reports commissioned by Australian Silica Pty Ltd of the Muchea Project northwest of Muchea, WA (Mattiske 2018a). VRX Silica Pty Ltd is currently exploring the Muchea Project tenement for high quality silica sand.

1.1. Location and Scope of Project

The Muchea Project is located south of Gingin Airfield, Western Australia, 14 km north of the town of Muchea and 15 km south of the town of Gingin (Figure 1). The survey area is within exploration mining tenement E70/4886, covering approximately 5850 ha of *Banksia* woodland and a small amount of agricultural land.

The tenement lies on private property within the Shire of Chittering, although a strip 900 m wide along the northern edge falls in the Shire of Gingin and a 500 m wide strip along the western edge sits partially within State Forest and the Yeal Nature Reserve (City of Wanneroo). The south-eastern portion of the tenement crosses both the Dampier Bunbury Gas Pipeline and the Brand Highway.

The Muchea Project lies within the Drummond Botanical Subdistrict (Swan Coastal Plain Subregion) of the Southwest Botanical Province Beard (1990). In particular, the survey area lies within the Bassendean Dune System, over eastern edge of the Gnangara Mound. The overall vegetation cover is characterised as *Banksia* low woodland, with the vegetation in swampy areas in dune swales comprising *Melaleuca*, heath communities and reeds (Beard, 1990). In the Interim Biogeographic Regionalisation for Australia (IBRA, version 7) the Muchea Project lies within the Perth subregion (SWA02) of the Swan Coastal Plain region (DAWE 2022c).

The purpose of this report is to update and summarise the 2017 desktop survey and previous flora and vegetation field survey in spring 2018 within the survey area (Figure 1). The 2021 field survey was to add an adjacent area due to adjustment of the survey area. The survey area includes 317ha of ML70/1380 and 567 ha of FNA 12671 within Mining tenement E70/4886. The Muchea Project is proposed to also use Timaru Road, and the Timaru Road Reserve was also visited and the results reported.

1.2. Environmental Legislation and Guidelines

The following key Commonwealth (federal) legislation relevant to this survey is the:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

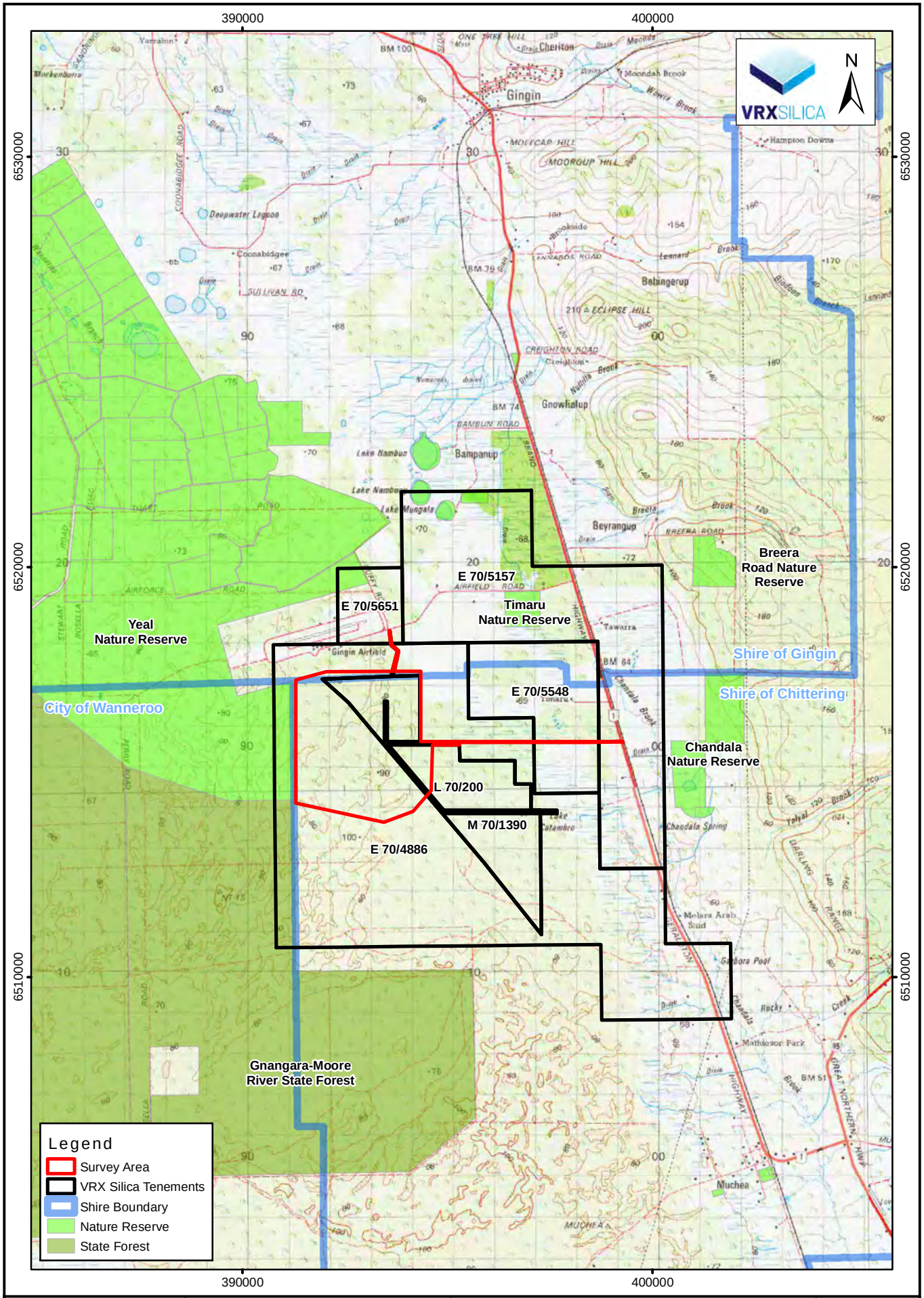
The following key Western Australian (state) legislation relevant to this survey includes the:

- *Biodiversity Conservation Act 2016* (BC Act) and *Regulations 2018*;
- *Biosecurity and Agriculture Management Act 2007* and *Regulations 2013*; and
- *Environmental Protection Act 1986*;

Furthermore, key Western Australian guidelines relevant to this survey are the:

- *Environmental Factor Guideline: Flora and Vegetation* (Environmental Protection Authority [EPA] 2016a); and
- *Technical Guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016b).

Definitions of flora and vegetation terminology commonly used throughout this report are provided in Appendices A1-6.



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Date: March 2022 | Rev: A | A4

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VRX Silica
Location of the Muchea Project

Figure: **1**

2. OBJECTIVES

The objective of this survey was to undertake a flora and vegetation assessment of the survey area of the Muchea Project including:

- Undertake a survey of the additional area with the adjustment of the survey area, at a suitable scale that allows the vegetation communities to be delineated, including replicate survey sites in similar vegetation types to enable statistical analysis of flora species data;
- Collect and identify the vascular plant species present in both the survey sites and opportunistically in order for a more complete assessment of the flora in the survey are to be made;
- Review the conservation status of the vascular plant species recorded by reference to current literature and listings by the Department of Biodiversity, Conservation and Attractions (DBCA) and plant collections held at the Western Australian State Herbarium (WAH), and listed by Department of Agriculture, Water and the Environment (DAWE)(2019b) under the EPBC Act;
- Collate and analyse data and compare with local and regional datasets and analyses;
- Define and map the vegetation communities, Floristic Community Types (FCTs) and Site-Vegetation Types (SVTs) in the survey area of the Muchea Project;
- Define and map the location of any Threatened or Priority flora and any Threatened or Priority Ecological Communities located within the survey area;
- Define any management issues related to flora and vegetation values;
- Provide recommendations on the local and regional significance of the vegetation communities; and
- Prepare a report summarising the findings.

3. METHODS

3.1. Desktop Assessment

A desktop assessment was undertaken in 2017 using FloraBase (WAH 1998-), NatureMap (Department of Parks and Wildlife 2007-) and the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Protected Matters Search Tool* (DAWE 2013) databases, to identify the possible occurrence of threatened and priority flora and fauna, and threatened and priority ecological communities within the Muchea Project (Mattiske 2017). The *NatureMap* search was conducted for the survey area in the northern part of the Muchea Project tenement E70/4886 (Figure 1). A 5 km buffer was applied to the search area; therefore, this area is smaller than the Muchea Project. Search parameters were 'by circle' using the following parameters:

- 115° 53' 21" E, - 31° 29' 49" S (accessed on 30/10/2017)

Additionally, the land systems, pre-European vegetation, vegetation complexes and Site-Vegetation Types of the Muchea Project were identified. Introduced flora (weeds) and fauna (feral animals) potentially present in the survey area were also noted. Previous flora studies from the Gnangara Mound (Mattiske 2002, 2018b) were used identify species that could potentially occur within the Muchea Project.

3.2. Field Survey

A detailed field assessment of the flora and vegetation of the Muchea Project was undertaken by botanists from Mattiske from August to October 2018 and on November 18th and 19th 2021, in accordance with methods outlined in *Technical Guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016b). All botanists held valid collection licences to collect flora for scientific purposes, issued under the BC Act.

The geographic co-ordinates defining the Muchea Project were supplied by VRX. Aerial photographic maps of the proposed Muchea Project were prepared and supplied by CAD Resources (Carine, WA). Survey sites for the Muchea Project were selected using aerial photographic maps and field observations. A total of 68 survey sites have been established in the Muchea Project. Ten of these survey sites were established during November 2021. Survey site locations were chosen to sample all vegetation types, with replication, within the survey area of the Muchea Project. Locations for the sites are given in Appendix B.

Timaru Road Reserve was assessed and field observations determined no sites were required to be established. Photographs were taken at intervals along the roadside and any vegetation was surveyed for native flora.

Survey sites consisted of marked (fence dropper, NW corner) 10 m x 10 m quadrats. Flora and vegetation were described and sampled systematically at each survey site, and additional opportunistic collections were undertaken wherever previously unrecorded plants were observed. At each survey site the following floristic and environmental parameters were recorded:

- GPS location (GDA94 datum, zone 50J);
- Photograph representative of the site;
- Local site topography and aspect;
- Soil type and colour;
- Outcropping rocks, their type and abundance;
- Surface cover (coarse fragments);
- Approximate time since fire;
- Vegetation condition;
- Vegetation structure; and

- For each vascular plant species, the average height and the percentage cover (of both alive and dead material) over the survey site.

All plant specimens collected during the field surveys were dried and processed in accordance with the requirements of the WAH. The plant species were identified based on taxonomic literature and through comparison with pressed specimens housed at the WAH. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded is in accordance with the WAH (1998-).

3.3. Analysis of Site Data

A species accumulation curve, based on accumulated species versus sites surveyed was prepared to provide an indication of the level of adequacy of the survey effort (*EstimateS* – Colwell 2013). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence-based coverage estimator of species richness (Chao 2004). When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered to be adequate.

Plymouth Routines in Multivariate Ecological Research v7 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites on the basis of their species composition (Clarke and Gorley 2015). Data were prepared for use in PRIMER using several simplification measures. To down-weigh the relative contributions of quantitatively dominant species, a presence-absence transformation was applied to the data set. Where species were identified with a "?" and the same species with certainty, the "?" identification was merged with the certain one. Annual species, introduced species, specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component nor listed in the Gibson et al. (1994) FCTs) were excluded from the data set prior to analysis. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Hierarchical Clustering was used in conjunction with Similarity Profile, Similarity Percentages, quadrat descriptions, quadrat photographs and aerial photographs; combining these methods increased the understanding of quadrat inter-relations and thus the ability to accurately delineate those vegetation communities based on species composition.

3.4. Vegetation Descriptions

Vegetation descriptions were based on Alpin's (1979) modification of the vegetation classification system of Specht (1970), to align with the National Vegetation Information System (NVIS) (see Appendix A4). Vegetation communities were described at the association level of the NVIS classification framework, as defined by the Executive Steering Committee for Australian Vegetation Information (2003). Vegetation condition of each of the mapping sites was assessed as per the criteria developed by Keighery (1994) (see Appendix A6).

3.5. Survey Limitations

An assessment of the survey against factors which may have had an impact on the outcomes of the present survey was made (Table 1). Based on this assessment, the present survey has not been subject to constraints which would affect the thoroughness of the survey, and the conclusions which have been formed.

Table 1: Potential limitations affecting the conclusions made in this report

POTENTIAL SURVEY LIMITATION	IMPACT ON CURRENT SURVEY
Sources of information and availability of contextual information	**Not a constraint.** The vegetation of the Gnangara Mound has been mapped at three scales by Heddle et al. (1980), Mattiske (2002) and Beard et al. (2013). Mattiske has completed various monitoring surveys in the area relating to this programme since the 1970's (Mattiske 2002).
Scope	**Not a constraint.** Vascular flora species were the focus of the survey and any unknown species or species that resembled threatened or priority flora was thoroughly sampled.
Proportion of flora collected and identified	**Potential constraint.** While many plants were in flower during the survey, a proportion of plants encountered during the survey were sterile and may impact the ability to identify some specimens to species level. Orchid species may not emerge each year if conditions are not favourable.
Completeness and further work which might be needed	**Not a constraint.** Species accumulation curve analysis (Section 5.1) indicates that 74% of potential flora species were recorded in the survey area. The full extent of the Muchea Project exploration tenement has not been surveyed; survey effort has been focused on the 1099 ha survey area.
Mapping reliability.	**Not a constraint.** Handheld GPS units were used for the survey, which for a majority of field conditions have an accuracy level of ± 5 m. Aerial photos from were supplied by CAD.
Timing, weather, season, cycle.	**Not a constraint.** The survey timing was appropriate for the area and the flowering times of the vegetation (see Section 4.1).
Disturbances	**Potential constraint.** No disturbances were encountered within the survey areas that had the potential to adversely affect the survey completion. Fire has had an impact on vegetation throughout the Muchea Project tenement.
Intensity	**Not a constraint.** The spring 2018 flora and vegetation survey was undertaken by botanists over six days establishing 58 survey sites to ensure thorough coverage of the survey area. Two botanists established 10 additional survey sites during two days in November 2021. Survey sites were replicated in each potential vegetation community. Flora that were unknown or resembled threatened or priority flora were collected, the location and habitat noted, and the number of plants estimated.
Resources	**Not a constraint.** Adequate resources (time, equipment and personnel) were available to carry out the survey.
Access problems	**Not a constraint.** Access to the survey area was not restricted by the land owners or managers or by track conditions. However, rain that occurred throughout the intended survey period significantly increased the risk of spreading *P. cinnamomi*, thus postponing survey work to later dates.
Experience levels	**Not a constraint.** The team carrying out the survey work comprised of one Senior Botanist and one Botanist, with experience in the Swan Coastal Plain subregion. Any unknown or potential threatened or priority flora species were collected and identified, utilising resources available at the WAH and consultation with expert taxonomists where appropriate.
Measures taken to improve the robustness of data and analysis.	**Not a constraint.** In order to apply statistical analysis to this survey's dataset, various data were simplified (as discussed in Section 3.5.2). The proportion of data edited was very small and effects on the overall results checked at each step of editing.
Comparisons with external databases	**Not a constraint.** Data recorded in this survey were compared with the Floristic Community Types (FCTs) determined for Swan Coastal Plain vegetation by Gibson *et al.* (1994). These datasets are not directly comparable and therefore comparison between the vegetation communities interpreted from this survey and the FCTs is not a definitive measure of the presence or absence of particular FCTs in the project area, and hence the related Priority Ecological Communities (see Section 3.5.3).

4. DESKTOP ASSESSMENT RESULTS

4.1. Climate and Survey Timing

The Drummond Botanical Subdistrict has a warm Mediterranean climate, with winter precipitation of approximately 600 - 1000 mm and 5-6 dry months per year (Beard 1990). Rainfall data from the Muchea weather station (9275) and temperature data from Gingin Aero weather station (9179) are illustrated in Figure 2 (Bureau of Meteorology [BOM] 2022). The mean annual precipitation at Muchea is 806.5 mm (BOM 2022). The effectiveness of the rainfall events is influenced by higher temperatures and evaporation rates, with obvious seasonal changes between summer and winter. According to the *Technical guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016b), the recommended primary survey timing for the Southwest Botanical Province is spring (September-November).

The rainfall in the three months preceding the 2018 survey (June to August totalling 502.5 mm) was 153.85 mm higher than the long-term average for the same period (348.65mm). The rainfall for the three months preceding the 2021 survey (August to September totalling 234.74 mm) was similar to the average with 17.1 mm higher rainfall recorded than the long-term average (251.8mm) for the same period. The field survey was timed, where possible, to align with peak flowering periods of conservation significant flora with the potential to occur in the survey area of the Muchea Project.

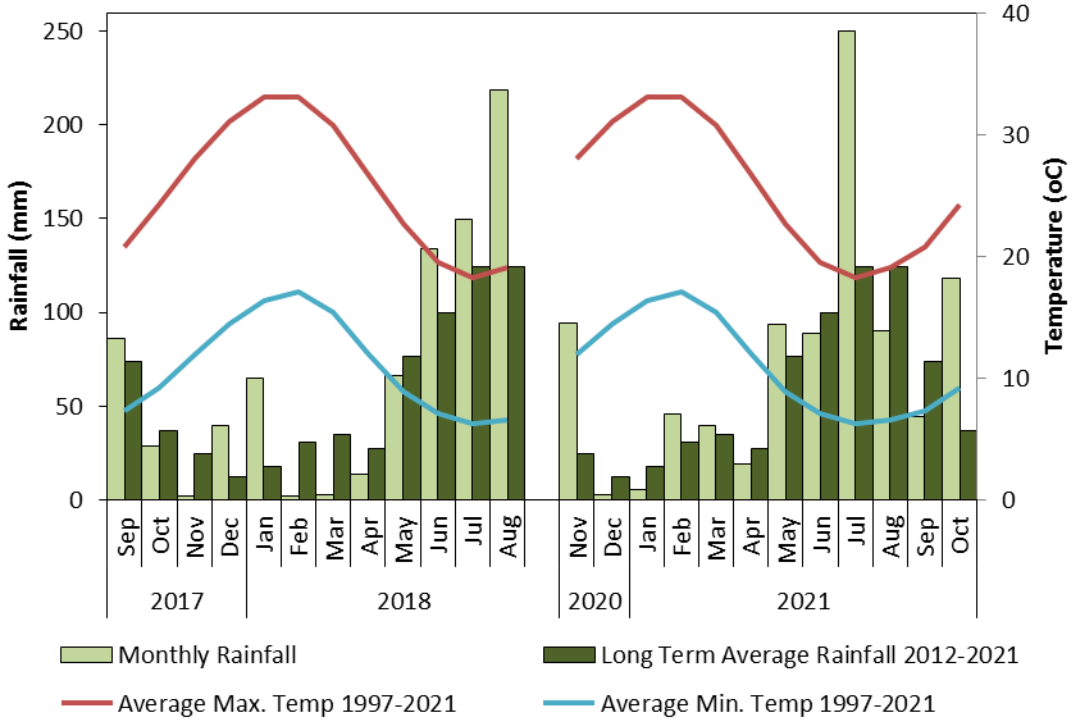


Figure 2: Rainfall and temperature data from the Muchea and Gingin Aero Weather Stations (located south and north respectively of the survey area)
Average rainfall and temperature data for the period 2012 to 2021 are shown (BOM 2022).

4.2. Managed Lands

A 500 m wide strip along the western edge of the Muchea Project falls within Gnangara State Forest and Yeal Nature Reserve, which is part of Gnangara Park and part of Bush Forever Site 380-Rosella Rd Bushland (Figure 1). Gnangara Park is vested in the Conservation and Parks Commission (Sonneman & Brown 2008).

The Bush Forever site contains, or is inferred to contain, the Floristic Community Types 5-Mixed shrub damplands, 21c-Low-lying *Banksia attenuata* woodlands or shrublands, 22-*Banksia ilicifolia* woodlands, 23a-Central *Banksia attenuata-Banksia menziesii* woodlands, and 23b-Northern *Banksia attenuata-Banksia menziesii* woodlands (Western Australian Planning Commission 2000). The survey area for the Muchea Project does not encroach on the Yeal Nature Reserve, but is within 1 km of the eastern edge of the Nature Reserve.

The Timaru Nature Reserve is located approximately 2 km to the northeast of the northeast corner of the survey area. The reserve was established to protect the TEC "Shrublands and woodlands on Perth to Gingin Ironstone Association of the Swan Coastal Plain" (Sonneman & Brown 2008), which may extend along the north-eastern boundary of the Muchea Project. Chandala Nature Reserve is located 1 km east of the Brand Highway opposite the Muchea Project. This reserve protects the PEC "*Wooded wetlands that support colonial waterbird nesting areas".*

4.3. Geology, Soils and Topography

The underlying geology of the area is Mesozoic to recent sediments of the Perth Basin, in particular the Bassendean dunes (Beard 1990). The Bassendean dunes area is a coastal plain that is often low-lying and swampy, with sandhills, soils are mainly recent sands or swamp deposits (Beard 1990). The Bassendean dunes can also be dissected country rising to the to the duricrusted Dandaragan plateau on Mesozoics, with mainly yellow sandy soils (Beard 1990). The Bassendean dunes occur in a belt 15 km wide and consist of low, vegetated hills of quart sand with numerous interdunal swamps and lakes (Beard 1990). There is no organised drainage except where the various rivers cross the plain (Beard 1990). The Muchea Project occurs on the elevated sand dune systems on the eastern edges of the Gnangara Mound to the northwest of Muchea, Figure 3.

The Department of Primary Industries and Regional Development's Land Systems present within the Muchea Project (Figure 3, Table 2) includes:

Bassendean System (212Bs): Sand dunes and sandplains with pale deep sand, semi-wet and wet soils. *Banksia*-Paperbark (*Melaleuca* spp.) woodlands and mixed heath. Swan Coastal Plain from Busselton to Jurien. The Bassendean System is the oldest of the aeolian deposits and consists of low hills of siliceous sand interspersed with poorly drained areas.

Yanga System (213Ya): Poorly drained plain with pale sands and deep sand duplex, wet, semi-wet, and saline wet soils. *Banksia* - Pricklybark (*Eucalyptus todtiana*) - Marri (*Corymbia calophylla*) - Swamp Sheoak (*Casuarina obesa*) - Paperbark (*Melaleuca* spp.) woodlands.

Table 2: Extent of Land Systems intersecting the survey area

LAND SYSTEM	MAPPING UNIT	TOTAL STATEWIDE EXTENT (ha)	AREA OF INTERSECTION WITH THE SURVEY AREA (ha)	PROPORTION OF CURRENT EXTENT (%)
Bassendean System	212Bs	372403.08	1093.82	0.29
Yanga System	213Ya	35218.10	5.23	0.01

4.4. Vegetation

Beard (1990) described the vegetation of the Drummond Botanical Subdistrict as mainly *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; woodland of Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) on less leached soils.

The Pre-European vegetation systems present within the Muchea Project (Figure 4, Table 3) include:

Vegetation Association 949.2 Low woodland or open low woodland

Other acacia, banksia, peppermint, cypress pine, casuarina, York gum Acacia spp., Banksia spp., Agonis flexuosa, Callitris spp., Allocasuarina spp., Eucalyptus loxophleba.

Vegetation Association 1014.1 Low woodland / Scrub

Vegetation Association 1018.1 Woodland / Low woodland / Low Forest or Woodland

Jarrah, marri and wandoo Eucalyptus marginata, Corymbia calophylla, E. wandoo.

Table 3: Extent of pre-European vegetation associations intersecting the Muchea Project

VEGETATION ASSOCIATION	STATE-WIDE PRE-EUROPEAN EXTENT (ha)	SURVEY AREA	
		AREA OF INTERSECTION (ha)	PROPORTION OF CURRENT EXTENT (%)
Vegetation Association 949.2	115066.15	872.51	0.76
Vegetation Association 1014.1	41045.05	218.73	0.53
Vegetation Association 1018.1	6047.67	7.81	0.13

4.4.1. Potential Threatened and Priority Ecological Communities

Searches of the State and Federal databases returned records of three Threatened Ecological Communities (TEC) and six Priority Ecological Communities (PEC) located at or near the Muchea Project (Figure 6).

Banksia *Woodlands of the Swan Coastal Plain*

The Banksia woodlands of the Swan Coastal Plain is listed as Endangered at a federal Level (DAWE 2022b). This is a variable community and the full description of the vegetation can be read in section 1.3 of the *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community* (Department of the Environment and Energy [DotEE] 2016). At the state level this community is split into three TECs and eight PECs. Four of the PECs are in close proximity to the Muchea Project and these are listed and described below. Two are listed as Priority 2 communities and 2 are listed as Priority 3 communities (Appendix A2).

***Banksia ilicifolia* woodlands, southern Swan Coastal Plain ('floristic community type 22')**
Priority 3(iii) Endangered TEC (part)
Low lying sites generally consisting of *Banksia ilicifolia – B. attenuata* woodlands, but *Melaleuca preissiana* woodlands and scrubs are also recorded. This community occurs on Bassendean and Spearwood systems in the central Swan Coastal Plain, north of Rockingham. Typically, this community has very open understorey, and sites are likely to be seasonally waterlogged.

Swan Coastal Plain *Banksia attenuata – Banksia menziesii* woodlands ('floristic community type 23b')
Priority 3(i) Endangered TEC (part)
These woodlands occur in the Bassendean system, from Melaleuca Park to Gingin. This community occurs in reasonably extensive *Banksia* woodlands north of Perth.

Low lying Banksia attenuata woodlands or shrublands ('floristic community type 21c')
Priority 3(i) Endangered TEC (part)

This community occurs sporadically between Gingin and Bunbury, and is largely restricted to the Bassendean system. The vegetation community tends to occupy lower lying wetter sites and is variously dominated by *Melaleuca preissiana*, *Banksia attenuata*, *Banksia menziesii*, *Regelia ciliata*, *Eucalyptus marginata* or *Corymbia calophylla*. Structurally, this community type may be either a woodland or occasionally shrubland.

***Banksia* woodland of the Gingin area restricted to soils dominated by yellow to orange sands**

Priority 2 Endangered TEC (part)

Species-rich *Banksia* woodland on deep yellow-red sands that appear restricted to the western Dandaragan Plateau. The vegetation is described as scattered *Eucalyptus todtiana* and *Corymbia calophylla* over *Banksia menziesii* and *Banksia attenuata* low open woodland over *Jacksonia sternbergiana* and *Adenanthos cygnorum* high open shrubland over *Allocasuarina humilis* and *Chamelaucium lullfitzii* (T) open shrubland over *Eremaea pauciflora* and *Styphelia xerophylla* low shrubland over *Mesomelaena pseudostygia* open sedgeland.

Shrublands and woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain

The Shrublands and Woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain TEC is listed as Endangered at Federal level (DAWE 2022b). At a state level this Threatened Ecological Community is listed as the Critically Endangered Perth to Gingin Ironstone Association and (Appendix A2). This TEC may occur along the north-eastern boundary of the Muchea Project. It is also possible that the Muchea Project is part of the buffer for the community, but it is not within the survey area (Figure 6). This community is associated with floristic community type 8, 'Herb rich shrublands in claypans' (Meissner & English 2005).

Shrublands and woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain

The plant community on these ironstone soils is the only one in the Perth area that is characterised by massed everlastings in the understorey (English *et al*. 1996). Floristic analyses of plots on this soil type link to 'herb rich shrublands in clay pans' ('floristic community type 8') as described by Gibson *et al*. (1994) - reflecting the clays in the soil (DEP 1996). Typical and common native species in the community are the shrubs *Kunzea* aff. *recurva*, *Grevillea curviloba* (T), *Melaleuca viminea, Acacia saligna, Jacksonia furcellata, Grevillea obtusifolia* and *Banksia sessilis* and the herbs *Rhodanthe manglesii, Tribonanthes australis* and *Isotropis cuneifolia* subsp. *glabra* (P3). The following exotic species are also currently common*; *Romulea rosea, *Briza maxima, *Trifolium dubium, *Spergula arvensis* and *Hesperantha falcata* (DEP 1996).

The federally listed TEC 'Clay Pans of the Swan Coastal Plain' which is listed as Critically Endangered and also called 'Herb rich shrublands in clay pans Swan Coastal Plain' TEC at the state level and listed as vulnerable should considered in conjunction with Shrublands and woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain (Department of Sustainability, Environment, Water, Population and Communities, 2012). The full list of descriptions and associated communities can be found in the *Commonwealth Listing Advice on Claypans of the Swan Coastal Plain* (2012). This community should be considered here as it also contains 'floristic community type 8', however it is unlikely to occur within the Muchea project as it occurs specifically on heavy clay.

Wooded wetlands that support colonial waterbird nesting areas

The Wooded wetlands that support colonial waterbird nesting areas are listed as a Priority 2 ecological community (DBCA 2021). This community occurs to the east of the Muchea Project in Chandala Nature Reserve (Figure 6). This community is unlikely to occur within the survey area as it is associated with freshwater wetlands. Freshwater wetlands do not appear on satellite imagery for the Muchea Project.

Wooded wetlands that support colonial waterbird nesting areas

Priority 2 Chandala, Booragoon Lake, unnamed wetland near Pinjarra, McCarleys Swamp

This vegetation community differs from the listed 'Perched wetlands of the Wheatbelt region with extensive stands of *Casuarina obesa* and *Melaleuca strobophylla'* ('Toolibin-type' wetlands) in that the Wheatbelt type is *Casuarina*, rather than *Melaleuca* dominated. Also, Toolobin Lake type is now brackish-saline (formerly fresh-brackish), whereas this type is currently fresh-brackish.

4.4.2. Regional Vegetation Types

Site-Vegetation Types (SVTs) as defined by Mattiske (2002) were inferred in the desktop assessment to occur in the Muchea Project. The SVTs were based on the earlier work of Havel (1968) on the Swan Coastal Plain and determined using aerial photography, field verification and sampling within the different site-vegetation types over four decades (Mattiske 2002). Neither the Havel (1968) nor Mattiske (2002) surveys had sites within the Muchea Project. Havel's (1968) sites were located in state forest to the west and south and sites used in Mattiske (2002) were to the north, west and south of this survey area.

The mapping codes of Mattiske (2002) are based on the A to K code as developed by Havel (1968), with an additional number to designate the variation in structure and composition. The Bassendean dune system supports the SVTs - F1, G1, G2, G3, H1, H2, H3, H4, I1, J1, J2, K1, K2, K3, K4 and K5. The F1 unit forms an intermediate type between the Spearwood and the Bassendean dunes systems. The gradient on the slopes of the Bassendean dune system is reflected in the shift from the G1 to G3 types on the drier upper slopes, through the H1 to H4 on the mid slopes, I1 on the moister lower slopes, J1 to J2 on the seasonally wetter soils on the lower slopes to the range of damplands and wetlands on the K1 to K5 types (Mattiske 2002).

Site-vegetation Type Mapping (Mattiske 2002) – Site Vegetation Types H1, I1, J1 and J2 – based on the earlier work of Havel (1968) on the Swan Coastal Plain and the expansion of these site-vegetation types to the wider Gnangara Mound by Mattiske (2002), Figure 5.

H1 Low Woodland of *Banksia attenuata - Banksia menziesii - Banksia ilicifolia - Nuytsia floribunda* over *Beaufortia elegans, Leucopogon polymorphus, Melaleuca systena, Calytrix angulata, Calytrix flavescens, Stirlingia latifolia, Dasypogon bromeliifolius, Styphelia conostephioides, Lyginia barbata, Macrozamia riedlei* and *Xanthorrhoea preissii*

I1 Low Open Woodland of *Banksia attenuata - Banksia menziesii* over *Verticordia nitens, Dasypogon bromeliifolius, Melaleuca seriata* and *Patersonia occidentalis*

J1 Woodland of *Corymbia calophylla - Banksia attenuata - Banksia menziesii - Melaleuca preissiana* over *Xanthorrhoea preissii, Hypocalymma angustifolium, Pultenaea reticulata, Adenanthos obovatus, Regelia ciliata* and *Jacksonia furcellata*

J2 Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii, Hibbertia subvaginata* and *Gompholobium scabrum*

Six of the SVTs as defined in Mattiske (2002) for the Gnangara Mound overlap with the FCTs as defined by Gibson et al. (1994) for the Swan Coastal Plain within the Bassendean dune system:

FCT 4 *Melaleuca preissiana* damplands as defined by Gibson *et al.* (1994) occurs on the eastern edges of the Bassendean dune system and in seasonally moister and wetter swamps within the Bassendean dune system. The key species also occur in the K1 – SVT as defined by Havel (1968) and Mattiske (Mattiske 2002).

FCT 23b Northern *Banksia attenuata – Banksia menziesii* woodlands as defined by Gibson et al. (1994) occurs on the Bassendean dune systems. The key species overlap with the SVTs G1 and H1 and form part of the continuum on the sandier soils.

4.5. Potential Flora

A total of 90 vascular plant taxa, representative of 71 genera and 31 families, have the potential to occur within the Muchea Project (based on NatureMap search results, Mattiske 2017, Appendix C). The most commonly represented families were the Fabaceae (9 taxa), Proteaceae (9 taxa) and Haemodoraceae (8 taxa).

4.5.1. Potential Threatened and Priority Flora

Thirteen threatened flora species, pursuant to Part 2, Division 1, and Subdivision 2 of the BC Act and as listed by the DBCA (2018c) have the possibility of occurring in the Muchea Project (Appendix C). All of these species are pursuant to section 179 of the EPBC Act or are listed by the DAWE (2022a) (Figure 6). Nine of these species are listed as Endangered, two are listed as Vulnerable and two are listed as Critically Endangered (Appendix D).

A total of 13 priority flora species, including one priority one, one priority two, eight priority three and three priority four species as listed by the Western Australian Herbarium (1998-) have the potential to occur in the Muchea Project (Appendix C).

An assessment of the likelihood of recording any of the listed threatened and priority taxa within the Muchea Project, based on factors including known soil type, topography and distribution, is set out in Appendix D.

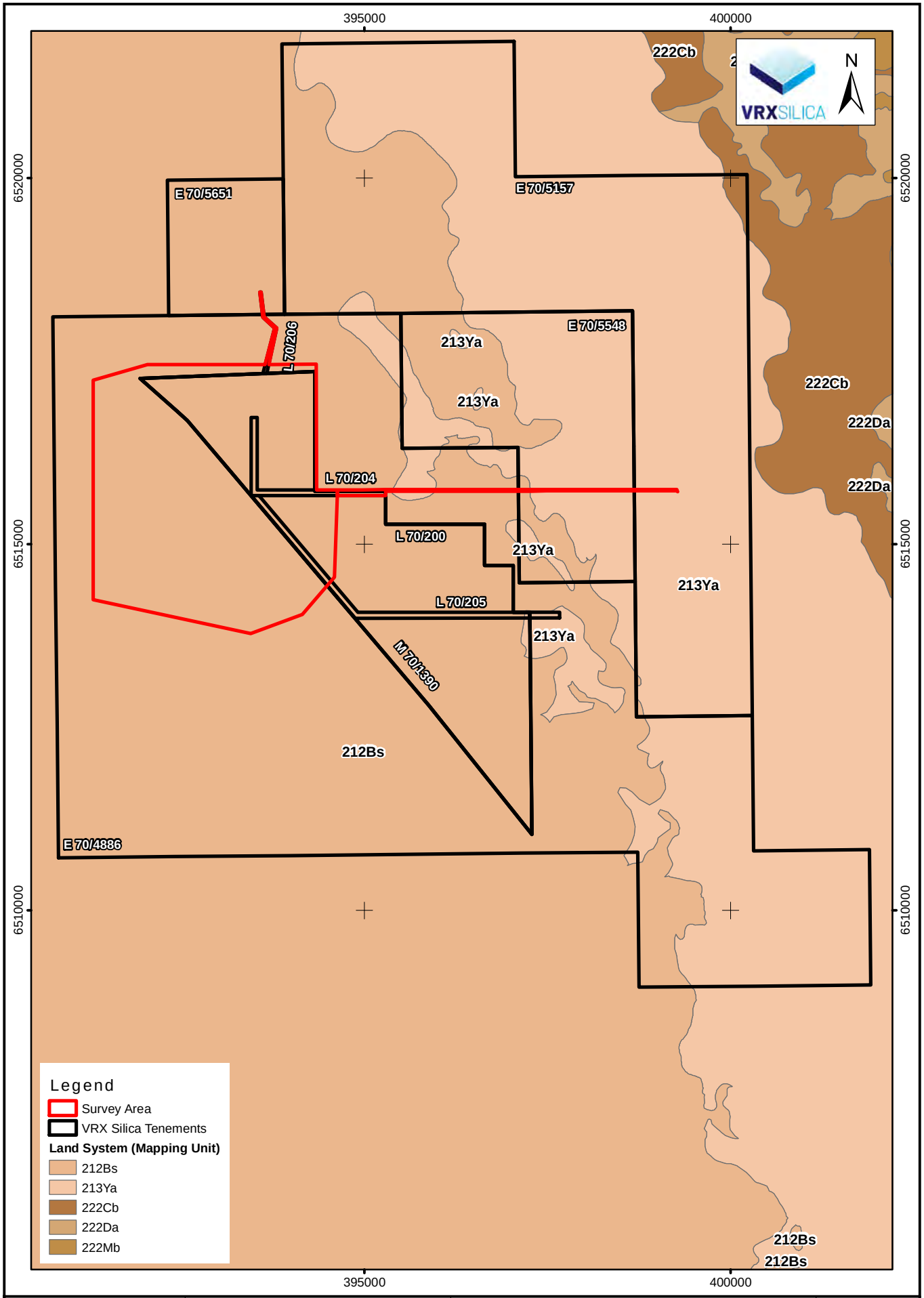
The majority of these occur on the low-lying landforms to the east of the Muchea Project which are subjected to seasonal water-logging. These areas have largely been cleared for agricultural activities. Three species *Leucopogon squarrosus* subsp. *trigynus* (Priority 2), *Cyathochaeta teretifolia* (Priority 3) and *Hibbertia helianthemoides* (Priority 4) have been recorded on the dune systems to the south of the survey area, and have the potential to occur within the Muchea Project (DBCA 2018a) (Figure 6).

The desktop assessment indicated that 25 of the 26 potential conservation significant species were likely to be flowering over the months August-October and 22 of the 26 flowering in November (Appendix D). The 2018 field survey was undertaken in August to October and the 2021 survey was carried out in November.

4.5.2. Potential Introduced (Weed) Species and Declared Pest (Plant) Organisms

Five introduced flora species have the potential to occur in the Muchea Project (Appendix C). None of these species are declared pest organisms pursuant to section 22 of the Biosecurity and Agriculture Management Act 2007 (BAM Act).

There is the potential to spread the fungal diseases associated with the species of *Phytophthor*a on the sand dunes within the Muchea Project. To appropriately fulfil management and control obligations the current extent of any *Phytophthora* species should be mapped. Any exploration and operational activities should follow guidelines set out in the *Threat abatement plan: For disease in natural ecosystems caused by Phytophthora cinnamomi* (DotEE 2018).



Source: Tenements - DMIRS), Land Systems - DAFWA

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MGA94 (Zone 50)

CAD Ref: a2602_f54_02
Date: March 2022 | Rev: A | A4

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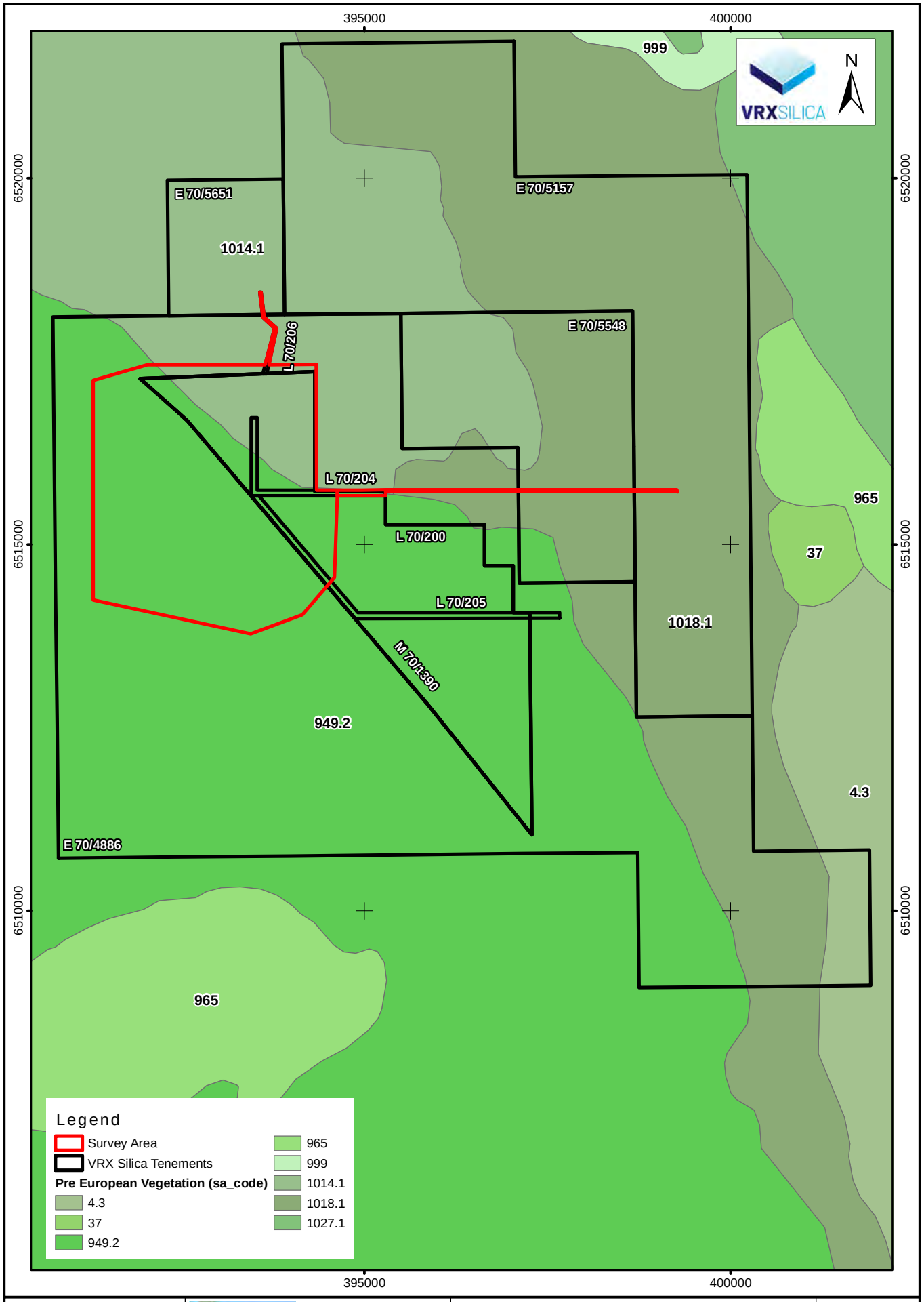
Tel: (08) 9246 3242 ~ Fax (08) 9246 3202

VRX Silica

Land Systems

Figure: **3**



Source: Tenements - DMIRS), Land Systems - DAFWA

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Scale: 1:70,000
MGA94 (Zone 50)

CAD Ref: a2602_f54_03

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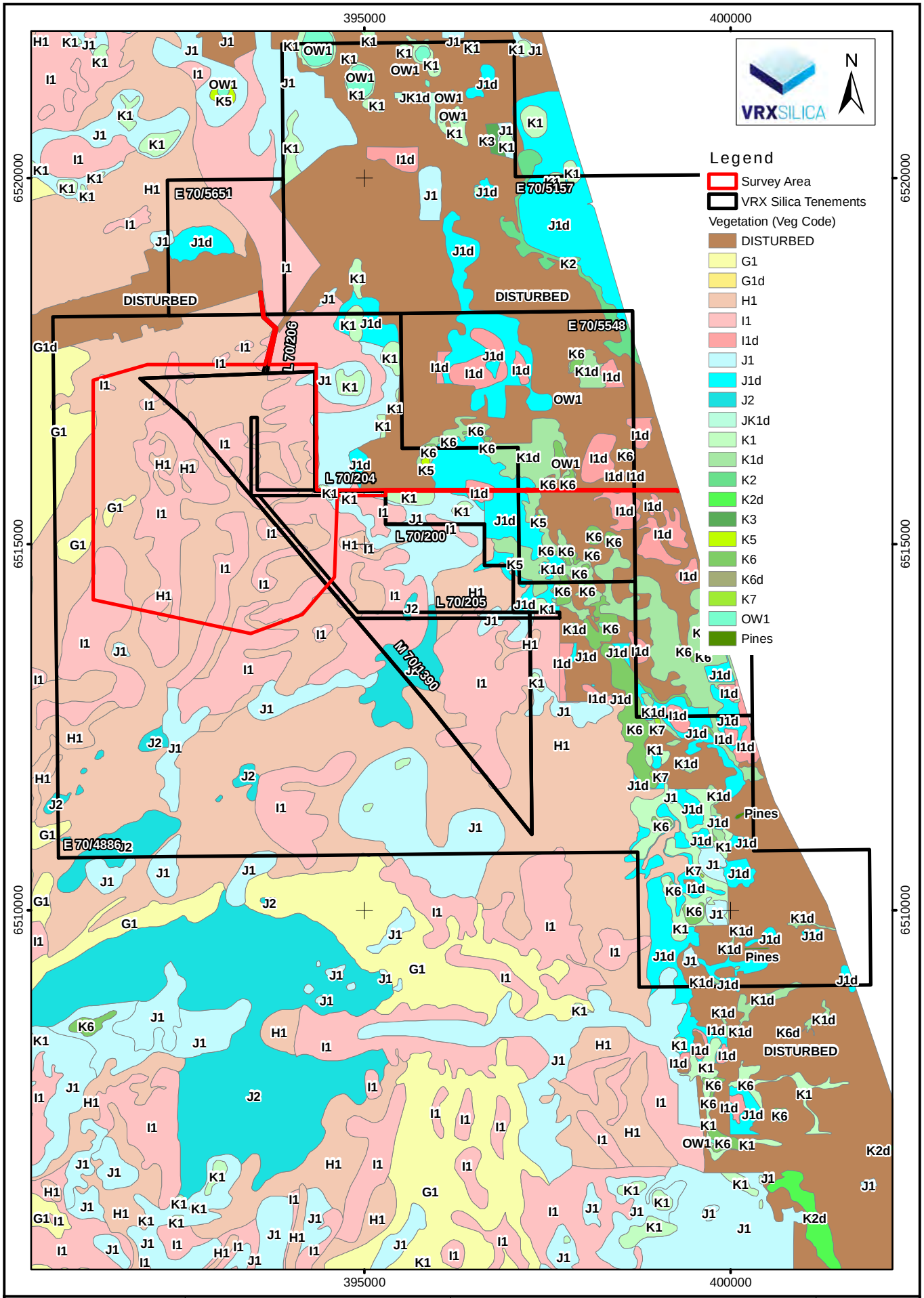
Pre European Vegetation

Figure: **4**



Source: Tenements - DMIRS), Land Systems - DAFWA

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Scale: 1:70,000
MGA94 (Zone 50)

CAD Ref: a2602_f54_04

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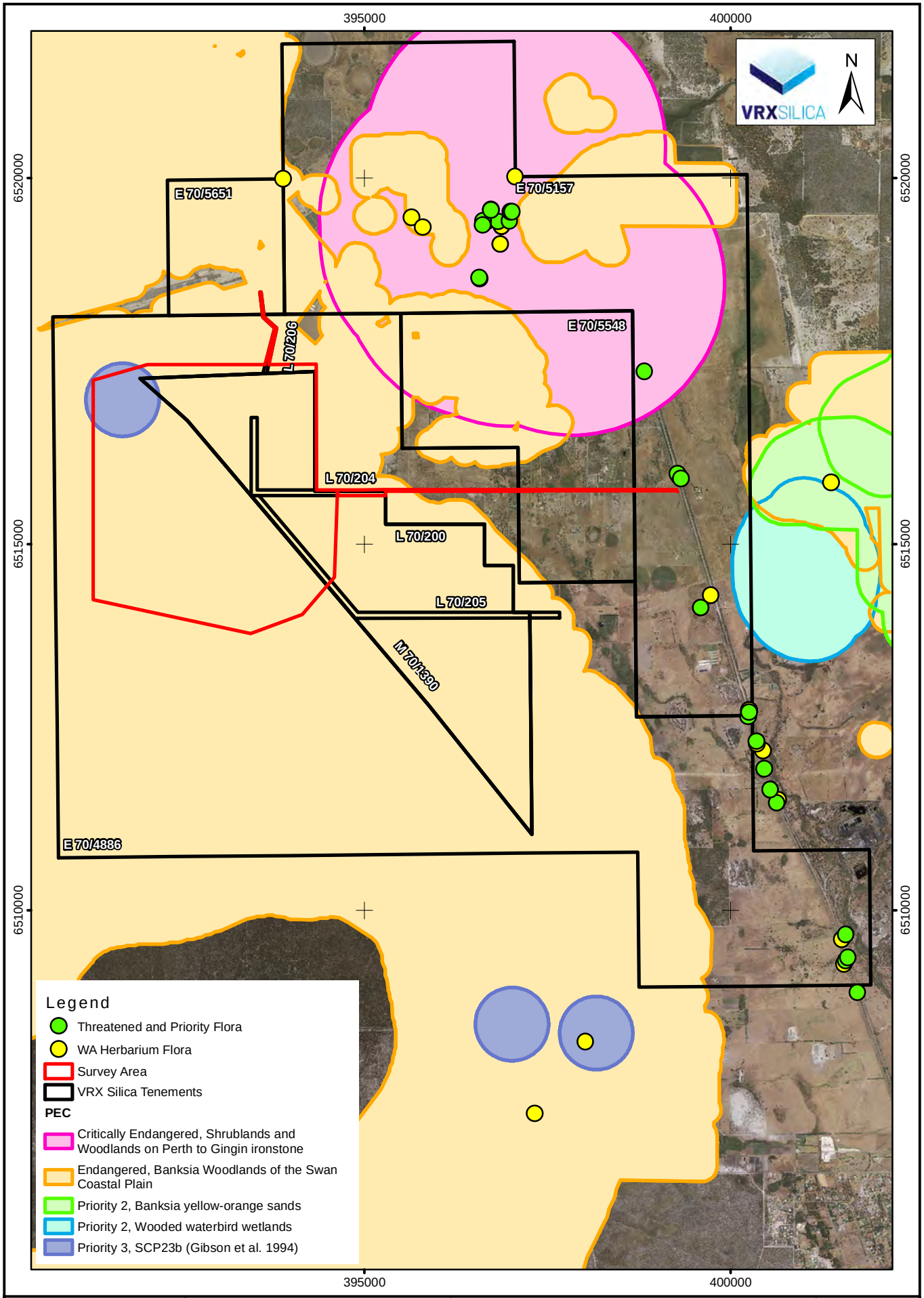
Site Vegetation Types

Figure: **5**



Source: Tenements - DMIRS), Land Systems - DAFWA

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DBCA Flora and Threatened & Priority Ecological Communities

Figure: 6

5. FIELD SURVEY RESULTS

5.1. Flora

A total of 225 vascular plant taxa, representative of 103 genera and 42 families, were recorded within the Muchea Project survey area. The majority of taxa recorded were representative of the Myrtaceae (33 taxa), Fabaceae (24 taxa), Stylidiaceae (17 taxa) and Ericaceae (14 taxa) families (see Appendix E for a complete species list and Appendix F for a list of species for each site). Eight taxa were identified as introduced species.

Some plant species could not be identified accurately to species level due to the absence of sufficient taxonomic characters to enable accurate identification. In most cases this was due to plant material being sterile or lacking sufficient taxonomic features to permit accurate identification to species level. In these cases the species is identified as, for example, Asteraceae sp. or *Beaufortia* sp. Of the 225 taxa recorded in this survey, eight were identified to family level and 35 to genus level only, while 20 taxa were identified to variety or subspecies level.

Annual species (including those which can be annual or perennial depending on local conditions) represented 9.78 % (22 taxa) of all recorded plants within the Muchea Project. Of the annual species, 27.27 % were introduced species (6 taxa). The average species richness for the 68 survey quadrats was 30.0 ± 0.9 (mean ± standard error), with a range of 8 to 48 species per quadrat.

A species accumulation curve was used to evaluate the sampling adequacy and is presented in Figure 7. The incidence-based coverage estimator of species richness was 331. Based on this value and the total of 227 species recorded, approximately 74 % of the flora species potentially present within the Muchea Project were recorded 2018 and 2021. If the calculation is repeated for the survey area only, approximately 74% of the flora species potentially present within the survey area were recorded.

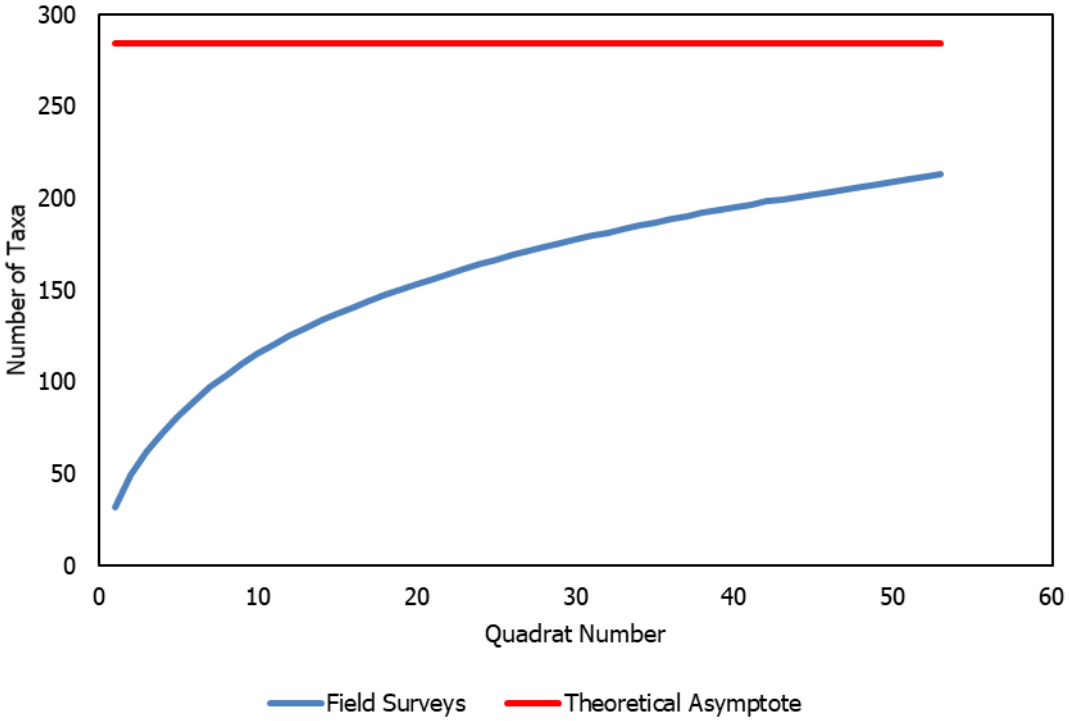


Figure 7: Species Accumulation Curve for the survey area within the Muchea Project

5.1.1. Threatened and Priority Flora

No threatened flora species pursuant to pursuant to Part 2, Division 1, Subdivision 2 of the BC Act and as listed by DBCA (2018a), or pursuant to section 179 of the EPBC Act or listed by the DAWE (2022a), were recorded within the Muchea Project. No priority flora species, as listed by DBCA (2018c) were recorded within the Muchea Project.

5.1.2. Introduced (Weed) Species

A total of eight introduced (weed) taxa were recorded within the survey area, four identified to species level (**Aira cupaniana, *Gladiolus caryophyllaceus, *Hypochaeris glabra* and **Ursinia anthemoides* subsp. *anthemoides*) and four to genus or family level (*Asteraceae sp., **Gladiolus* sp., **Medicago* sp. and **Pentameris* sp.). None of these are declared pest organisms (see Appendix A3 for definitions) pursuant to section 22 of the *Biosecurity and Agriculture Management Act 2007* (WA). On DBCA's list of environmental weeds for the Swan region (Department of Parks and Wildlife 2016) they are ranked for ecological impact and invasiveness as shown in Table 4:

Table 4: Ecological Impact and Invasiveness rankings for Introduced (Weed) Species recorded in the Muchea Project
(Department of Parks and Wildlife 2016)

SPECIES	DPAW[1]		WAOL[2]	WONS[3]	GDA94_Z50	
	ECOLOGICAL IMPACT	INVASIVENESS			EASTING	NORTHING
**Aira cupaniana*	Unknown	Unknown	Permitted - S11	No	391506	6515929
*Asteraceae sp.	-	-	-	-	391982	6516278
					393322	6514277
					393745	6517344
					393791	6516189
					393909	6516199
					394008	6517130
					396053	6515474
					396254	6515154
**Gladiolus caryophyllaceus*	High	Rapid	Permitted - S11	No	393444	6517708
**Gladiolus* sp.	-	-	-	-	392482	6517120
					393791	6516189
					394406	6515689
					396254	6515154
**Hypochaeris glabra*	High	Rapid	Permitted - S11	No	391506	6515929
					395985	6514978
					396184	6515431
**Medicago* sp.	Unknown	Rapid	-	-	395985	6514978
					396184	6515431
**Pentameris* sp.	-	-	-	-	393322	6514277
					395985	6514978
					396184	6515431
**Ursinia anthemoides* subsp. *anthemoides*	Unknown	Rapid	Permitted - S11	No	391506	6515929
					391734	6514549
					393262	6516398
					393609	6516422
					393745	6517344
					393791	6516189
					393807	6515627
					394008	6517130
					394512	6515367
					394675	6515671
					395985	6514978
					396254	6515154

5.2. Vegetation

The mapping of pre-European vegetation, vegetation complexes and SVTs is described in section 4.4. In summary the Pre-European vegetation comprises 'Low woodland dominated by *Banksia'* (949.2), 'Mosaic of Low woodland dominated by *Banksia* with Shrublands dominated by tea-tree thicket' (1014.1) and Jarrah, Marri and Wandoo Woodland (1018.1, Beard et al. 2013). The Bassendean North vegetation complex covers the Muchea Project; vegetation ranges from Low open forest and Low open woodland of *Banksia* species and *Eucalyptus todtiana* to Low woodland of *Melaleuca* species and Sedgelands on the moister sites (Heddle *et al*. 1980).

Mattiske (2002) identified 25 SVTs occurring within the broader Gnangara Mound area from Whiteman Park in the south to Neergabby (T11) in the north (Figure 5). These are related to the underlying soil and site conditions on Bassendean and Spearwood dune systems as well as the vegetation recorded. Those of relevance to this survey are the woodland, low woodland and open low woodland SVTs due to the location of the Muchea Project on the Bassendean Dune system and the height and density of the overstory species. The woodlands are dominated by *Banksia* spp. or *Melaleuca* spp. overstorey with occasional *Eucalyptus* spp. or *Corymbia calophylla* over a Myrtaceous and Proteaceous shrub layer over low shrubs and herbs with *Xanthorrhoea preissii*.

5.3. Statistical Analysis

After data preparation including the newly established sites (see Section 3.3), 111 taxonomic entities remained for analysis. Similarity Profile Analysis in PRIMER was used to identify significantly associated groups of quadrats. Where appropriate, outliers and small groupings were assigned to broader comparative vegetation units based on factors including species composition, site vegetation descriptions and topography. For the purposes of vegetation mapping (i.e. extrapolating quadrat data to generalise vegetation communities over broad areas), an inclusive rather than exclusive approach was adopted. In addition to the statistical analysis, survey quadrat physical data, aerial photographic maps and topographic maps were used to delineate the boundaries of the vegetation communities. Using this approach, eight vegetation communities were defined and mapped in the survey area of the Muchea Project (Mattiske 2018a, Figure 9).

The sites established in 2021 were included in the results of the Similarity Profile Analysis with the final eight vegetation communities delineated and displayed in Figure 9. Three of the new sites were on mid to upper slopes with *Eucalyptus todtiana* and were included in vegetation communities J (MP60, MP62) and K (MP48). These two communities are both mixed low woodlands of *Banksia attenuata*, *Banksia menziesii* and *Eucalyptus todtiana*. The other six survey sites were all included in vegetation community H, low woodland of *Banksia attenuata* and *Banksia menziesii* over a diverse sclerophyllous understorey.

The six vegetation community groups A, F, G, H, J and K are closely related low woodland communities dominated by *Banksia attenuata* and *Banksia menziesii*. Communities J and K are delineated from the other four communities (A, F, G and H) due to *Eucalyptus todtiana* as an equal part of the woodland structure. In defining these six groups the associations of the understorey species were important. Aerial photographs provide little distinction and hence little support for extrapolation of communities away from quadrats. The topographical position of sites was therefore very useful for mapping; the topography is undulating and varies from valley floor to dune ridge, but changes are subtle (relief is no more than 20 m).

The total area mapped and percentage cover for each delineated vegetation community (Figures 9) is shown in Table 5. Low woodland communities accounted for 96.4 % (1059.1 ha), and Low open woodlands 2.4 % (26.9 ha) of the Muchea survey area. Community A lies on high dunes in the south of the Muchea survey area. Several patches of communities B, F, G and J are situated inside the Muchea survey area. Community H is the least restricted in its distribution and covers a large part of the Muchea survey area. Community M occurs on the western boundary of the Muchea survey area.

5.4. Vegetation Communities

Details of the eight vegetation communities defined in 2018 and updated in 2021 are presented in Appendix G and a summary description given below. Vegetation map is shown in Figure 9. All vegetation communities are low woodlands.

A: Low woodland of *Banksia attenuata* and *Banksia menziesii* with occasional *Eucalyptus todtiana* over *Beaufortia elegans, Bossiaea eriocarpa, Eremaea pauciflora, Jacksonia floribunda, Petrophile linearis and Scholtzia involucrata*, over *Drosera erythrorhiza, Lyginia barbata* and *Patersonia occidentalis* on white-grey sand. Occurs predominantly on mid slopes, but also flats and upper slopes.

B: Low open woodland of *Banksia attenuata* and *Banksia menziesii* over *Jacksonia floribunda*, *Scholtzia involucrata, Styphelia conostephioides, Verticordia nitens* and *Xanthorrhoea preissii* over *Dasypogon bromeliifolius* and *Patersonia occidentalis* on white-grey sand. Occurs mostly on lower slopes and valley floors in moister sites (but not as wet as those for M).

F: Low woodland of *Banksia attenuata* and *Banksia menziesii* over *Allocasuarina humilis*, *Conostephium pendulum, Jacksonia floribunda, Melaleuca trichophylla, Petrophile linearis, Scholtzia involucrata* and *Stirlingia latifolia,* over *Burchardia congesta, Drosera drummondii* and *Lyginia barbata* on white-grey sand. Occurs on upper slopes and some ridges.

G: Low woodland of *Banksia attenuata* and *Banksia menziesii* over *Calytrix flavescens, Eremaea pauciflora* var. *calyptra, Hibbertia subvaginata, Jacksonia floribunda, Leptomeria empetriformis* and *Petrophile linearis* over *Lyginia barbata* and *Phlebocarya ciliata* on white-grey-brown sand. Occurs on mid slopes and some upper slopes.

H: Low woodland of *Banksia attenuata* and *Banksia menziesii* over *Hibbertia subvaginata, Jacksonia floribunda*, *Melaleuca trichophylla, Petrophile linearis, Scholtzia involucrata* and *Styphelia conostephioides* over *Lyginia barbata* and *Patersonia occidentalis* on white-grey-brown sand and sandy loam. Occurs predominantly on flats, but also across a range of lower slopes to ridges.

J: Low woodland of *Eucalyptus todtiana*, *Banksia menziesii* and *Banksia attenuata* over *Beaufortia elegans, Bossiaea eriocarpa Eremaea pauciflora* var. *calyptra, Hibbertia subvaginata Jacksonia floribunda*, *Philotheca spicata* and *Scholtzia involucrata* over *Lyginia barbata* and *Patersonia occidentalis* on white-grey sand and sandy loam, occurs mostly on upper slopes.

K: Low woodland of *Eucalyptus todtiana*, *Banksia attenuata* and *Banksia menziesii* over *Beaufortia elegans, Eremaea pauciflora, Hibbertia subvaginata, Jacksonia floribunda, Philotheca spicata* and *Scholtzia involucrata,* over *Patersonia occidentalis* and *Phlebocarya* spp. on white grey sands over yellow/brown sand on mid to upper slopes.

M: Low woodland of *Melaleuca preissiana* and *Banksia attenuata* over *Kunzea glabrescens* and *Xanthorrhoea preissii* over *Hibbertia subvaginata* and *Dasypogon bromeliifolius* on white-grey-brown sands and sandy loams or moist black loam and clay peat. Occurs in moist valley floors and flats.

Figure 8a: Dendrogram for the Muchea Project area illustrating hierarchical clustering of sites

The legend lists: Vegetation Community Code

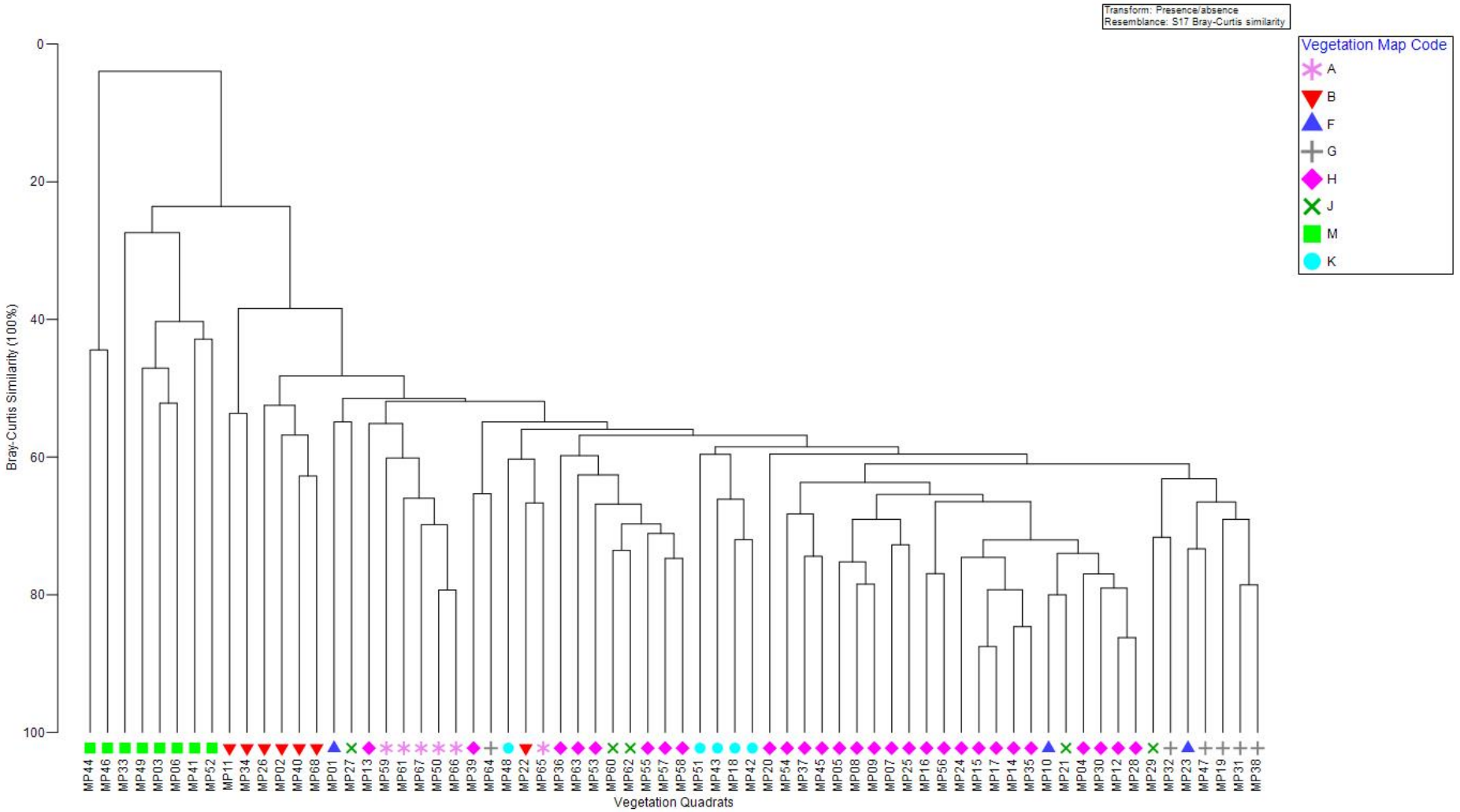
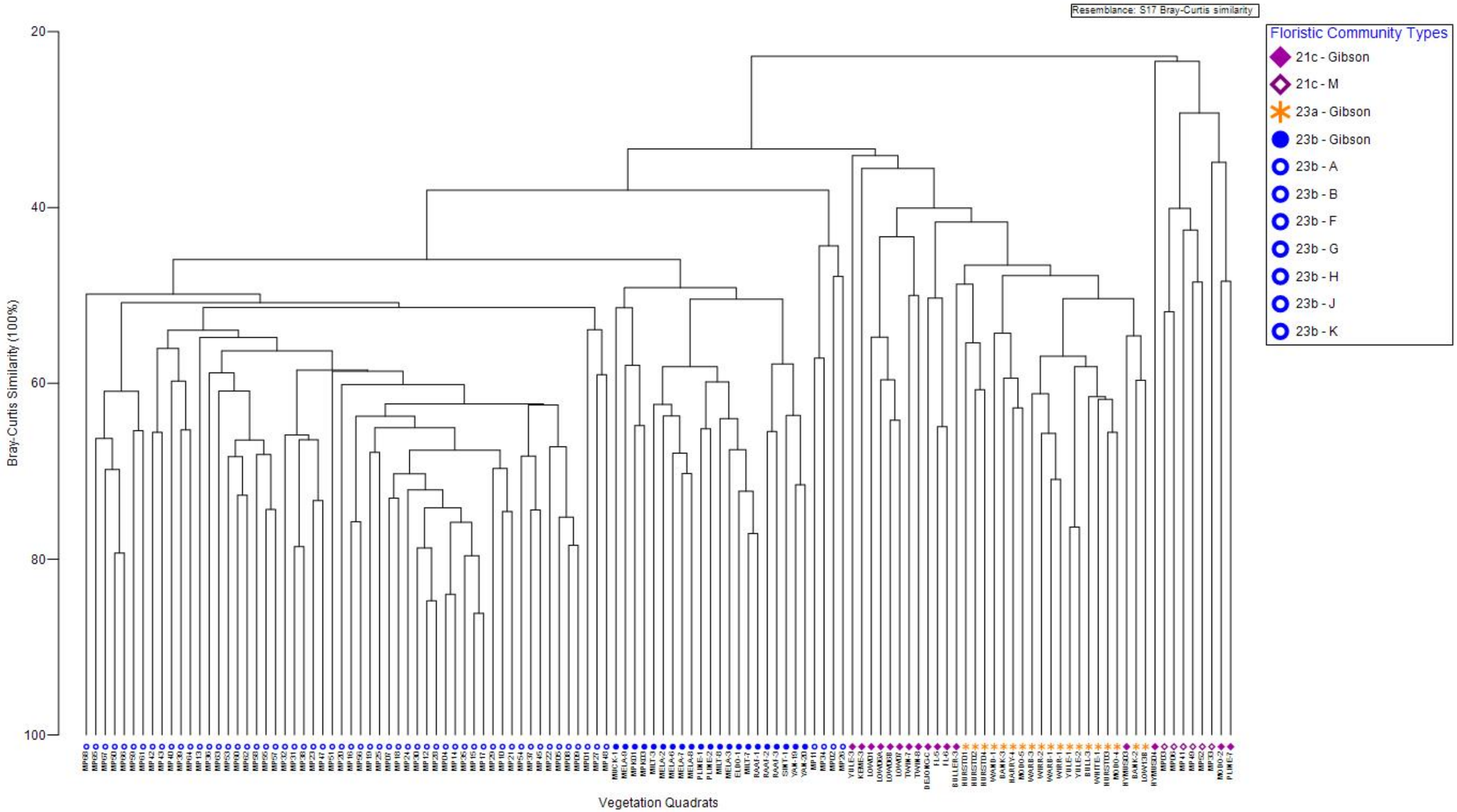
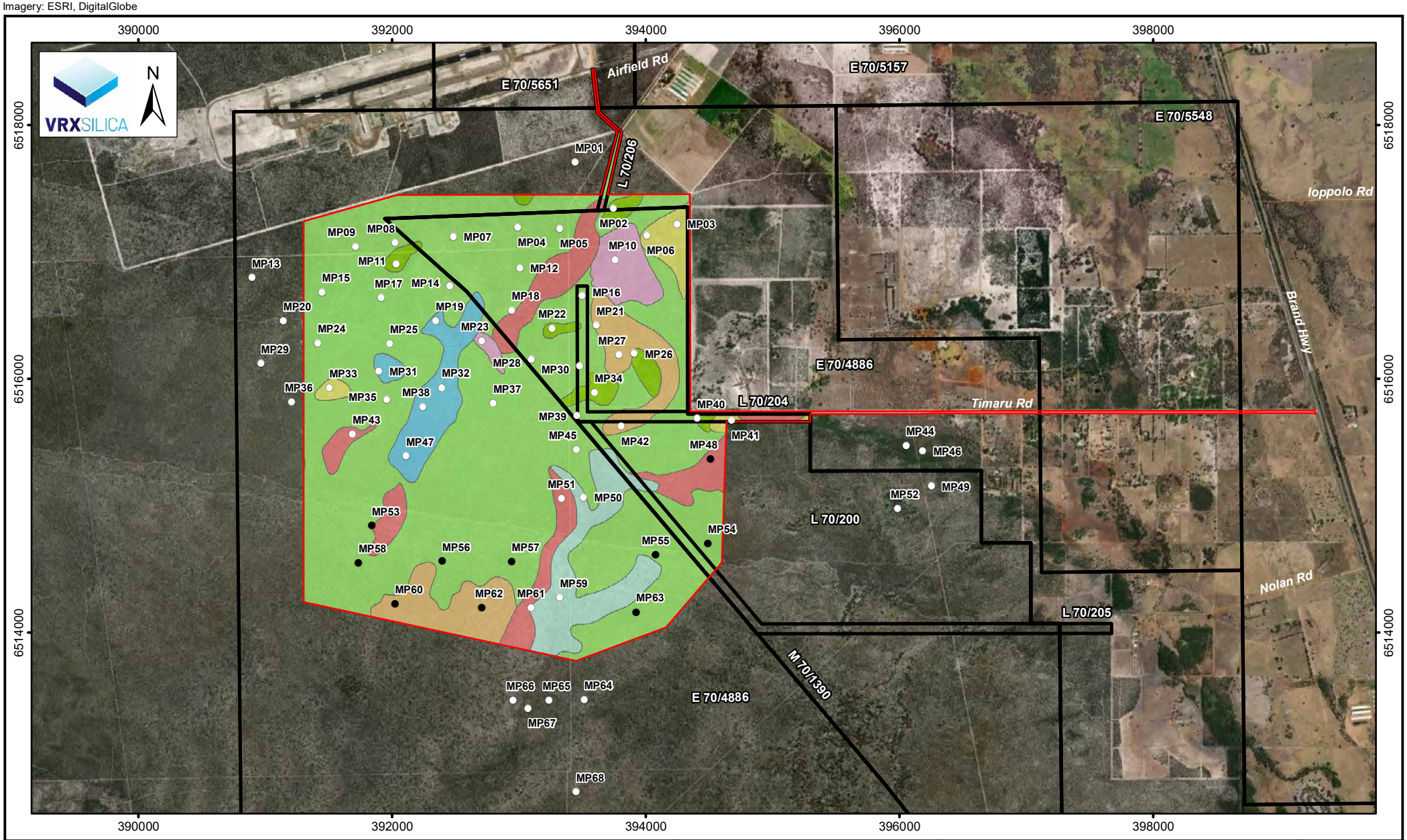


Figure 8b: Dendrogram for the Muchea Project area illustrating hierarchical clustering of sites including Gibson et al (1994) sites

The legend lists: Gibson Floristic Community Type and Vegetation Community Code (Mattiske)



Imagery: ESRI, DigitalGlobe



Legend

Survey Area
VRX Silica Tenements

MCPL Sites
2018
2021

Vegetation
A
B
D
F
G
H
J
K
M

0 0.45 0.9km
Scale: 1:40,000
MGA94 (Zone 50)

CAD Ref: a2602_f54_06
Date: March 2022 | Rev: B | A4

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VRX Silica

Vegetation Communities in the survey area of the Muchea Project

Figure: **9**

Table 5: Mapped coverage of vegetation communities, FCTs and SVTs in the survey area
FCT from Gibson et al. (1994), SVT from Mattiske (2002).

Vegetation Community	FCT	SVT	Area mapped (ha)	Proportion of survey area (%)	Quadrats
A	23b	G1	59.69	5.43	6
B	23b	H1	26.88	2.45	7
F	23b	H1	27.97	2.54	3
G	23b	H1	43.75	3.98	6
H	23b	I1	754.66	68.67	28
J	23b	G1	71.08	6.47	5
K	23b	G1	80.32	7.31	5
M	21c	K1	21.61	1.97	8
Disturbed	-	-	13.09	1.19	-
TOTAL			**1099.04**	**100**	**68**

Banksia attenuata and Banksia *menziesii* dominated the upper stratum in all of the vegetation communities except M. Other species (*Eucalyptus todtiana, Melaleuca preissiana*) did form a significant part of the canopy in communities J and M, but only in one site did these species reach a height greater than 10 m. These tree species, along with *Nuytsia floribunda*, appear in other vegetation communities, but not in significant numbers. Hence the survey area is covered by Low woodlands.

In all communities other than M, *Jacksonia floribunda* was commonly found in the tall shrub layer throughout the entire survey area. This species is listed by Gibson et al. (1994) in FCT 23b, but is not listed by Mattiske (2002) in their SVTs. Other tall shrubs found in a number of sites include *Allocasuarina humilis, Kunzea glabrescens* and *Xanthorrhoea preissii*. In the mid shrub stratum *Eremaea pauciflora* var. *calyptra*, *Hibbertia subvaginata* and *Scholtzia involucrata* were common throughout the area, while in the low shrub layer *Bossiaea eriocarpa, Leucopogon conostephioides*, *Melaleuca trichophylla* and *Petrophile linearis* and were often found. *Patersonia occidentalis* and *Lyginia barbata* were frequently recorded in the herbaceous layer.

5.4.1. Floristic Community Types

Six vegetation quadrats from vegetation community M (MP03, MP06, MP33, MP41, MP49 and MP52) were clustered with two Gibson et al. (1994) sites which are part of FCT 21c (Low lying *Banksia attenuata* woodlands or shrublands). Two vegetation quadrats (MP44 and MP46) from vegetation community M had very low similarity to the rest of the vegetation quadrats (Figure 8a) and are not included in the FCT comparison (Figure 8b).

The remainder of the vegetation quadrats from the surveys fell into branches with high similarity to those of the Gibson et al. (1994) sites which are part of FCT 23b (Northern *Banksia attenuata-Banksia menziesii* woodlands). The vegetation quadrats were also compared to FCTs 4 (*Melaleuca preissiana* damplands), 8 (Herb rich shrublands in clay pans), 22 (*Banksia ilicifolia* woodlands), and 23a (Central *Banksia attenuata-Banksia menziesii* woodlands). The next most similar FCT was 21c and then FCT 22 and FCT 23a. There are only five vegetation quadrats that have occurrences of *Banksia ilicifolia,* with the highest foliage cover only 2%. It is therefore unlikely the surveyed area aligns with FCT 22 (*Banksia ilicifolia* woodlands). FCTs 23a and 23b are very similar in species composition; given the geographic distribution of these two FCTs, it is more likely that the sites from this survey align with those of FCT 23b.

The characteristics of FCTs 21c (aligning with vegetation community M) and 23b (aligning with communities A, B, F, G, H, J and K) are shown in Table 6.

Table 6: Floristic Community Types occurring within the Muchea Project
(DBCA 2021, Gibson et al. 1994). SCP = Swan Coastal Plain. SCC = State Conservation Code (Appendix A1); FCC = Federal Conservation Code (Appendix A1).

SCP	21c	23b
Description	**Low lying *Banksia attenuata* woodlands or shrublands**	**Northern *Banksia attenuata-Banksia menziesii* woodlands**
SCC	P3	P3
FCC	Endangered	Endangered
Vegetation Community	M	A, B, F, G, H, J, K
Typical Tree Species	*Banksia attenuata*	*Banksia attenuata* *Banksia menziesii*
Common Tree Species	*Banksia menziesii*	-
Typical Shrub Species	-	*Bossiaea eriocarpa* *Calytrix flavescens* *Eremaea pauciflora* *Philotheca spicata* *Hibbertia subvaginata* *Jacksonia floribunda* *Petrophile linearis* *Scholtzia involucrata*
Common Shrub Species	*Gompholobium tomentosum* *Kunzea glabrescens* *Petrophile linearis* *Scholtzia involucrata* *Styphelia conostephioides*	*Acacia pulchella* var. *pulchella* *Beaufortia elegans* *Conostephium minus* *Conostephium pendulum* *Hibbertia hypericoides* *Melaleuca* aff. *trichophylla* *Stirlingia latifolia* *Styphelia conostephioides*
Typical herb species	*Lomandra caespitosa* *Lyginia barbata* *Thysanotus manglesianus/patersonii* *Trachymene pilosa*	*Alexgeorgea nitens* *Anigozanthos humilis* *Burchardia congesta* *Chaetospora curvifolia* *Lomandra hermaphrodita* *Lyginia barbata* *Patersonia occidentalis* *Stylidium repens* *Xanthosia huegelii*
Common herb species	*Burchardia congesta* *Caladenia flava* *Dasypogon bromeliifolius* *Drosera erythrorhiza* *Hypolaena exsulca* *Lomandra hermaphrodita* *Patersonia occidentalis* *Stylidium brunonianum* complex *Stylidium repens*	*Amphipogon turbinatus* *Conostylis juncea* *Dasypogon bromeliifolius* *Drosera erythrorhiza* *Drosera drummondii* *Phyllangium paradoxum* *Stylidium brunonianum* complex *Stylidium diuroides* *Stylidium piliferum*

5.4.2. Threatened and Priority Ecological Communities

The TEC 'Banksia Woodlands of the Swan Coastal Plain', listed as Endangered at Federal level (DAWE 2022b) and as a Priority 3 PEC at State level (DBCA 2021), is inferred to occur in the Muchea Project by DAWE (2013) (Figure 6). The comparison of the survey area sites to the FCTs described by Gibson et al (1994) shows a high similarity between the survey sites and FCTs 21c and 23b. Both of these FCTs are included as part of the Banksia Woodlands of the Swan Coastal Plain TEC.

Two PECs, both ranked as Priority 3 at State level, making up a subset of the *Banksia Woodlands* TEC are inferred to occur within the Muchea Project. These are Low lying *Banksia attenuata* woodlands or

shrublands ('floristic community type 21c') and Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands ('floristic community type 23b') (see Section 4.4.1 and Table 6 for descriptions).

5.4.3. Site-Vegetation Types

The main determinants of the location of different plant species and their associations on the northern Swan Coastal Plain are the underlying site conditions including the soil substrate and the availability of water due to topography as well as local climatic conditions (Mattiske 2002).

The following SVTs were interpreted to correspond to the eight vegetation communities interpreted from this survey's data:

G1: The drier, SVT, G1 occurs on upper slopes and corresponds with vegetation communities A, J and K. These communities occur on mid to upper slopes. *Eucalyptus todtiana* is commonly found in the overstorey, along with *Banksia attenuata* and *Banksia menziesii* over species that tolerate drier Bassendean dunes with leached grey sands.

H1: Vegetation communities B, F and G all align with type H1. These communities comprise a range of topographical positions, from lower slopes and valley floors for community B, through mid slopes for community G to upper slopes for F. All three communities have a canopy of *Banksia attenuata* and *Banksia menziesii* over a tall shrub layer that includes *Jacksonia floribunda* amongst other species. The differences between these communities are defined by understorey species reflective of their topographic position, e.g., the tall shrub layer of community B also includes *Xanthorrhoea preissii* and the herbaceous layer *Dasypogon bromeliifolius*, whilst for community F the tall shrubs include *Allocasuarina humilis* and for community G the herbaceous layer includes *Phlebocarya ciliata*.

I1: The vegetation community, H, corresponds with SVT I1. Quadrats making up community H are on flats and slopes of the Bassendean dune system. Vegetation in this community is "typical" for the Muchea Project i.e., it lacks any distinguishing species that differentiate it from any of the other five communities with canopy dominated by *Banksia* spp. (communities A, B, F, G, J and K); although it tends to occur on the lower slopes and flats.

K1: Vegetation community M aligns most closely with SVT K1, which is characterised by an overstorey containing *Eucalyptus rudis, Melaleuca preissiana* and *Banksia ilicifolia* with only occasional *Banksia attenuata* and *Banksia menziesii*. Community M occurs on the lowest, wettest areas of the survey, generally in the eastern part of the Muchea Project. This community and hence SVT K1 occurs mostly on the north eastern boundary and one small patch (centred about site MP33) on the western boundary of the survey area.

5.5. Vegetation Condition

The overall vegetation condition of the Muchea Project area is ranked as Pristine to Excellent (Keighery 1994), with 42 of the 68 quadrats rated as Pristine, 17 as Excellent and 3 as Very Good (Table 8). One vegetation quadrat (MP46) was ranked as Completely Degraded/Fire; this quadrat has overstorey coverage of 79.5 % (59 % alive, 20.5 % dead) and shrub coverage of 10 % (9 % alive, 1 % dead), but the herbaceous layer coverage (44 %, all alive) is dominated by introduced species. Timaru Road Reserve is ranked as Completely Degraded. The vegetation has predominately been cleared with small stands of *Melaleuca preissiana* or *Acacia blakelyi* over introduced species (Appendix H).

Minor weeds and disturbances from feral pigs were noted during the survey. There are several vehicle tracks through the area, some of which are also used by equestrians, and these comprise the only cleared areas within the mapped survey area.

Table 7: Vegetation Condition within the Muchea Project

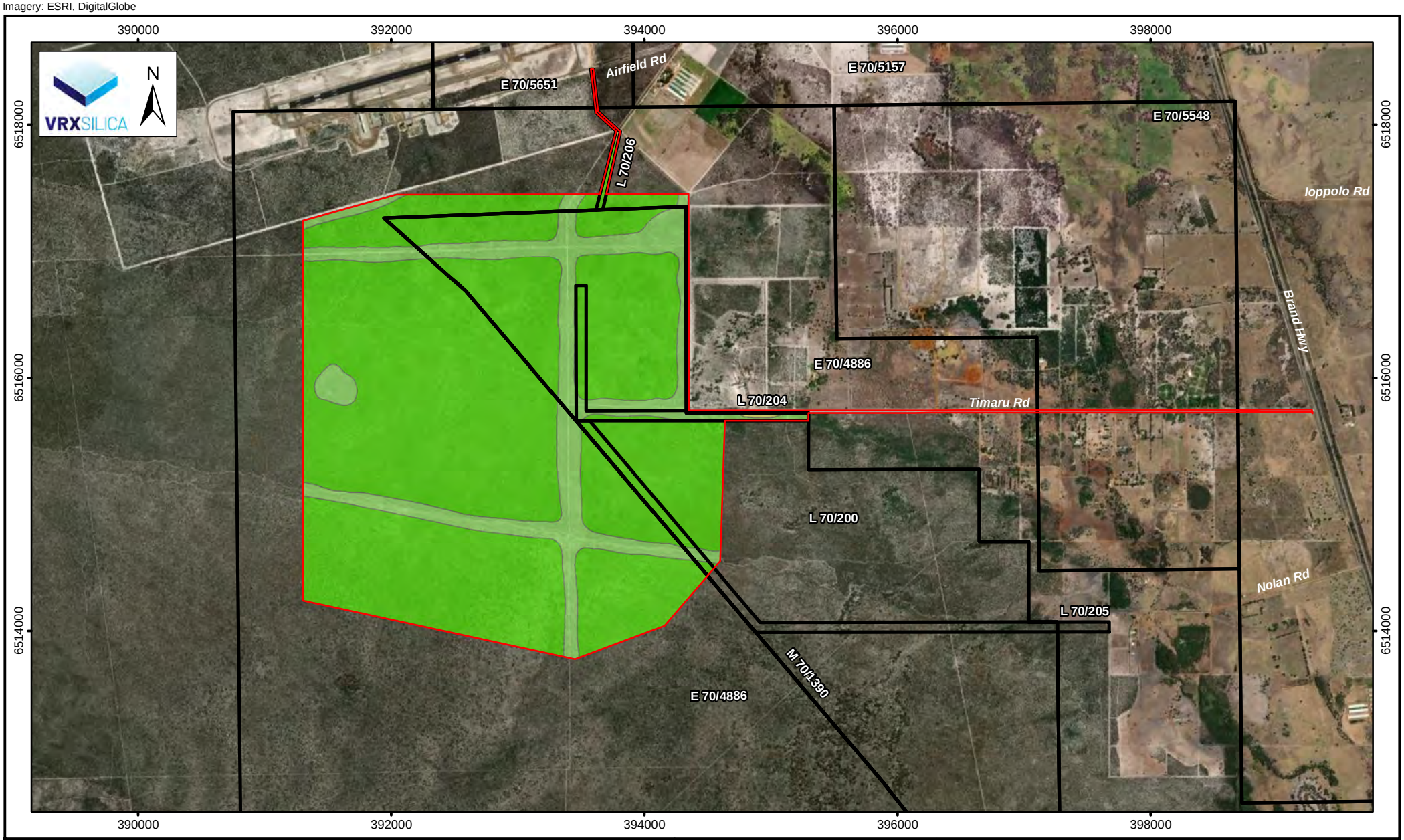
Keighery Condition Ranking	Area (ha)	Proportion of survey area (%)
Pristine	913.73	83.14
Excellent	170.00	15.47
Very Good	2.17	0.20
Good	-	-
Degraded	-	-
Completely Degraded	13.15	1.20
TOTAL	**1099.04**	**100**

Figure 10 shows that within the survey area, vegetation in Excellent condition tends to occur around the tracks/firebreaks and farmland boundaries and Pristine areas towards the centre, further away from sources of disturbance. The vegetation along Timaru Road was in Completely Degraded condition.

The Muchea Project area has been subjected to frequent fires. Most of the survey area was subject to a bushfire in 2003 and smaller areas to the north, northeast and southeast by fires in 2011. Vegetation quadrats in this survey to the north and east of the survey area were burnt in 2011, those to the south in 2003 or 2015, and to the west in 2011 or 2013 (DBCA 2020).

The vegetation condition of the adjacent Bush Forever site 380 in 2000 was given as >90% Pristine to Excellent, <10% Very Good, with areas of localised disturbance along tracks (Western Australian Planning Commission 2000).

Imagery: ESRI, DigitalGlobe



Legend

- Survey Area
- VRX Silica Tenements

Vegetation Condition

- Pristine
- Excellent
- Very Good
- Completely Degraded

0 0.5 1km

Scale: 1:40,000
MGA94 (Zone 50)

CAD Ref: a2602_f54_07

Date: March 2022 | Rev: A | A4

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Vegetation Condition in the survey area of the Muchea Project

Figure: **10**

5.6. Regional and Local Extent of Vegetation

In order to provide a measure of the impact the Muchea Project will have on regional and local vegetation, the area of vegetation to be impacted in the survey area is compared with the regional and/or local extent of various levels of vegetation classification in Table 8.

Table 8: Impact of Muchea Project on regional and local vegetation extent

Vegetation Classification	Vegetation Unit	Current Regional extent (ha)	Area to be disturbed in survey area (ha)	Proportion of Regional Extent to be cleared (%)
Pre-European Vegetation Association (DBCA 2019b)	Low woodland; banksia (949.2)	115,066.15	872.51	0.76
	Mosaic: Low woodland; banksia / Shrublands; teatree thicket (1014.1)	41,045.05	218.73	0.53
	Woodland; Low Forest (1018.1)	6,047.67	7.81	0.13
Mattiske Site-Vegetation Types (Gnangara Mound)	G1	3,943.66	9.47	0.24
	H1	12,770.31	581.09	4.55
	I1	17,543.46	488.81	2.79
	J1	14,116.77	11.39	0.08
	K1	3,317.67	3.85	0.12
Threatened Ecological Community (DotEE 2016)	Banksia Woodlands of the Swan Coastal Plain	334,608 (SWA IBRA region)	1099.04	0.33

Local impacts on vegetation can be estimated by considering the figures for the Mattiske SVTs, which are calculated over the Gnangara Mound, an area of 155,231 ha. The vegetation in the Muchea survey area (1099.04 ha) covers 0.7 % of that on the Gnangara Mound.

Regionally, the impact on vegetation in the survey area affects no more than 5 % of each measure (all of which overlap in part) of vegetation within the Swan Coastal Plain IBRA bioregion, with the biggest proportional impact being on the H1 Site Vegetation type (4.55 % of regional extent).

6. DISCUSSION AND CONCLUSIONS

6.1. General

Mattiske Consulting Pty Ltd was commissioned in July 2021 by VRX Silica Ltd (VRX) to undertake a flora and vegetation survey of the Muchea Silica Sands Project (Muchea Project) northwest of Muchea, WA and the road reserve area of Timaru Road, Muchea, WA. This survey was combined with desktop and flora and vegetation reports commissioned by Australian Silica Pty Ltd to provide an update of the current proposal. The survey area is within exploration mining tenement E70/4886 which covers approximately 5850 ha of *Banksia* woodland and a small amount of agricultural land.

A total of 68 vegetation quadrats were established to sample all the apparent vegetation community types which were located within the Muchea Project survey area. A total of 58 vegetation quadrats were established to sample all the apparent vegetation community types which were located within the Muchea Project survey area in 2018. An additional 10 vegetation quadrats were established in 2021. No survey sites were established along Timaru Road Reserve.

The survey time of both the 2018 and 2021 surveys was selected to align with the peak flowering periods of conservation significant flora. Rainfall for the 3 months prior to the 2018 survey (June to August) was well above average and rainfall for the 3 months prior to the 2021 survey (August to September) was average. Overall, based on a range of factors including the proportion of potential flora recorded (estimated at 74 %), proportion of annual taxa recorded (9.78 %), and vegetation quadrat distribution within the survey area, the survey has not been constrained by factors which would adversely affect the survey outcomes nor the conclusions derived from the data used to support vegetation analysis.

While many taxa were in flower during the surveys, a proportion of the plants encountered during the surveys were sterile and this impacted the identification of some specimens to species level. Botanists that undertook the survey were experienced with the flora of the Swan Coastal Plain. A review of the potential constraints associated with these surveys determined that the surveys were not subject to constraints that would adversely affect the outcome nor the conclusions formed from the results.

6.2. Flora

A total of 225 vascular plant taxa, representative of 103 genera and 42 families, were recorded within the Muchea Project survey area during the 2018 and 2021 surveys. The majority of the taxa recorded are widespread both locally and more broadly within the Swan Coastal Plain. The 225 taxa recorded during the survey, is much higher than the 90 taxa recorded as being potentially present within the desktop assessment. The desktop assessment was completed with a 5 km buffer from a point within the survey area and the higher number of taxa recorded by during these surveys indicates that the local area may be under surveyed.

In comparison, over a survey area approximately twice as large in the Gnangara and East Gnangara Mound Survey of 2001 (Mattiske 2003), 463 taxa were identified, comprising 233 genera and 66 families. A total of 60 introduced taxa and two Priority flora species were recorded. Monitoring of a similar but slightly smaller area in 2017 (Mattiske 2018) resulted in identification of 302 taxa representative of 172 genera and 59 families, with 37 introduced taxa and one Priority flora species recorded.

Conservation significant taxa

Of the 13 threatened flora species and 13 priority taxa identified during the desktop assessment, none were recorded in the Muchea Project. Twenty-five of the species were likely to be flowering during these surveys. Rainfall during the winters preceding the surveys was at or above the long-term average, so there should have been little variation in flowering times from those expected. In larger surveys conducted within Banksia woodland of the Gnangara Mound in 2002 (Mattiske 2003) and 2017 (Mattiske 2018b), only one priority flora *Jacksonia sericea* (P4) was recorded. The number of threatened and priority species identified as having the potential to occur within the survey area, can be attributed to the search including a larger, and more edaphically diverse area. Many of these species are restricted to specific landscape features such as that do not occur in the survey area but may occur in the larger tenement area.

An assessment of the likelihood of recording any of the listed threatened and priority taxa within the survey area, was conducted based on factors including known soil type, topography and distribution. Based on this initial assessment, no threatened flora species had a high likelihood of occurring in survey area. Seventeen of the 26 conservation significant flora were recorded to occur in or around winter wet depressions, swamps or creeklines. None of these systems are present in the survey area but are likely to occur in the larger tenement area.

No threatened flora species pursuant to Part 2, Division 1, and Subdivision 2 of the BC Act and as listed by the DBCA (2018a), or pursuant to section 179 of the EPBC Act or listed by the DAWE (2022a) were recorded within the Muchea Project. No priority flora species, as listed by DBCA (2018c) were recorded within the Muchea Project.

Introduced (Weed) Species and Declared Pest (Plant) Organisms

Eight introduced species were recorded during the 2018 and 2021 surveys. Four of these have an Ecological Impact Ranking of 'High' and/or Invasiveness ranking of 'Rapid'. These species, **Gladiolus caryophyllaceus, *Hypochaeris glabra, *Medicago* sp. and **Ursinia anthemoides* subsp. *anthemoides* were found in one, three, two and twelve sites respectively. These sites are located along the eastern edge of the survey area and beside tracks, close to vegetation disturbance or in damp lower lying areas where water availability encourages the persistence of invasive species. The low coverage of introduced species is reflective of the Pristine to Excellent condition of the vegetation.

There is the potential to spread the fungal diseases associated with the species of *Phytophthor*a on the sand dunes within the Muchea Project. To appropriately fulfil management and control obligations the current extent of any *Phytophthora* species should be mapped. Any exploration and operational activities should follow guidelines set out in the *Threat abatement plan: For disease in natural ecosystems caused by Phytophthora cinnamomi* (DotEE 2018).

Taxa representing range extensions

No species recorded at the survey area represented extensions to their current known distributions. In this report, 100 km has been used as a basis to determine an extension to the currently known range for a species.

6.3. Vegetation

The TEC 'Banksia Woodlands of the Swan Coastal Plain' listed as Endangered at Federal level and as a Priority 3 PEC at State level, are inferred to occur in the Muchea Project. *Banksia* Woodlands of the Swan Coastal Plain includes multiple Floristic Community Types (including FCT23b and FCT21a) as defined by Gibson et al. (1994). The *Banksia* Woodlands community includes all *Banksia* woodlands persisting on the Swan Coastal Plain; these extend well beyond the Muchea Project and Gnangara

Mound. There are range of threats to these woodlands from clearing activities, changed fire regimes and disease infestations.

Two Priority Ecological Communities, both ranked as Priority 3 at State level, making up a subset of the *Banksia Woodlands* TEC are inferred to occur within the Muchea Project. These are 'Low lying *Banksia attenuata* woodlands or shrublands ('floristic community type 21c')' and 'SCP Northern *Banksia attenuata* – *Banksia menziesii* woodlands ('floristic community type 23b')'.

Vegetation mapping of the survey area, based upon the quadrat-based species data, resulted in eight low woodland vegetation communities. All communities aside from M are very similar in species composition, and it is possible that larger groupings of communities could have been made. The eight communities defined in this report are reflective of their general species composition, topographical situation and aerial photograph characteristics. The most dominant vegetation type was the H vegetation community (Low woodland of *Banksia attenuata* and *Banksia menziesii*) which was present throughout survey area. This community accounted for 68.67 % of the total area surveyed. The remaining seven communities account for 30.14 % of the survey area. The most restricted vegetation community defined was the M community, accounting for 1.97 % of the survey area.

Analysis of data collected during these surveys along with data from the Gibson et al. (1994) regional database of FCTs showed that most of the vegetation (all communities except M) in the survey area was similar to the FCT 23b 'Northern *Banksia attenuata-Banksia menziesii* woodlands'. The exception to this was vegetation community M, which was similar to FCT 21c 'Low lying *Banksia attenuata* woodlands or shrublands'. It is also possible that the north-eastern edge of the survey area may be part of the TEC 'Shrublands and Woodlands on Perth to Gingin ironstone (Perth to Gingin ironstone association) of the Swan Coastal Plain', which relates to FCT 8. This area of the Tenement has not yet been surveyed.

The vegetation of the survey area was primarily in Pristine condition with little signs of disturbance caused by human activities. Some areas were downgraded to Excellent condition near tracks, where occasional non-aggressive weeds were observed. Timaru Road Reserve vegetation was recorded as Completely Degraded and cleared.

Overall, the vegetation communities mapped and species recorded in the survey area corridor were consistent with the historical mapping of Beard (1976, 1990) and Gibson et al (1994).

6.4. Conclusion

The Muchea Silica Sand Project lies in a regionally well surveyed area with a high level of diversity between Muchea and Gingin although the local area appears under surveyed. The vegetation in this survey area mostly consisted of native vegetation in a near-pristine condition, which is part of the Threatened Ecological Community 'Banksia Woodlands of the Swan Coastal Plain', listed as Endangered at Federal level and both the Priority Ecological Communities 'Low lying *Banksia attenuata* woodlands or shrublands ('floristic community type 21c')' and 'SCP Northern *Banksia attenuata* – *Banksia menziesii* woodlands ('floristic community type 23b')' which are ranked as Priority 3 for Western Australia. The desktop survey identified 13 threatened flora and 13 priority flora that have the potential to occur within the survey area and none were found. Of the 13 threatened flora species, none had a high likelihood, four had a moderate likelihood and nine a low likelihood of occurring in the survey area based on preferred soil types.

The vegetation communities mapped and species recorded in the survey area were consistent with the historical mapping of Havel (1968), Heddle et al (1980), Beard (1976, 1990), Gibson et al (1994) and Mattiske (2002). The survey area is situated on low sand dunes supporting low open to low woodland communities consisting of *Banksia attenuata, Banksia menziesii*, *Eucalyptus todtiana* and *Melaleuca preissiana*, over mixed sclerophyllous shrubs and forbs. The vegetation communities recorded within the survey area are not locally or regionally unique and are represented in the wider area.

The proportion of regional vegetation proposed to be disturbed in the survey area (< 5 % for all measures) may seem insignificant; however, as noted in the conservation advice for the Banksia Woodlands of the Swan Coastal Plain TEC (DotEE 2016), this ecological community has been "very heavily cleared and modified, and now exists as mostly very small and highly fragmented patches". The geographic extent of the Banksia Woodlands TEC over the Swan Coastal Plain is estimated to have declined by 50-60 % since Pre-European time. Approximately 81,800 ha of the TEC were estimated to exist in reserves in 2016, which is around 24 % of the estimated extent of the TEC. The greatest ongoing threat to the existence of the TEC is clearing and fragmentation, including mining of silica sands (DotEE 2016). Other threats include: dieback diseases, invasive species, fire regime change, hydrological degradation, climate change, grazing, decline in pollinating and seed dispersing fauna, and loss of key *Banksia* species.

7. ACKNOWLEDGEMENTS

The authors would like to thank Mike Hislop from the Western Australian Herbarium for his plant identification support.

8. PERSONNEL

A range of personnel from Mattiske Consulting Pty Ltd have been involved in this project over several years and their efforts have contributed to the work that has been integrated with this report. The following Mattiske Consulting Pty Ltd personnel were involved in the recent 2021 work on this project.

NAME	POSITION	PROJECT INVOLVEMENT	FLORA COLLECTION PERMITS
Dr EM Mattiske	Managing Director & Principal Ecologist	Planning, managing, editing, reporting	
Ms L Cockram	Experienced Botanist	Planning, fieldwork, plant identification, data analysis, reporting	FB62000266-2
Ms L Ducki	Botanist	Fieldwork	FB62000394
Ms L McDermott	Botanist	Fieldwork, plant identification	FB26000367
Dr S Ruoss	Senior Botanist	Reporting	N/A

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APPENDIX A1: THREATENED AND PRIORITY FLORA DEFINITIONS

Under section 179 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), **threatened flora** are categorised as extinct, extinct in the wild, critically endangered, endangered, vulnerable and conservation dependent (Table A1.1).

Table A1.1 Federal definition of Threatened Flora Species

Note: Adapted from section 179 of the EPBC Act.

CODE	CATEGORY	DEFINITION
Ex	**Extinct**	Species which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild**	Species which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered**	Species which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered**	Species which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable**	Species which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent**	Species which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

The *Biodiversity Conservation Act 2016* (BC Act) provides for (amongst other things) the protection of flora that is facing an extremely high risk of extinction in the wild in the immediate, near or medium-term future in Western Australia under Part 10 (Division 2).

Threatened flora are listed in the *Wildlife Conservation (Rare Flora) Notice 2018* (under Part 2, Division 1, Subdivision 2 of the BC Act; Department of Biodiversity, Conservation and Attractions 2018a) and are categorised under Schedules 1-3**.** A flora species is defined as **threatened** if it is facing an extremely high risk of extinction in the wild in the immediate, near or medium-term future, pursuant to sections 20, 21 and 22 of the BC Act (Department of Biodiversity, Conservation and Attractions 2019). Threatened species are categorised as critically endangered, endangered, and vulnerable (Table A1.2).

Table A1.2 State definition of Threatened Flora Species

Note: Adapted from Department of Biodiversity, Conservation and Attractions (2019a).

CODE	CATEGORY	DEFINITION
CR	**Critically endangered**	Species considered to be facing an extremely high risk of becoming extinct in the wild (listed under Schedule 1 of the *Wildlife Conservation (Rare Flora) Notice 2018*).
EN	**Endangered**	Species considered to be facing a very high risk of becoming extinct in the wild (listed under Schedule 2 of the *Wildlife Conservation (Rare Flora) Notice 2018*).
VU	**Vulnerable**	Species considered to be facing a high risk of becoming extinct in the wild (listed under Schedule 3 of the *Wildlife Conservation (Rare Flora) Notice 2018*).

Priority flora species are defined as "possibly threatened species that do not meet the survey criteria, or are otherwise data deficient" or species that are "adequately known, are rare but not threatened, meet criteria for near threatened or have recently been removed from the threatened species list" for other than taxonomic reasons" (Department of Biodiversity, Conservation and Attractions 2019). Priority species are not afforded additional protection under state or federal legislation, however are considered significant under the Environmental Protection Authority's *Environmental Factor Guideline: Flora and Vegetation* (Environmental Protection Authority 2016a). The Department of Biodiversity, Conservation and Attractions categorises priority flora into four categories: Priority 1; Priority 2, Priority 3 and Priority 4 (Table A1.3).

Table A1.3: State definition of Priority Flora Species

Note: Adapted from Department of Biodiversity, Conservation and Attractions (2019a).

CODE	CATEGORY	DEFINITION
P1	**Priority 1:** Poorly-known species	Known from one or a few locations (< 5) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation; or are otherwise under threat of habitat destruction or degradation. In urgent need of further survey.
P2	**Priority 2:** Poorly-known species	Known from one or a few locations (< 5). Some occurrences are on lands managed primarily for nature conservation. In urgent need of further survey.
P3	**Priority 3:** Poorly-known species	Known from several locations and the species does not appear to be under imminent threat; or from few but widespread locations with either a large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. In need of further survey.
P4	**Priority 4:** 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) Other -** Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

APPENDIX A2: THREATENED AND PRIORITY ECOLOGICAL COMMUNITY DEFINITIONS

Under section 181 of the EPBC Act, **threatened ecological communities** are categorised as critically endangered, endangered and vulnerable (Table A2.1).

Table A2.1 Federal definition of Threatened Ecological Communities

Note: Adapted from section 181 and section 182 of the EPBC Act.

CATEGORY	DEFINITION
Critically Endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

The *Biodiversity Conservation Act 2016* (BC Act) provides for (amongst other things) some protection of ecological communities at risk of collapse in Western Australia under Part 3 (Division 2).

Threatened ecological communities (TECs) are listed in the *List of Threatened Ecological Communities endorsed by the Western Australian Minister for Environment (28 June 2018)* (under Part 2, Division 2, Subdivision 1 of the BC Act; Department of Biodiversity, Conservation and Attractions 2018b). An ecological community is defined as **threatened** if it is facing an extremely high risk of collapse in the immediate, near or medium-term future, pursuant to sections 28, 29 and 30 of the BC Act. Threatened ecological communities are categorised as critically endangered, endangered, and vulnerable (Table A2.2). Some of these TECs are also endorsed by the Federal Minister as threatened, and some of these are listed under the EPBC Act and therefore afforded legislative protection at the Commonwealth level.

Table A2.2 State definition of Threatened Ecological Communities

Note: Adapted from Department of Environment and Conservation (2013).

CODE	CATEGORY	DEFINITION
CR	**Critically Endangered**	An ecological community will be listed as CR when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting **any one or more of** the following criteria: **1.** The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification; **2.** The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; or **3.** The ecological community is highly modified with potential of being rehabilitated in the immediate future.
EN	**Endangered**	An ecological community will be listed as EN when it has been adequately surveyed and is not CR, but is facing a very high risk of total destruction in the near future. The ecological community must meet **any one or more of** the following criteria: **1.** The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short term future, or is unlikely to be substantially rehabilitated in the short term future due to modification; **2.** The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; or **3.** The ecological community is highly modified with potential of being rehabilitated in the short term future.
VU	**Vulnerable**	An ecological community will be listed as VU when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet **any one or more of** the following criteria: **1.** The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated; **2.** The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution; or **3.** The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.

Priority ecological communities (PECs) are defined as possible threatened ecological communities that do not meet the stringent survey criteria for the assessment of threatened ecological communities, and are listed by the Department of Biodiversity, Conservation and Attractions (2021) in the *Priority Ecological Communities for Western Australia – Version 31 (20 March 2021)*. Similarly to priority flora, PECs are not afforded legislative protection, however are considered significant under the Environmental Protection Authority's (2016a) *Environmental Factor Guideline: Flora and Vegetation*. The Department of Biodiversity, Conservation and Attractions categorises priority ecological communities into five categories: Priority 1; Priority 2, Priority 3, Priority 4 and Priority 5 (Table A2.3).

Table A2.3 State definition of Priority Ecological Communities

Note: Adapted from Department of Environment and Conservation (2013).

CODE	CATEGORY	DEFINITION
P1	**Priority 1** (Poorly known ecological communities)	Ecological communities that are known from very few, restricted occurrences (generally ≤ 5 occurrences or a total area of ≤ 100 ha). Most of these occurrences are not actively managed for conservation (e.g. located within agricultural or pastoral lands, urban areas, or active mineral leases) and for which immediate threats exist.
P2	**Priority 2** (Poorly known ecological communities)	Communities that are known from few small occurrences (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.
P3	**Priority 3** (Poorly known ecological communities)	**1.** Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation; **2.** Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat; or **3.** Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	**Priority 4** (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)	**1.** Rare – Communities known from few occurrences that are considered to have been adequately surveyed, sufficient knowledge is available, and are considered not to be currently threatened. **2.** Near Threatened – Communities considered to have been adequately surveyed and do not qualify for Conservation Dependent, but are close to qualifying for Vulnerable. **3.** Communities that have been removed from the list of threatened communities during the past five years.
P5	**Priority 5** (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 A3: CATEGORIES AND CONTROL MEASURES OF DECLARED PEST (PLANT) ORGANISMS IN WESTERN AUSTRALIA

Section 22 of Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act) makes provision for a plant taxon to be listed as a declared pest organism in respect to parts of, or the entire State. According to the BAM Act, a declared pest is defined as a prohibited organism (section 12), or an organism for which a declaration under section 22 (2) of the Act is in force.

Under the *Biosecurity and Agriculture Management Regulations 2013* (WA), declared pest plants are placed in one of three control categories, C1 (exclusion), C2 (eradication) or C3 (management), which determines the measures of control which apply to the declared pest (Table A4.1). The current listing of declared pest organisms and their control category is through the Western Australian Organism List (Department of Primary Industries and Regional Development 2021).

Table A3.1 Categories and Control Measures of Declared Pest (Plant) Organisms

Note: Adapted from *Biosecurity and Agriculture Management Regulations 2013*.

CONTROL CATEGORY	CONTROL MEASURES
C1 (Exclusion) '(a) Category 1 (C1) — Exclusion: if in the opinion of the Minister introduction of the declared pest into an area or part of an area for which it is declared should be prevented.' Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.	In relation to a category 1 declared pest, the owner or occupier of land in an area for which an organism is a declared pest or a person who is conducting an activity on the land must take such of the control measures specified in subregulation (1) as are reasonable and necessary to destroy, prevent or eradicate the declared pest.
C2 (Eradication) '(b) Category 2 (C2) — Eradication: if in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is feasible.' Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.	In relation to a category 2 declared pest, the owner or occupier of land in an area for which an organism is a declared pest or a person who is conducting an activity on the land must take such of the control measures specified in subregulation (1) as are reasonable and necessary to destroy, prevent or eradicate the declared pest.
C3 (Management) '(c) Category 3 (C3) — Management: if in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is not feasible but that it is necessary to: **(i)** alleviate the harmful impact of the declared pest in the area; or **(ii)** reduce the number or distribution of the declared pest in the area; or **(iii)** prevent or contain the spread of the declared pest in the area.' Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.	In relation to a category 3 declared pest, the owner or occupier of land in an area for which an organism is a declared pest or a person who is conducting an activity on the land must take such of the control measures specified in subregulation (1) as are reasonable and necessary to: **(a)** alleviate the harmful impact of the declared pest in the area for which it is declared; or **(b)** reduce the number or distribution of the declared pest in the area for which it is declared; or **(c)** prevent or contain the spread of the declared pest in the area for which it is declared.

APPENDIX A4: OTHER DEFINITIONS

Environmentally sensitive areas

Environmentally sensitive areas are declared by the State Minister under section 51B of the *Environmental Protection Act 1986* (EP Act) and are listed in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, gazetted 8 April 2005 (DWER 2022). Specific environmentally sensitive areas relevant to this report include: a defined wetland and the area within 50 metres of the wetland; the area covered by vegetation within 50 metres of rare flora; the area covered by a threatened ecological community; a Bush Forever site – further areas and information are described in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*.

Conservation significant flora

Under the *Environmental Factor Guideline: Flora and Vegetation* (Environmental Protection Authority 2016a), flora may be considered significant for a range of reasons, including, but not limited to the following:

- being identified as threatened or priority species;
- locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- new species or anomalous features that indicate a potential new species;
- representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids; or
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

Conservation significant vegetation

Under the *Environmental Factor Guideline: Flora and Vegetation* (Environmental Protection Authority 2016a), vegetation may be considered significant for a range of reasons, including, but not limited to the following:

- being identified as threatened or priority ecological communities;
- restricted distribution;
- degree of historical impact from threatening processes;
- a role as a refuge; or
- providing an important function required to maintain ecological integrity of a significant ecosystem.

APPENDIX A5: DEFINITION OF VEGETATION CONDITION SCALE FOR THE SOUTH WEST AND INTERZONE BOTANICAL PROVINCES

Vegetation condition ratings relate to vegetation structure, level of disturbance at each structural layer and the ability of the vegetation unit to regenerate (Table A5.1). Vegetation condition provides complementary information for assessing the significance of potential impacts.

Table A5.1 Definition of Vegetation Condition Categories

Note: Adapted from Keighery (1994).

CATEGORY	DEFINITION
Pristine	Pristine or nearly so, no obvious sign of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
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 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 very aggressive weeds, 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 at high density, 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 A6: NVIS STRUCTURAL FORMATION TERMINOLOGY

Note: Adapted from ESCAVI (2003).

COVER CHARACTERISTICS							
Foliage cover*	70-100	30-70	10-30	<10	≈0	0-5	unknown
Crown cover**	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
% cover***	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
Cover code	d	c	i	r	bi	bc	unknown

GROWTH FORM	HEIGHT RANGES (m)	STRUCTURAL FORMATION CLASSES						
tree, palm	<10, 10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	mallee trees
shrub, cycad, grass-tree, tree-fern	<1, 1-2, >2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrubs
heath shrub	<1, 1-2, >2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrubs
chenopod shrub	<1, 1-2, >2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrubs
samphire shrub	<0.5, >0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	spare samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrubs
hummock grass	<2, >2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grasses
tussock grass	<0.5, >0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grassland	isolated clumps of tussock grasses	tussock grasses
other grass	<0.5, >0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grasses
sedge	<0.5, >0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedges
rush	<0.5, >0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rushes
forb	<0.5, >0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forbs
fern	<1, 1-2, >2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	ferns
bryophyte	<0.5	closed bryophyteland	bryophyteland	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichens
vine	<10, 10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vines
aquatic	0-0.5, <1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics	aquatics
seagrass	0-0.5, <1	closed seagrass bed	seagrass bed	open seagrass bed	sparse seagrasses	isolated seagrasses	isolated clumps of seagrasses	seagrasses

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

SITE NAME	LOCATION (GDA94 Z50)		2018	2021
	EASTING (mE)	NORTHING (mN)		
MP01	393444	6517708	x	
MP02	393745	6517344	x	
MP03	394246	6517220	x	
MP04	392992	6517195	x	
MP05	393324	6517185	x	
MP06	394008	6517130	x	
MP07	392482	6517120	x	
MP08	392023	6517073	x	
MP09	391713	6517042	x	
MP10	393760	6516938	x	
MP11	392032	6516904	x	
MP12	393008	6516875	x	
MP13	390896	6516798	x	
MP14	392455	6516732	x	
MP15	391447	6516682	x	
MP16	393497	6516658	x	
MP17	391916	6516639	x	
MP18	392942	6516539	x	
MP19	392344	6516459	x	
MP20	391143	6516456	x	
MP21	393609	6516422	x	
MP22	393262	6516398	x	
MP23	392707	6516299	x	
MP24	391414	6516283	x	
MP25	391982	6516278	x	
MP26	393909	6516199	x	
MP27	393791	6516189	x	
MP28	393098	6516151	x	
MP29	390968	6516121	x	
MP30	393479	6516102	x	
MP31	391895	6516060	x	
MP32	392393	6515930	x	
MP33	391506	6515929	x	
MP34	393597	6515892	x	
MP35	391960	6515837	x	
MP36	391208	6515819	x	
MP37	392797	6515806	x	
MP38	392243	6515778	x	
MP39	393458	6515709	x	
MP40	394406	6515689	x	
MP41	394675	6515671	x	
MP42	393807	6515627	x	
MP43	391687	6515565	x	
MP44	396053	6515474	x	
MP45	393456	6515442	x	
MP46	396184	6515431	x	
MP47	392112	6515390	x	
MP48	394512	6515367		x
MP49	396254	6515154	x	
MP50	393510	6515067	x	
MP51	393335	6515056	x	
MP52	395985	6514978	x	
MP53	391840	6514843		x
MP54	394489	6514702		x

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

SITE NAME	LOCATION (GDA94 Z50)		2018	2021
	EASTING (mE)	NORTHING (mN)		
MP55	394077	6514612		x
MP56	392394	6514561		x
MP57	392943	6514557		x
MP58	391734	6514549		x
MP59	393322	6514277	x	
MP60	392022	6514224		x
MP61	393095	6514196	x	
MP62	392708	6514196		x
MP63	393924	6514160		x
MP64	393514	6513469	x	
MP65	393239	6513465	x	
MP66	392955	6513465	x	
MP67	393073	6513402	x	
MP68	393452	6512744	x	

APPENDIX C: SUMMARY OF VASCULAR PLANT SPECIES WITH THE POTENTIAL TO OCCUR WITHIN THE MUCHEA SURVEY AREA

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a). SCC denotes State Conservation Code; FCC denotes Federal Conservation Code; V denotes Vulnerable; E denotes Endangered and CE denotes Critically Endangered flora species (EPBC Act).

Family	Species	SCC	FCC	Nature Map	EPBC Act
ANARTHRIACEAE	*Lyginia barbata*			x	
APIACEAE	*Eryngium pinnatifidum* subsp. Palustre (G.J. Keighery 13459)	P3		x	
	Xanthosia huegelii			x	
ASPARAGACEAE	*Laxmannia ramosa* subsp. *ramosa*			x	
	Lomandra hermaphrodita			x	
	Thysanotus patersonii			x	
ASTERACEAE	* *Cotula coronopifolia*			x	
	Pithocarpa corymbulosa	P3		x	
	Podolepis gracilis			x	
	Podolepis lessonii			x	
	Rhodanthe spicata			x	
CELASTRACEAE	*Tripterococcus brunonis*			x	
CYPERACEAE	*Eleocharis keigheryi*	T	V		x
	Isolepis producta			x	
	Isolepis stellata			x	
	Lepidosperma rostratum	T	E		x
	Schoenus brevisetis			x	
	Schoenus curvifolius			x	
DASYPOGONACEAE	*Dasypogon bromeliifolius*			x	
DILLENIACEAE	*Hibbertia subvaginata*			x	
DROSERACEAE	*Drosera erythrorhiza*			x	
	Drosera menziesii			x	
ERICACEAE	*Andersonia gracilis*	T	E		x
	Andersonia lehmanniana			x	
	Conostephium minus			x	
	Conostephium pendulum			x	
	Leucopogon conostephioides			x	
	Leucopogon oxycedrus			x	
	Lysinema ciliatum			x	
FABACEAE	*Acacia huegelii*			x	
	Aotus gracillima			x	
	Bossiaea eriocarpa			x	
	Gastrolobium ebracteolatum			x	
	Gompholobium capitatum			x	
	Isotropis cuneifolia			x	
	Isotropis cuneifolia subsp. *glabra*	P2		x	
	Jacksonia floribunda			x	
	* *Ornithopus compressus*			x	
GOODENIACEAE	*Dampiera linearis*			x	
	Scaevola lanceolata			x	

APPENDIX C: SUMMARY OF VASCULAR PLANT SPECIES WITH THE POTENTIAL TO OCCUR WITHIN THE MUCHEA SURVEY AREA

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a). SCC denotes State Conservation Code; FCC denotes Federal Conservation Code; V denotes Vulnerable; E denotes Endangered and CE denotes Critically Endangered flora species (EPBC Act).

Family	Species	SCC	FCC	Nature Map	EPBC Act
HAEMODORACEAE	*Anigozanthos humilis*			x	
	Anigozanthos viridis subsp. *terraspectans*	T	V		x
	Anigozanthos viridis subsp. *viridis*			x	
	Conostylis aculeata subsp. *aculeata*			x	
	Conostylis juncea			x	
	Conostylis setigera subsp. *setigera*			x	
	Phlebocarya ciliata			x	
	Tribonanthes australis			x	
HEMEROCALLIDACEAE	*Hensmania turbinata*			x	
IRIDACEAE	*Patersonia occidentalis*			x	
	* *Romulea obscura*			x	
LAURACEAE	*Cassytha flava*			x	
LENTIBULARIACEAE	*Utricularia multifida*			x	
LYTHRACEAE	* *Lythrum hyssopifolia*			x	
MENYANTHACEAE	*Liparophyllum capitatum*			x	
MYRTACEAE	*Beaufortia elegans*			x	
	Calytrix flavescens			x	
	Chamelaucium sp. Gingin (N.G. Marchant 6)	T	E		x
	Darwinia foetida	T	CE		x
	Scholtzia involucrata			x	
	Verticordia nitens			x	
ORCHIDACEAE	*Caladenia huegelii*	T	E		x
	Diuris purdiei	T	E		x
	Drakaea elastica	T	E		x
	Thelymitra stellata	T	E		x
PITTOSPORACEAE	*Billardiera fraseri*			x	
POACEAE	*Amphipogon turbinatus*			x	
	* *Hainardia cylindrica*			x	
	Sporobolus virginicus			x	
POLYGONACEAE	*Rumex drummondii*	P4		x	
PROTEACEAE	*Banksia attenuata*			x	
	Banksia menziesii			x	
	Conospermum crassinervium			x	
	Grevillea curviloba			x	
	Grevillea curviloba subsp. *curviloba*	T	E		x
	Grevillea curviloba subsp. *incurva*	T	E	x	x
	Grevillea obtusifolia			x	
	Hakea trifurcata			x	
	Petrophile linearis			x	
RESTIONACEAE	*Alexgeorgea nitens*			x	
	Dielsia stenostachya			x	

APPENDIX C: SUMMARY OF VASCULAR PLANT SPECIES WITH THE POTENTIAL TO OCCUR WITHIN THE MUCHEA SURVEY AREA

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a). SCC denotes State Conservation Code; FCC denotes Federal Conservation Code; V denotes Vulnerable; E denotes Endangered and CE denotes Critically Endangered flora species (EPBC Act).

Family	Species	SCC	FCC	Nature Map	EPBC Act
RUTACEAE	*Boronia ramosa*			x	
STYLIDIACEAE	*Stylidium brunonianum*			x	
	Stylidium crossocephalum			x	
	Stylidium diuroides			x	
	Stylidium ecorne			x	
	Stylidium guttatum			x	
	Stylidium piliferum			x	
	Stylidium repens			x	
THYMELAEACEAE	*Pimelea sulphurea*			x	
URTICACEAE	*Parietaria debilis*			x	
VIOLACEAE	*Hybanthus calycinus*			x	

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Andersonia gracilis	Ericaceae	T	Endangered	Habit: Slender erect or open scraggly shrub, growing to 50 cm tall Flower colour: white-pink-purple Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: White/grey sand, sandy clay, gravelly loam. Grows on winter wet areas or near swamps IBRA Distribution: GES, SWA Florabase records: 31	Low Habitat unlikely to occur in survey area.
Anigozanthos viridis subsp. *terraspectans*	Haemodoraceae	T	Vulnerable	Habit: Rhizomatous, perennial herb, growing to 20 cm tall Flower colour: green/yellow-green Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey sand, clay loam. Grows on winter wet depressions IBRA Distribution: GES, SWA Florabase records: 15	Low Habitat potentially occurs in survey area.
Caladenia huegelii	Fabaceae	T	Endangered	Habit: Tuberous perennial herb, growing to 60 cm tall Flower colour: green & cream & red Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey or brown sand, clay loam IBRA Distribution: JAF, SWA Florabase records: 41	Low Habitat potentially occurs in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Chamelaucium lullfitzii	Myrtaceae	T	Endangered	Habit: Erect open branching shrub, growing to 180 cm tall Flower colour: white Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Yellow/Brown-White/grey Sand or sandy gravel, Red brown gravel. Grows on undulating plains or slopes IBRA Distribution: SWA Florabase records: 17	Moderate Habitat potentially occurs in survey area.
Darwinia foetida	Myrtaceae	T	Critically Endangered	Habit: Compact shrub growing to 50 cm tall Flower colour: Green-Pink/Red, Bracts purple /brown Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey/black peaty sand, brown sandy loam. Grows on winter wet areas, plains IBRA Distribution: SWA Florabase records: 21	Moderate Habitat potentially occurs in survey area.
Diuris purdiei	Orchidaceae	T	Endangered	Habit: Tuberous, perennial herb, growing to 35 cm tall Flower colour: Yellow Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey-black sand moist. Grows on winter wet swamps IBRA Distribution: JAF, SWA Florabase records: 26	Low Habitat potentially occurs in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Drakaea elastica	Orchidaceae	T	Endangered	Habit: Tuberous, perennial herb, growing to 30 cm tall Flower colour: red & green & yellow Flowering period (indicated in green): J F M A M J J **A S O N** D ▲ ▲ ▲ ▲ Survey (▲) Soils: White or grey sand. Grows on low-lying situations adjoining winter wet swamps IBRA Distribution: SWA Florabase records: 19	Low Habitat potentially occurs in survey area.
Eleocharis keigheryi	Cyperaceae	T	Vulnerable	Habit: Rhizomatous, clumped perennial sedge, growing to 40 cm tall Flower colour: green Flowering period (indicated in green): J F M A M J J **A S O N** D ▲ ▲ ▲ ▲ Survey (▲) Soils: Clay, sandy loam. Emergent in freshwater: creeks and clay pans IBRA Distribution: AVW, GES, JAF, SWA Florabase records: 57	Moderate Habitat unlikely to occur in survey area.
Grevillea curviloba	Proteaceae	T	Endangered	Habit: prostrate to erect shrub, growing to 250 cm tall Flower colour: white-cream Flowering period (indicated in green): J F M A M J J **A S O** N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey sand, sandy loam. Grows on winter wet heath IBRA Distribution: JAF, SWA Florabase records: 84	Moderate Habitat potentially occurs in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Grevillea thelemanniana	Proteaceae	T	Critically Endangered	Habit: spreading, lignotuberous shrub, growing to 150 cm tall Flower colour: pink-red Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Sand, sandy clay. Grows on winter wet low lying flats IBRA Distribution: JAF, SWA Florabase records: 37	Low Habitat potentially occurs in survey area.
Lepidosperma rostratum	Cyperaceae	T	Endangered	Habit: Rhizomatous, tufted perennial sedge, growing to 50 cm tall Flower colour: brown Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Peaty sand, clay. IBRA Distribution: SWA Florabase records: 34	Low Habitat unlikely to occur in survey area.
Macarthuria keigheryi	Macarthuriaceae	T	Endangered	Habit: Erect or spreading perennial herb or shrub, growing to 40 cm tall Flower colour: white-green Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: White or grey sand IBRA Distribution: GES, SWA Florabase records: 30	Moderate Habitat potentially occurs in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Thelymitra stellata	Orchidaceae	T	Endangered	Habit: Tuberous, perennial herb, growing to 25 cm tall Flower colour: yellow & brown Flowering period (indicated in green): J F M A M J J **A S O N** D ▲ ▲ ▲ ▲ Survey (▲) Soils: sand, gravel, lateritic loam IBRA Distribution: GES, JAF, SWA Florabase records: 20	Low Habitat unlikely to occur in survey area.
Grevillea evanescens	Proteaceae	P1	-	Habit: Erect, robust shrub, growing to 400 cm tall Flower colour: red Flowering period (indicated in green): J F M A M J **J A S** O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Brown sandy/clay loam. Grows on winter wet flats IBRA Distribution: SWA Florabase records: 17	Low Habitat unlikely to occur in survey area.
Leucopogon squarrosus subsp. *trigynus*	Ericaceae	P2	-	Habit: Open, multi-stemmed shrub, growing to 100 cm tall Flower colour: white Flowering period (indicated in green): J F M A M **J J** A **S O** N D ▲ ▲ ▲ ▲ Survey (▲) Soils: White/Grey sand IBRA Distribution: SWA Florabase records: 20	Moderate Habitat potentially occurs in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Acacia drummondii subsp. *affinis*	Fabaceae	P3	-	Habit: Erect shrub, growing to 100 cm tall Flower colour: yellow Flowering period (indicated in green): J F M A M J **J** **A** S O N D; ▲ ▲ ▲ ▲ Survey (▲) Soils: Lateritic gravelly soils IBRA Distribution: AVW, JAF, SWA Florabase records: 37	Low Habitat unlikely to occur in survey area.
Cyathochaeta teretifolia	Cyperaceae	P3	-	Habit: Rhizomatous, clumped, robust, perennial sedge, growing to 200 cm tall Flower colour: brown Flowering period (indicated in green): **J** F M A M J J A S O N D; ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey sand, sandy clay. Grows on swamps, creek edges IBRA Distribution: JAF, SWA, WAR Florabase records: 39	Low Habitat potentially occurs in survey area.
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	Apiaceae	P3	-	Habit: Tuberous, perennial herb, growing to 30 cm tall Flower colour: blue-white Flowering period (indicated in green): J F M A M J J A **S** **O** **N** D; ▲ ▲ ▲ ▲ Survey (▲) Soils: Grey/black sand, brown/grey clay. Grows on winter wet flats, clay pans IBRA Distribution: SWA Florabase records: 11	Low Habitat unlikely to occur in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

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Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Isotropis cuneifolia subsp. *glabra*	Fabaceae	P3	-	Habit: Prostrate to ascending, spreading perennial herb or shrub, growing to 15 cm tall Flower colour: yellow/orange & red Flowering period (indicated in green): J F M A M J J A **S** O N D; Survey (▲): ▲ ▲ ▲ ▲ Soils: Sand, clay loam. Grows on winter wet flats IBRA Distribution: AVW, SWA Florabase records: 19	Low Habitat potentially occurs in survey area.
Meionectes tenuifolia	Haloragaceae	P3	-	Habit: Erect, semi aquatic herb, growing to 25 cm tall Flower colour: red/orange, cream-green Flowering period (indicated in green): J F M A M J J A **S** **O** **N** D; Survey (▲): ▲ ▲ ▲ ▲ Soils: Grey-brown sandy clay. Grows on inundated winter wet depressions, swamp edge and granite pools IBRA Distribution: JAF, SWA Florabase records: 26	Low Habitat potentially occurs in survey area.
Myriophyllum echinatum	Haloragaceae	P3	-	Habit: Erect annual herb, growing to 3 cm tall Flower colour: red Flowering period (indicated in green): J F M A M J J A S O **N** D; Survey (▲): ▲ ▲ ▲ ▲ Soils: Clay. Grows on winter wet flats IBRA Distribution: JAF, SWA Florabase records: 19	Low Habitat unlikely to occur in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

Note: Refer to Appendix A for State (SCC; Department of Biodiversity, Conservation and Attractions 2019) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: AVW – Avon Wheatbelt; ESP – Esperance Plains; GES – Geraldton Sandplains, JAF – Jarrah Forest; SWA – Swan Coastal Plain. Likelihood of occurrence in survey area is based on a Low, Moderate or High ranking.

Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Pithocarpa corymbulosa	Asteraceae	P3	-	Habit: Erect to scrambling, perennial herb, growing to 100 cm tall Flower colour: white Flowering period (indicated in green): J F M A M J J A S O N D Survey (▲): ▲ ▲ ▲ ▲ Soils: Gravelly or sandy loam. Grows amongst granite outcrops IBRA Distribution: GES, JAF, SWA Florabase records: 22	Low Habitat unlikely to occur in survey area.
Verticordia serrata var. *linearis*	Myrtaceae	P3	-	Habit: Shrub, growing to 100 cm tall Flower colour: yellow Flowering period (indicated in green): J F M A M J J A S O N D Survey (▲): ▲ ▲ ▲ ▲ Soils: White sand, gravel. Grows on open woodland IBRA Distribution: JAF, SWA Florabase records: 21	Low Habitat potentially occurs in survey area.
Jacksonia sericea	Fabaceae	P4	-	Habit: Low spreading shrub, growing to 60 cm tall Flower colour: orange Flowering period (indicated in green): J F M A M J J A S O N D Survey (▲): ▲ ▲ ▲ ▲ Soils: Calcareous and sandy soils IBRA Distribution: SWA Florabase records: 61	Low Habitat unlikely to occur in survey area.

APPENDIX D: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE MUCHEA SURVEY AREA

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Species	Family	SCC	FCC	Description and Habitat	Likelihood of Occurrence
Rumex drummondii	Polygonaceae	P4	-	Habit: Erect, perennial herb, growing to 90 cm tall Flower colour: Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Black pearty sand. Grows on winter wet disturbed areas IBRA Distribution: AVW, ESP, JAF, SWA Florabase records: 19	Low Habitat unlikely to occur in survey area.
Stylidium longitubum	Stylidiaceae	P4	-	Habit: Erect annual (ephemeral), herb, 0.05-0.12 m high. Flower colour: pink Flowering period (indicated in green): J F M A M J J A S O N D ▲ ▲ ▲ ▲ Survey (▲) Soils: Sandy clay, clay. Seasonal wetlands IBRA Distribution: GES, JAF, SWA Florabase records: 47	Low Habitat unlikely to occur in survey area.

APPENDIX E: SUMMARY OF VASCULAR PLANT SPECIES RECORDED AT MAPPING SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a).

Family	Species
ANARTHRIACEAE	*Lyginia barbata*
	Lyginia imberbis
APIACEAE	*Xanthosia huegelii*
	Xanthosia sp.
ARALIACEAE	*Trachymene pilosa*
	Trachymene sp.
ASPARAGACEAE	*Laxmannia omnifertilis*
	Laxmannia ramosa subsp. *ramosa*
	Lomandra caespitosa
	Lomandra effusa
	Lomandra hermaphrodita
	Lomandra preissii
	Lomandra sp.
	Thysanotus manglesianus
	Thysanotus sp.
ASTERACEAE	*Hyalosperma cotula*
	* *Hypochaeris glabra*
	Millotia myosotidifolia
	Olearia paucidentata
	Pithocarpa pulchella var. *pulchella*
	Siloxerus humifusus
	* *Ursinia anthemoides* subsp. *anthemoides*
	Waitzia ?*suaveolens*
	* *Asteraceae* sp.
CAMPANULACEAE	*Lobelia rhytidosperma*
CASUARINACEAE	*Allocasuarina humilis*
CELASTRACEAE	*Tripterococcus brunonis*
CENTROLEPIDACEAE	*Centrolepis inconspicua*
COLCHICACEAE	*Burchardia congesta*
CRASSULACEAE	*Crassula colorata* var. *colorata*
CYPERACEAE	*Chaetospora curvifolia*
	Isolepis marginata
	Lepidosperma drummondii
	Lepidosperma sp.
	Morelotia sp.
	Schoenus brevisetis sens. lat.
	Schoenus caespititius
	Schoenus ?*clandestinus*
	Schoenus sp.
	Cyperaceae sp.
DASYPOGONACEAE	*Dasypogon bromeliifolius*
DILLENIACEAE	*Hibbertia aurea*
	Hibbertia huegelii
	Hibbertia hypericoides subsp. *hypericoides*
	Hibbertia sericosepala
	Hibbertia subvaginata
	Hibbertia sp.

APPENDIX E: SUMMARY OF VASCULAR PLANT SPECIES RECORDED AT MAPPING SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a).

Family	Species
DROSERACEAE	*Drosera drummondii*
	Drosera erythrorhiza
	Drosera macrantha
	Drosera sp.
	Drosera sp. (climbing)
ELAEOCARPACEAE	*Platytheca galioides*
ERICACEAE	*Andersonia heterophylla*
	Andersonia lehmanniana
	Andersonia lehmanniana subsp. *lehmanniana*
	Andersonia sp.
	Brachyloma preissii
	Conostephium minus
	Conostephium pendulum
	Leucopogon polymorphus
	Lysinema pentapetalum
	Styphelia conostephioides
	Styphelia erubescens
	Styphelia pallida
	Styphelia propinqua
	Styphelia xerophylla
EUPHORBIACEAE	*Monotaxis grandiflora*
	Monotaxis occidentalis
	Stachystemon axillaris
FABACEAE	*Acacia barbinervis*
	Acacia barbinervis subsp. *borealis*
	Acacia huegelii
	Acacia pulchella
	Acacia pulchella var. *glaberrima*
	Acacia pulchella var. *goadbyi*
	Acacia saligna
	Aotus procumbens
	Bossiaea eriocarpa
	Daviesia physodes
	Daviesia podophylla
	Daviesia triflora
	Daviesia sp.
	Gastrolobium capitatum
	Gastrolobium linearifolium
	Gastrolobium oxylobioides
	Gastrolobium plicatum
	Gompholobium confertum
	Gompholobium tomentosum
	Hovea pungens
	Hovea trisperma
	Jacksonia floribunda
	Jacksonia furcellata
	* *Medicago* sp.
GOODENIACEAE	*Dampiera linearis*
	Lechenaultia biloba
	Lechenaultia ?*expansa*
	Lechenaultia floribunda
	Scaevola repens
	Scaevola sp.
	Goodeniaceae sp.

APPENDIX E: SUMMARY OF VASCULAR PLANT SPECIES RECORDED AT MAPPING SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a).

Family	Species
GYROSTEMONACEAE	*Gyrostemon ramulosus*
HAEMODORACEAE	*Anigozanthos humilis*
	Anigozanthos humilis subsp. *humilis*
	Anigozanthos sp.
	Conostylis aculeata subsp. ?*aculeata*
	Conostylis aculeata subsp. *bromelioides*
	Conostylis juncea
	Conostylis sp.
	Haemodorum sp.
	Phlebocarya ciliata
	Phlebocarya filifolia
	Phlebocarya sp.
HALORAGACEAE	*Gonocarpus pithyoides*
	Gonocarpus ?*cordiger*
HEMEROCALLIDACEAE	*Tricoryne tenella*
IRIDACEAE	* *Gladiolus caryophyllaceus*
	* *Gladiolus* sp.
	Patersonia occidentalis
LAURACEAE	*Cassytha flava*
	Cassytha glabella forma glabella
	Cassytha pomiformis
	Cassytha sp.
LOGANIACEAE	*Phyllangium divergens*
	Phyllangium paradoxum
	Phyllangium sp.
LORANTHACEAE	*Nuytsia floribunda*
MOLLUGINACEAE	*Macarthuria apetala*
MYRTACEAE	*Astartea* sp.
	Beaufortia elegans
	Beaufortia sp.
	Beaufortia squarrosa
	Calytrix angulata
	Calytrix flavescens
	Calytrix fraseri
	Calytrix sapphirina
	Eremaea asterocarpa
	Eremaea pauciflora
	Eremaea pauciflora var. *calyptra*
	Eucalyptus marginata
	Eucalyptus rudis subsp. *rudis*
	Eucalyptus todtiana
	Eucalyptus sp.
	Hypocalymma angustifolium
	Kunzea glabrescens
	Leptospermum oligandrum
	Leptospermum spinescens
	Melaleuca parviceps
	Melaleuca preissiana
	Melaleuca rhaphiophylla
	Melaleuca seriata

APPENDIX E: SUMMARY OF VASCULAR PLANT SPECIES RECORDED AT MAPPING SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a).

Family	Species
MYRTACEAE (continued)	*Melaleuca trichophylla* *Melaleuca viminea* subsp. *viminea* *Melaleuca* sp. *Regelia ciliata* *Regelia inops* *Scholtzia involucrata* *Verticordia nitens* *Verticordia ovalifolia* *Verticordia* sp. *Myrtaceae* sp.
ORCHIDACEAE	*Caladenia flava* *Caladenia* sp. *Elythranthera brunonis* *Pterostylis* sp. *Pterostylis vittata* *Pyrorchis nigricans* ?*Pyrorchis* sp. *Thelymitra campanulata* *Orchidaceae* sp.
PHYLLANTHACEAE	*Poranthera ericoides*
POACEAE	* *Aira cupaniana* *Austrostipa macalpinei* *Austrostipa trichophylla* * *Pentameris* sp. *Rytidosperma occidentale* *Poaceae* sp.
PORTULACACEAE	*Calandrinia liniflora*
PRIMULACEAE	?*Samolus repens*
PROTEACEAE	*Adenanthos cygnorum* *Adenanthos cygnorum* subsp. *cygnorum* *Banksia attenuata* *Banksia ilicifolia* *Banksia menziesii* *Banksia* sp. *Conospermum stoechadis* subsp. *stoechadis* *Persoonia comata* *Petrophile linearis* *Stirlingia latifolia* *Stirlingia simplex*
RESTIONACEAE	*Alexgeorgea nitens* *Chordifex microcodon* *Desmocladus flexuosus* *Desmocladus* sp. *Hypolaena exsulca* *Restionaceae* sp.
RUTACEAE	*Boronia purdieana* subsp. *purdieana* *Boronia* sp. *Cyanothamnus ramosus* subsp. *anethifolius* *Philotheca spicata* *Rutaceae* sp.
SANTALACEAE	*Leptomeria cunninghamii*

APPENDIX E: SUMMARY OF VASCULAR PLANT SPECIES RECORDED AT MAPPING SITES WITHIN THE MUCHEA SURVEY AREA, 2018 AND 2021

Note: * denotes introduced species; T denotes threatened flora and P1-P4 denote priority flora species (DBCA 2019a).

Family	Species
SANTALACEAE (continued)	*Leptomeria empetriformis* *Leptomeria pauciflora*
STYLIDIACEAE	*Levenhookia* sp. *Stylidium adpressum* *Stylidium amoenum* *Stylidium araeophyllum* *Stylidium brunonianum* *Stylidium crossocephalum* *Stylidium diuroides* *Stylidium diuroides* subsp. *diuroides* *Stylidium junceum* *Stylidium ?miniatum* *Stylidium neurophyllum* *Stylidium piliferum* *Stylidium repens* *Stylidium rigidulum* *Stylidium scariosum* *Stylidium* sp. *Stylidium spiciforme*
XANTHORRHOEACEAE	*Xanthorrhoea brunonis* *Xanthorrhoea gracilis* *Xanthorrhoea preissii*
ZAMIACEAE	*Macrozamia fraseri*

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

SPECIES	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33	MP34	MP35	MP36
Acacia barbinervis																																				
Acacia barbinervis subsp. *borealis*																																				
Acacia huegelii	x	x			x															x															
Acacia pulchella																																				
Acacia pulchella var. *glaberrima*				x			x	x	x				x		x		x	x			x				x				x		x				x
Acacia pulchella var. *goadbyi*																						x														
Acacia saligna											x																									
Adenanthos cygnorum																																				
Adenanthos cygnorum subsp. *cygnorum*																																		x		
* *Aira cupaniana*																																	x			
Alexgeorgea nitens	x			x	x		x	x	x					x	x	x	x	x	x	x			x	x	x	x	x		x			x		x	
Allocasuarina humilis	x									x										x			x		x							x				
Andersonia heterophylla		x		x				x				x	x	x	x	x	x											x			x			x	x	
Andersonia lehmanniana																																				
Andersonia lehmanniana subsp. *lehmanniana*					x		x	x							x	x	x								x											
Andersonia sp.																																				
Anigozanthos humilis													x										x													
Anigozanthos humilis subsp. *humilis*																																				
Anigozanthos sp.												x				x		x	x		x							x								
Aotus procumbens											x																						x	x		
Astartea sp.																																				
* Asteraceae sp.		x				x																			x	x	x									
Austrostipa macalpinei																																				
Austrostipa trichophylla																																				
Banksia attenuata	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x			x	x	x	x			x	x	
Banksia ilicifolia		x								x																										
Banksia menziesii	x			x	x			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Banksia sp.			x																			x														
Beaufortia elegans		x		x	x		x	x	x	x		x	x	x	x		x	x			x	x		x			x	x	x	x				x	x	x
Beaufortia squarrosa																																				
Beaufortia sp.											x																									
Boronia purdieana subsp. *purdieana*																																				
Boronia sp.																																				
Bossiaea eriocarpa	x		x	x	x		x		x	x		x		x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x
Brachyloma preissii																																				
Burchardia congesta	x	x		x						x				x		x	x		x		x		x				x		x	x	x	x			x
Caladenia flava													x														x									
Caladenia sp.	x			x																																
Calandrinia liniflora																																				
Calytrix angulata					x			x	x																											

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

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SPECIES	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33	MP34	MP35	MP36
Calytrix flavescens				x			x			x		x		x	x	x	x	x	x	x	x		x	x	x			x	x	x	x	x			x	x
Calytrix fraseri																																				
Calytrix sapphirina													x							x									x							
Cassytha flava																							x													
Cassytha glabella forma *glabella*													x																							
Cassytha pomiformis												x						x		x	x			x			x		x	x						
Cassytha sp.					x																											x				x
Centrolepis inconspicua										x																										
Chaetospora curvifolia																								x												
Chordifex microcodon				x																																
Conospermum stoechadis subsp. *stoechadis*																																				
Conostephium minus		x		x			x			x		x			x	x	x	x	x					x				x	x	x	x			x	x	
Conostephium pendulum	x	x		x	x		x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x		x				x
Conostylis aculeata subsp. ?*aculeata*																																x				
Conostylis aculeata subsp. *bromelioides*	x																																			
Conostylis juncea		x		x						x		x									x	x	x	x			x	x								x
Conostylis sp.																x																				
Crassula colorata var. *colorata*																					x								x							
Cyanothamnus ramosus subsp. *anethifolius*	x				x	x					x		x							x		x			x		x									
Cyperaceae sp.																																				
Dampiera linearis															x	x	x		x	x				x					x		x	x			x	x
Dasypogon bromeliifolius		x	x			x					x					x					x	x		x		x		x			x		x		x	x
Daviesia physodes																																				
Daviesia podophylla															x									x												
Daviesia triflora																													x			x				
Daviesia sp.																																				
Desmocladus flexuosus	x									x						x					x				x		x									
Desmocladus sp.			x																																	
Drosera drummondii	x								x	x				x				x					x					x		x						
Drosera erythrorhiza					x																															
Drosera macrantha																																				
Drosera sp.	x	x	x	x		x	x	x	x	x		x		x	x			x		x	x	x	x		x			x		x		x		x		
Drosera sp. (climbing)				x	x		x				x	x			x	x	x		x		x														x	
Elythranthera brunonis																																				
Eremaea asterocarpa																																				
Eremaea pauciflora				x			x	x	x	x		x	x	x		x		x	x	x	x	x	x		x		x	x		x	x	x				x
Eremaea pauciflora var. *calyptra*															x		x							x					x						x	
Eucalyptus marginata																																				
Eucalyptus rudis subsp. *rudis*																																				
Eucalyptus todtiana					x													x			x	x					x		x			x				
Eucalyptus sp.										x																										

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

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SPECIES	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33	MP34	MP35	MP36
Gastrolobium capitatum							x	x	x			x	x			x		x					x		x					x						
Gastrolobium linearifolium																																				
Gastrolobium oxylobioides					x																															
Gastrolobium plicatum															x		x																			x
* *Gladiolus caryophyllaceus*	x																																			
* *Gladiolus* sp.							x																				x									
Gompholobium confertum																																				
Gompholobium tomentosum	x			x	x	x		x	x		x	x		x	x			x		x	x	x		x		x	x	x	x	x	x	x		x	x	
Gonocarpus ?cordiger													x																							
Gonocarpus pithyoides																																				
Goodeniaceae sp.																																				
Gyrostemon ramulosus																																				
Haemodorum sp.									x													x														
Hibbertia aurea												x	x							x			x							x						
Hibbertia huegelii	x			x		x	x		x	x		x	x	x			x		x		x		x	x	x	x	x	x	x	x	x	x		x		
Hibbertia hypericoides subsp. *hypericoides*																													x							
Hibbertia sericosepala					x						x																									
Hibbertia subvaginata				x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x
Hibbertia sp.		x	x			x	x					x	x	x	x		x					x														
Hovea pungens																																				
Hovea trisperma																																				
Hyalosperma cotula																																				
Hypocalymma angustifolium																																				
* *Hypochaeris glabra*																																	x			
Hypolaena exsulca																							x		x			x		x	x		x	x	x	x
Isolepis marginata		x																x			x					x	x									
Jacksonia floribunda	x	x		x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Jacksonia furcellata																																	x			
Kunzea glabrescens			x			x																				x							x			
Laxmannia omnifertilis																																				
Laxmannia ramosa subsp. *ramosa*		x																																		
Lechenaultia biloba	x												x								x				x	x	x		x							
Lechenaultia ?expansa																																				
Lechenaultia floribunda																																				
Lepidosperma drummondii																																				
Lepidosperma sp.					x				x																								x			
Leptomeria cunninghamii																																				
Leptomeria empetriformis																	x		x	x					x					x	x	x			x	
Leptomeria pauciflora							x																x													x
Leptospermum oligandrum																																				
Leptospermum spinescens																x																				

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

SPECIES	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33	MP34	MP35	MP36
Leucopogon polymorphus								x			x								x		x				x					x	x	x				
Levenhookia sp.																																				
Lobelia rhytidosperma																																				
Lomandra caespitosa																																				
Lomandra effusa																																				
Lomandra hermaphrodita				x	x		x	x	x		x	x				x			x	x						x		x		x				x		
Lomandra preissii																																				
Lomandra sp.			x		x											x	x		x				x								x					
Lyginia barbata	x			x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x
Lyginia imberbis												x						x		x									x						x
Lysinema pentapetalum									x		x					x						x						x								x
Macarthuria apetala																																				
Macrozamia fraseri																																				
* *Medicago* sp.																																				
Melaleuca parviceps																																				
Melaleuca preissiana			x			x					x																					x				
Melaleuca rhaphiophylla																																				
Melaleuca seriata																																				
Melaleuca trichophylla	x	x			x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x			x	x
Melaleuca viminea subsp. *viminea*																																				
Melaleuca sp.	x															x				x					x											
Millotia myosotidifolia																																	x			
Monotaxis grandiflora																																				
Monotaxis occidentalis			x																																	
Morelotia sp.							x																								x					
Myrtaceae sp.																																				
Nuytsia floribunda							x																			x	x									
Olearia paucidentata																																				
Orchidaceae sp.	x		x											x										x												
Patersonia occidentalis		x		x	x		x	x	x	x		x	x	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x			x	x
* *Pentameris* sp.																																				
Persoonia comata															x																		x			
Petrophile linearis	x			x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x			x	x
Philotheca spicata							x	x		x		x		x	x		x	x			x		x	x			x	x	x	x	x			x	x
Phlebocarya ciliata		x								x		x	x			x					x		x	x			x	x	x	x	x	x	x	x		
Phlebocarya filifolia																																				
Phlebocarya sp.																																				
Phyllangium divergens										x		x																	x	x						
Phyllangium paradoxum																	x		x															x		
Phyllangium sp.	x		x																																x	
Pithocarpa pulchella var. *pulchella*																																				

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

SPECIES	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33	MP34	MP35	MP36
Platytheca galioides				x							x																						x			
Poaceae sp.	x																										x									
Poranthera ericoides												x																								
Pterostylis sp.		x																																		
Pterostylis vittata	x																																			
Pyrorchis nigricans		x																								x								x		
?*Pyrorchis* sp.																																				
Regelia ciliata																																				
Regelia inops																																				
Restionaceae sp.							x												x				x											x		
Rutaceae sp.																																				
Rytidosperma occidentale																																				
?*Samolus repens*	x																																			
Scaevola repens																																				
Scaevola sp.																									x											
Schoenus ?*clandestinus*					x				x				x																							
Schoenus brevisetis sens. lat.																																				
Schoenus caespititius											x				x	x	x							x						x				x		x
Schoenus sp.		x		x			x			x		x									x		x													x
Scholtzia involucrata	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Siloxerus humifusus																																	x			
Stachystemon axillaris																				x																
Stirlingia latifolia	x									x													x													x
Stirlingia simplex																																				
Stylidium adpressum																																				
Stylidium amoenum													x																							
Stylidium araeophyllum																															x	x				
Stylidium brunonianum																																				
Stylidium crossocephalum																			x																	
Stylidium diuroides																																				
Stylidium diuroides subsp. *diuroides*																			x										x		x					
Stylidium junceum																																				
Stylidium ?*miniatum*																																				
Stylidium neurophyllum																																				x
Stylidium piliferum															x		x		x					x												x
Stylidium repens														x	x		x	x		x				x			x								x	x
Stylidium rigidulum																													x			x				
Stylidium scariosum																																x				
Stylidium spiciforme																													x							
Stylidium sp.	x	x				x			x	x	x					x			x	x			x						x					x		
Styphelia conostephioides	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x	x	

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

SPECIES	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09	MP10	MP11	MP12	MP13	MP14	MP15	MP16	MP17	MP18	MP19	MP20	MP21	MP22	MP23	MP24	MP25	MP26	MP27	MP28	MP29	MP30	MP31	MP32	MP33	MP34	MP35	MP36
Styphelia erubescens												x			x	x	x											x						x	
Styphelia pallida																																				
Styphelia propinqua																																				
Styphelia xerophylla												x																								
Thelymitra campanulata																												x								
Thysanotus manglesianus																													x			x				
Thysanotus sp.																																				
Trachymene pilosa																																	x			
Trachymene sp.	x	x	x			x																					x									
Tricoryne tenella																																				
Tripterococcus brunonis																																				
* *Ursinia anthemoides* subsp. *anthemoides*		x				x															x	x					x						x			
Verticordia nitens	x	x	x	x	x		x	x	x		x	x	x	x		x	x		x			x			x	x		x	x	x				x	x	
Verticordia ovalifolia																																				
Verticordia sp.																x																				
Waitzia ?suaveolens						x																														
Xanthorrhoea brunonis	x		x			x																														
Xanthorrhoea gracilis		x				x	x																x			x					x			x		
Xanthorrhoea preissii		x	x			x			x		x												x			x			x		x		x	x	x
Xanthosia huegelii																																	x			x
Xanthosia sp.																				x																

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

	SPECIES	MP37	MP38	MP39	MP40	MP41	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP50	MP51	MP52	MP53	MP54	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP67	MP68
	Acacia barbinervis																										x				x		
	Acacia barbinervis subsp. *borealis*											x																					x
	Acacia huegelii			x										x		x																	
	Acacia pulchella																			x		x	x		x								
	Acacia pulchella var. *glaberrima*			x			x								x														x	x	x	x	
	Acacia pulchella var. *goadbyi*																																
	Acacia saligna								x																								
	Adenanthos cygnorum																			x					x								
	Adenanthos cygnorum subsp. *cygnorum*				x	x									x									x		x					x		
*	*Aira cupaniana*																																
	Alexgeorgea nitens		x									x			x					x	x	x	x		x	x	x			x	x	x	
	Allocasuarina humilis							x															x							x		x	
	Andersonia heterophylla		x													x																	
	Andersonia lehmanniana																				x							x					
	Andersonia lehmanniana subsp. *lehmanniana*																									x							
	Andersonia sp.	x																															
	Anigozanthos humilis																	x				x	x		x		x	x					
	Anigozanthos humilis subsp. *humilis*																									x							
	Anigozanthos sp.		x	x				x				x	x																				
	Aotus procumbens																																
	Astartea sp.								x																								
*	Asteraceae sp.								x					x										x									
	Austrostipa macalpinei												x																				
	Austrostipa trichophylla												x						x			x	x		x			x					
	Banksia attenuata	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Banksia ilicifolia				x	x											x																
	Banksia menziesii	x	x	x	x	x	x	x		x		x	x		x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
	Banksia sp.									x																							
	Beaufortia elegans						x	x		x					x									x		x			x	x	x		
	Beaufortia squarrosa												x					x	x	x	x	x	x		x		x	x					
	Beaufortia sp.					x																											
	Boronia purdieana subsp. *purdieana*															x								x		x							
	Boronia sp.														x																		
	Bossiaea eriocarpa	x	x	x	x		x	x		x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Brachyloma preissii																																
	Burchardia congesta		x		x							x				x					x	x					x	x					
	Caladenia flava						x																								x	x	
	Caladenia sp.																x							x						x	x		
	Calandrinia liniflora																																
	Calytrix angulata																							x		x				x	x	x	

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

SPECIES	MP37	MP38	MP39	MP40	MP41	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP50	MP51	MP52	MP53	MP54	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP67	MP68
Calytrix flavescens	x	x	x	x		x	x		x		x						x		x	x	x	x		x		x	x	x				x
Calytrix fraseri												x																				
Calytrix sapphirina																																
Cassytha flava			x												x																	
Cassytha glabella forma *glabella*																																
Cassytha pomiformis						x																										
Cassytha sp.				x								x		x					x		x			x		x					x	
Centrolepis inconspicua																																
Chaetospora curvifolia																				x						x						x
Chordifex microcodon																																
Conospermum stoechadis subsp. *stoechadis*																													x			
Conostephium minus				x			x																x	x								x
Conostephium pendulum	x	x	x	x	x	x	x		x		x		x	x	x		x	x	x	x	x	x		x		x		x	x	x		
Conostylis aculeata subsp. ?*aculeata*							x																									
Conostylis aculeata subsp. *bromelioides*						x																										
Conostylis juncea	x			x													x			x								x	x			
Conostylis sp.																																
Crassula colorata var. *colorata*						x	x																									
Cyanothamnus ramosus subsp. *anethifolius*			x	x		x	x					x	x				x		x		x	x		x	x	x	x	x		x		x
Cyperaceae sp.					x																											
Dampiera linearis		x									x						x			x				x								
Dasypogon bromeliifolius	x	x	x	x							x		x			x	x		x	x	x	x		x		x	x	x	x			x
Daviesia physodes																								x								
Daviesia podophylla																																
Daviesia triflora																	x								x					x		
Daviesia sp.																															x	
Desmocladus flexuosus			x									x								x	x			x		x						
Desmocladus sp.																																
Drosera drummondii																																
Drosera erythrorhiza														x				x				x	x		x				x	x	x	
Drosera macrantha				x																								x				x
Drosera sp.	x			x		x					x		x		x				x							x	x					x
Drosera sp. (climbing)	x						x					x							x	x		x		x					x	x	x	
Elythranthera brunonis	x																															
Eremaea asterocarpa																																
Eremaea pauciflora	x	x	x			x			x		x			x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Eremaea pauciflora var. *calyptra*							x																									
Eucalyptus marginata																												x				
Eucalyptus rudis subsp. *rudis*										x																						
Eucalyptus todtiana				x		x	x					x		x	x								x	x		x			x			
Eucalyptus sp.																																

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

	SPECIES	MP37	MP38	MP39	MP40	MP41	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP50	MP51	MP52	MP53	MP54	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP67	MP68
	Gastrolobium capitatum			x			x			x		x				x																
	Gastrolobium linearifolium																				x				x			x					
	Gastrolobium oxylobioides																																
	Gastrolobium plicatum																																
*	*Gladiolus caryophyllaceus*																																
*	*Gladiolus* sp.				x									x																			
	Gompholobium confertum																								x								
	Gompholobium tomentosum			x	x		x	x					x										x						x				
	Gonocarpus ?cordiger														x									x		x							
	Gonocarpus pithyoides																			x													
	Goodeniaceae sp.																									x							
	Gyrostemon ramulosus							x																									
	Haemodorum sp.									x																						x	
	Hibbertia aurea	x	x	x						x																							
	Hibbertia huegelii											x	x			x		x	x	x	x	x	x	x	x		x	x					
	Hibbertia hypericoides subsp. *hypericoides*						x	x							x	x		x						x	x	x	x			x	x		
	Hibbertia sericosepala														x		x									x				x	x	x	
	Hibbertia subvaginata	x	x	x	x	x	x	x				x	x	x	x	x	x	x		x		x	x	x	x		x		x		x		x
	Hibbertia sp.																																x
	Hovea pungens							x								x																	
	Hovea trisperma													x																			
	Hyalosperma cotula																						x										
	Hypocalymma angustifolium																x																
*	*Hypochaeris glabra*										x						x																
	Hypolaena exsulca		x													x					x	x	x		x		x						
	Isolepis marginata						x	x																									
	Jacksonia floribunda	x	x		x		x	x		x		x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Jacksonia furcellata					x					x																						
	Kunzea glabrescens					x					x						x								x								
	Laxmannia omnifertilis																					x											
	Laxmannia ramosa subsp. *ramosa*																																
	Lechenaultia biloba						x								x	x										x					x	x	x
	Lechenaultia ?expansa							x																									
	Lechenaultia floribunda																			x		x		x			x	x					
	Lepidosperma drummondii																																
	Lepidosperma sp.																																
	Leptomeria cunninghamii																	x		x	x	x	x										
	Leptomeria empetriformis	x	x									x																					
	Leptomeria pauciflora											x										x											
	Leptospermum oligandrum																				x												
	Leptospermum spinescens																																

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SPECIES	MP37	MP38	MP39	MP40	MP41	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP50	MP51	MP52	MP53	MP54	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP67	MP68
Leucopogon polymorphus	x	x							x						x		x	x			x	x		x							x
Levenhookia sp.																	x															
Lobelia rhytidosperma																	x			x	x											
Lomandra caespitosa																												x				
Lomandra effusa																	x			x		x		x								
Lomandra hermaphrodita		x									x	x										x				x	x	x	x			
Lomandra preissii																				x				x								
Lomandra sp.		x						x	x		x		x	x		x													x			
Lyginia barbata	x	x	x			x	x		x		x			x	x								x		x			x		x	x	
Lyginia imberbis	x											x					x	x	x	x	x	x		x		x	x					
Lysinema pentapetalum	x											x								x		x		x		x	x		x			
Macarthuria apetala																											x					x
Macrozamia fraseri												x																	x			
* *Medicago* sp.										x						x																
Melaleuca parviceps																															x	
Melaleuca preissiana					x			x		x						x						x										
Melaleuca rhaphiophylla										x																						
Melaleuca seriata																		x														
Melaleuca trichophylla	x	x	x	x			x		x		x	x		x	x		x	x	x	x	x	x		x	x	x	x		x	x	x	x
Melaleuca viminea subsp. *viminea*								x		x																						
Melaleuca sp.			x												x																	x
Millotia myosotidifolia																																
Monotaxis grandiflora																											x					
Monotaxis occidentalis																												x				
Morelotia sp.																																
Myrtaceae sp.		x																														
Nuytsia floribunda				x								x		x	x									x			x			x	x	
Olearia paucidentata			x																													
Orchidaceae sp.			x																													
Patersonia occidentalis	x	x		x		x	x		x			x	x	x	x	x	x	x		x	x	x	x	x		x	x		x	x	x	x
* *Pentameris* sp.										x						x							x									
Persoonia comata																	x		x	x	x			x		x					x	
Petrophile linearis	x	x	x	x			x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Philotheca spicata		x	x			x	x				x	x		x	x	x		x	x		x	x	x				x	x	x			
Phlebocarya ciliata		x									x																	x	x	x	x	x
Phlebocarya filifolia																	x			x	x			x		x	x					
Phlebocarya sp.								x																								
Phyllangium divergens																																
Phyllangium paradoxum																			x		x											
Phyllangium sp.																																
Pithocarpa pulchella var. *pulchella*																															x	

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SPECIES	MP37	MP38	MP39	MP40	MP41	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP50	MP51	MP52	MP53	MP54	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP67	MP68
Platytheca galioides																																
Poaceae sp.								x																							x	
Poranthera ericoides																																
Pterostylis sp.																													x			
Pterostylis vittata																																
Pyrorchis nigricans						x										x																x
?*Pyrorchis* sp.													x																			
Regelia ciliata																x																
Regelia inops																						x		x								
Restionaceae sp.																																
Rutaceae sp.																							x						x	x	x	
Rytidosperma occidentale																						x										
?*Samolus repens*																																
Scaevola repens																	x							x								
Scaevola sp.																																
Schoenus ?*clandestinus*														x		x																
Schoenus brevisetis sens. lat.																																x
Schoenus caespititius		x										x					x			x	x	x				x					
Schoenus sp.													x				x			x												
Scholtzia involucrata	x	x	x	x		x			x			x		x	x			x	x	x	x	x	x	x	x	x	x		x	x	x	x
Siloxerus humifusus																																
Stachystemon axillaris																																
Stirlingia latifolia	x								x			x							x					x	x	x			x			
Stirlingia simplex																				x												
Stylidium adpressum												x					x			x				x		x						
Stylidium amoenum																							x		x							
Stylidium araeophyllum		x									x																					
Stylidium brunonianum												x		x									x		x				x	x		
Stylidium crossocephalum																										x	x					
Stylidium diuroides												x														x	x					
Stylidium diuroides subsp. *diuroides*							x																									
Stylidium junceum																											x					
Stylidium ?*miniatum*																					x	x										
Stylidium neurophyllum																	x		x		x	x		x		x	x					
Stylidium piliferum		x									x																					
Stylidium repens				x	x		x								x			x	x		x	x					x					
Stylidium rigidulum							x														x											
Stylidium scariosum																																
Stylidium spiciforme																																
Stylidium sp.	x					x			x						x													x				x
Styphelia conostephioides	x		x	x		x			x			x					x	x	x	x	x	x		x	x	x	x		x	x		x

APPENDIX F: SUMMARY OF VASCULAR PLANT SPECIES RECORDED IN EACH SURVEY SITE IN THE MUCHEA SURVEY AREA

Note: * denotes introduced species, list does not contain opportunistic taxa.

SPECIES	MP37	MP38	MP39	MP40	MP41	MP42	MP43	MP44	MP45	MP46	MP47	MP48	MP49	MP50	MP51	MP52	MP53	MP54	MP55	MP56	MP57	MP58	MP59	MP60	MP61	MP62	MP63	MP64	MP65	MP66	MP67	MP68
Styphelia erubescens			x				x		x																		x					x
Styphelia pallida												x																				
Styphelia propinqua																						x										
Styphelia xerophylla																																
Thelymitra campanulata																																
Thysanotus manglesianus							x																									
Thysanotus sp.				x								x							x	x				x								
Trachymene pilosa																						x										
Trachymene sp.																																
Tricoryne tenella																	x					x				x	x					
Tripterococcus brunonis																				x												
* *Ursinia anthemoides* subsp. *anthemoides*					x	x						x	x			x						x										
Verticordia nitens			x	x					x			x			x		x	x	x	x	x	x		x		x	x					x
Verticordia ovalifolia																			x										x		x	
Verticordia sp.			x																													
Waitzia ?suaveolens																																
Xanthorrhoea brunonis																																
Xanthorrhoea gracilis			x	x	x	x					x		x															x				
Xanthorrhoea preissii			x	x	x	x		x			x		x			x	x	x		x		x		x				x			x	
Xanthosia huegelii																			x	x	x	x				x						
Xanthosia sp.																																

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: A **FCT:** 23b **SVT:** G1

Structural

Low woodland of *Banksia attenuata* and *Banksia menziesii* with occasional *Eucalyptus todtiana* over *Beaufortia elegans, Bossiaea eriocarpa, Eremaea pauciflora, Jacksonia floribunda, Petrophile linearis and Scholtzia involucrata*, over *Drosera erythrorhiza, Lyginia barbata* and *Patersonia occidentalis*

Associated species

Alexgeorgea nitens, Calytrix angulata, Melaleuca trichophylla, Stylidium brunonianum, Nuytsia floribunda, Lechenaultia floribunda, Hibbertia sericosepala and *Hibbertia hypericoides* subsp. *hypericoides*

Soils and Landforms: white – grey sand on mid slopes and flats or upper slopes

Outcropping: absent

Condition: excellent

Area: 59.69 ha **Proportion of survey area:** 5.43 %

Number of Quadrats: 6 **Species richness:** 30.8 ± 1.1 (SE)

Representative Photograph

Site MP66

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: B **FCT:** 23b **SVT:** H1

Structural

Low open woodland of *Banksia attenuata* and *Banksia menziesii* over *Jacksonia floribunda*, *Scholtzia involucrata, Styphelia conostephioides, Verticordia nitens* and *Xanthorrhoea preissii* over *Dasypogon bromeliifolius* and *Patersonia occidentalis*

Associated species

Petrophile linearis, Melaleuca trichophylla, Gompholobium tomentosum, Xanthorrhoea gracilis, Cyanothamnus ramosus subsp. *anethifolius, Conostephium pendulum, Conostephium minus* and *Bossiaea eriocarpa.*

Soils and Landforms: white-grey sand, on lower slopes and valley floors in moister sites

Outcropping: absent

Condition: pristine - excellent

Area: 26.88 ha **Proportion of survey area:** 2.45 %

Number of Quadrats: 7 **Species richness:** 26.0 ± 1.6 (SE)

Representative Photograph

Site MP40

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: F **FCT:** 23b **SVT:** H1

Structural

Low woodland of *Banksia attenuata* and *Banksia menziesii* over *Allocasuarina humilis*, *Conostephium pendulum, Jacksonia floribunda, Melaleuca trichophylla, Petrophile linearis, Scholtzia involucrata* and *Stirlingia latifolia,* over *Burchardia congesta, Drosera drummondii* and *Lyginia barbata*

Associated species

Bossiaea eriocarpa, Hibbertia huegelii, Styphelia conostephioides, Philotheca spicata, Phlebocarya ciliata, Hibbertia subvaginata, Eremaea pauciflora and Desmocladus flexuosus

Soils and Landforms: white-grey sand. Occurs on upper slopes and some ridges

Outcropping: absent

Condition: pristine - excellent

Area: 27.97 ha **Proportion of survey area:** 2.54 %

Number of Quadrats: 3 **Species richness:** 34.0 ± 1.0 (SE)

Representative Photograph

Site MP23

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: G **FCT:** 23b **SVT:** H1

Structural

Low woodland of *Banksia attenuata* and *Banksia menziesii* over *Calytrix flavescens, Eremaea pauciflora* var. *calyptra, Hibbertia subvaginata, Jacksonia floribunda, Leptomeria empetriformis* and *Petrophile linearis* over *Lyginia barbata* and *Phlebocarya ciliata*

Associated species

Bossiaea eriocarpa, Burchardia congesta, Conostephium pendulum, Dampiera linearis, Melaleuca trichophylla, Stylidium araeophyllum, Scholtzia involucrata, Philotheca spicata, and *Dasypogon bromeliifolius*

Soils and Landforms: on white-grey-brown sand. Occurs on mid slopes and some upper slopes

Outcropping: absent

Condition: pristine

Area: 43.75 ha **Proportion of survey area:** 3.98 %

Number of Quadrats: 6 **Species richness:** 29.8 ± 1.2 (SE)

Representative Photograph

Site MP38

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: H **FCT:** 23b **SVT:** I1

Structural

Low woodland of *Banksia attenuata* and *Banksia menziesii* over *Hibbertia subvaginata, Jacksonia floribunda*, *Melaleuca trichophylla, Petrophile linearis, Scholtzia involucrata* and *Styphelia conostephioides* over *Lyginia barbata* and *Patersonia occidentalis*

Associated species

Bossiaea eriocarpa, Beaufortia elegans, Alexgeorgea nitens, Andersonia heterophylla, Calytrix flavescens, Conostephium pendulum, Drosera sp. Eremaea pauciflora, Hibbertia huegelii, Philotheca spicata, Stylidium spp. *and Verticordia nitens.*

Soils and Landforms: on white-grey-brown sand and sandy loam. Occurs predominantly on flats but also across a range from lower slopes to ridges.

Outcropping: absent

Condition: pristine - excellent

Area: 754.66 ha **Proportion of survey area:** 68.67 %

Number of Quadrats: 28 **Species richness:** 32.6 ± 1.1 (SE)

Representative Photograph

Site MP63

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: J **FCT:** 23b **SVT:** G1

Structural

Low woodland of *Eucalyptus todtiana*, *Banksia menziesii* and *Banksia attenuata* over *Beaufortia elegans, Bossiaea eriocarpa Eremaea pauciflora* var. *calyptra, Hibbertia subvaginata Jacksonia floribunda*, *Philotheca spicata* and *Scholtzia involucrata* over *Lyginia barbata* and *Patersonia occidentalis*

Associated species

Alexgeorgea nitens, Burchardia congesta, Calytrix flavescens, Conostephium pendulum, Desmocladus flexuosus, Hibbertia huegelii, Melaleuca trichophylla, Petrophile linearis and *Styphelia conostephioides.*

Soils and Landforms: on white-grey sand and sandy loam, occurs mostly on upper slopes.

Outcropping: Absent

Condition: pristine - excellent

Area: 71.08 ha **Proportion of survey area:** 6.47 %

Number of Quadrats: 5 **Species richness:** 38.8 ± 3.0

Representative Photographs

Site MP21

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: K **FCT:** 23b **SVT:** G1

Structural

Low woodland of *Eucalyptus todtiana*, *Banksia attenuata* and *Banksia menziesii* over *Beaufortia elegans, Eremaea pauciflora, Hibbertia subvaginata, Jacksonia floribunda, Philotheca spicata* and *Scholtzia involucrata,* over *Patersonia occidentalis* and *Phlebocarya* spp.

Associated species

Bossiaea eriocarpa, Drosera spp., Gompholobium tomentosum, Lyginia barbata, Petrophile linearis, Styphelia conostephioides, Stylidium spp., Conostephium pendulum and *Hibbertia hypericoides* subsp. *hypericoides.*

Soils and Landforms: White grey sands over yellow/brown sand on mid to upper slopes.

Outcropping: absent

Condition: pristine

Area: 80.32 ha **Proportion of survey area:** 7.31 %

Number of Quadrats: 5 **Species richness:** 32.4 ± 1.6 (SE)

Representative Photograph

Site MP42

APPENDIX G: SUMMARY OF VEGETATION COMMUNITIES RECORDED IN THE MUCHEA PROJECT

Vegetation Community Description

Vegetation map code: M **FCT:** 21c **SVT:** G1

Structural

Low woodland of *Melaleuca preissiana* and *Banksia attenuata* over *Kunzea glabrescens* and *Xanthorrhoea preissii* over *Hibbertia subvaginata* and *Dasypogon bromeliifolius*

Associated species

Acacia huegelii, Bossiaea eriocarpa, Conostephium pendulum, Cyanothamnus ramosus subsp. *anethifolius*, *Drosera sp., Petrophile linearis and Xanthorrhoea gracilis.*

Soils and Landforms: White-grey-brown sands and sandy loams or moist black loam and clay peat. Occurs in moist valley floors and flats.

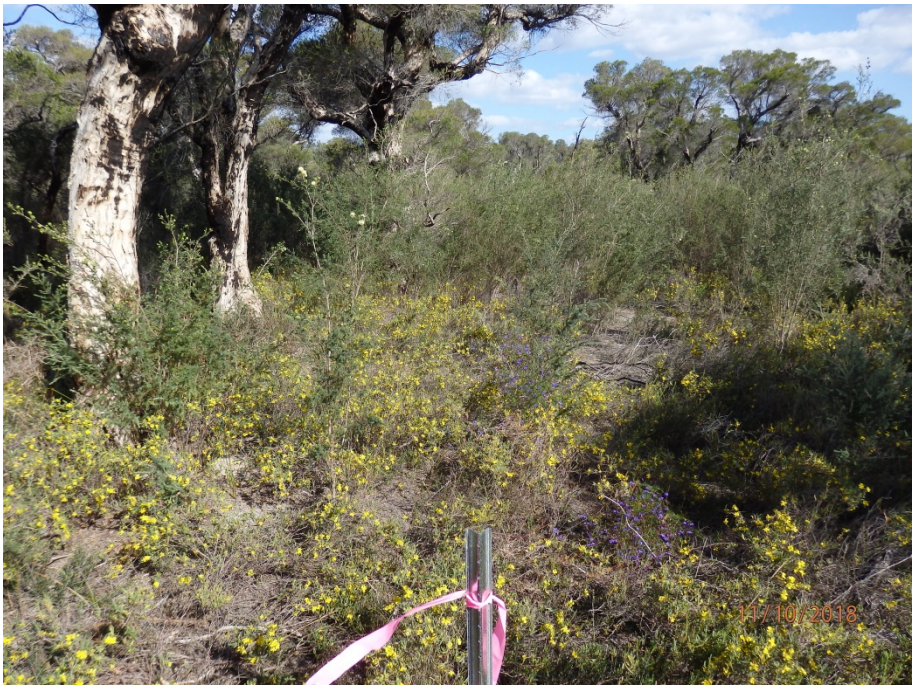
Outcropping: absent

Condition: excellent – very good

Area: 21.61 ha **Proportion of survey area:** 1.97 %

Number of Quadrats: 8 **Species richness:** 15.5 ± 1.7 (SE)

Representative Photograph



Site MP33

APPENDIX H: PHOTOGRAPHIC RECORD OF TIMARU ROAD RESERVE, MUCHEA WA, 2021

Photograph 1: Timaru Road 100 m East of Brand Hwy facing west

Photograph 2: Timaru Road 100 m East of Brand Hwy facing east

APPENDIX H: PHOTOGRAPHIC RECORD OF TIMARU ROAD RESERVE, MUCHEA WA, 2021

Photograph 3: Timaru Road 1000 m East of Brand Hwy facing west