Shire of Dandaragan: Gravel Pit Reserve R35593 – Area 2; Flora and Vegetation Reconnaissance Survey, Targeted Flora Survey and Desktop Fauna Assessment

Version 1

Maia Environmental Consultancy Pty Ltd
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SUMMARY

The Shire of Dandaragan (the Shire) wishes to extend an existing gravel pit located in Section 5(1)(g) Reserve R35593 north-east of Jurien Bay, Western Australia (WA). The reserve has the designated purpose of "Gravel Resource Management, Restoration and Conservation" and the extraction of gravel from the reserve is covered by Gravel Lease 176, which is in the process of being renewed. A clearing permit is required as no exemption applies.

Maia Environmental Consultancy Pty Ltd (Maia) and Western Wildlife were engaged to carry out a flora and vegetation desktop assessment and reconnaissance survey over a 18.38 ha section of the gravel reserve, as well as a fauna desktop assessment. The area is referred to as the Survey Area in this report.

The Survey Area is in the Geraldton Sandplains IBRA bioregion and the Lesueur Sandplain subregion. It is mapped as one pre-European vegetation association (VA) – 1031 – and one vegetation system association (VSA) - 1031. Currently, 34.48% of VA 1031 remains in the Geraldton Sandplains bioregion and the Lesueur Sandplain subregion, and 14.72% of it is protected in conservation tenure. Similarly, 59.20% of VSA 1031 currently remains in the bioregion and subregion and 47.10% is protected. The vegetation of the Survey Area is rated as having high susceptibility to dieback, although no known positive *Phytophthora* species points are located within 2 km of the Survey Area.

Database searches indicated that no threatened flora species and four priority flora species have been recorded in R35593 previously: *Lasiopetalum rutilans*, *Leucopogon plumuliflorus* (both Priority (P) 2), *Gompholobium gairdnerianum* and *Hensmania stoniella* (both P3). Maia carried out a reconnaissance survey in an adjacent block of vegetation in October 2019 and recorded five priority flora species: *Synaphea lesueurensis* (P2), *Haemodorum loratum*, *Patersonia argyria*, *Verticordia rutilastra* (all P3) and *Xanthosia tomentosa* (P4).

The Survey Area does not lie in a Threatened Ecological Community (TEC) protected by federal or state law or within the boundaries of a currently known Priority Ecological Community (PEC). The closest TEC / PEC buffer boundary is approximately 0.2 km west of the Survey Area.

The flora and vegetation survey was carried out in mid-October 2020, and 107 species were recorded from 31 families and 62 genera. No threatened flora species were recorded in the Survey Area. Four live priority flora species were recorded - *Persoonia filiformis* and *P. rudis* (both P3), *Verticordia rutilastra* (P3) and *Xanthosia tomentosa* (P4) - and one senesced / dead priority species *Synaphea lesueurensis* (P2).

One vegetation type (Mixed Heathland) in excellent condition occurs in the Survey Area. The vegetation type does not resemble any TEC or PEC currently listed for the Geraldton Sandplains bioregion and DBCA Midwest region, respectively. The Survey Area is on the footslopes of lateritic uplands and the heathland vegetation type is similar to GFG 20-13, which is noted as occurring on uplands and well drained slopes of grey sandy lateritic gravel between Eneabba, Lesueur, Watheroo and Dandaragan. The vegetation of the Survey Area is therefore likely to occur around and some distance from the Survey Area.

The botanical survey was carried out over the 18.38 ha area and the Shire selected an 8.72 ha area to be cleared within the 18.38 ha Survey Area. The 8.72 ha area was aligned to minimise impact to the conservation significant flora species located in the Survey Area and to be a manageable shape to clear. An impact assessment was then carried out for the priority species located in the Survey Area. Regional impacts estimated for the plants located range from 0.3% (*Synaphea lesueurensis*) to 11.1% (*Persoonia filiformis*), while regional impact for plant populations known to Maia ranges from 2.0% (*Persoonia rudis*) to 9.1% (*Synaphea lesueurensis*); 50.0% of the *Persoonia filiformis* populations known to Maia in the local area are in protected lands and 62.5% of the local area *Synaphea lesueurensis* populations. Given the number of priority plants located in the 18.38 ha area surveyed, and that the vegetation

type recorded in the Survey Area extends around and beyond the Survey Area, it is likely that the five priority species recorded in the Survey Area occur in similar numbers and densities in the surrounding vegetation.

Currently 44.78% of the native vegetation in the Geraldton Sandplains remains, 34.48% in the Lesueur Sandplain, 44.21% in the Shire of Dandaragan and 73.84% in the local area (the area within a 10 km radius of the Survey Area). Clearing of 8.72 ha of vegetation association 1031 in the Survey Area would reduce its remaining extent in the Geraldton Sandplains bioregion (and the Lesueur Sandplain subregion) by 0.004%, while the remaining extent of vegetation system association 1031 would decrease by 0.053% (currently 59.20% in the bioregion and subregion). The local area will retain approximately 73.81% native vegetation extent after the proposed 8.72 ha of clearing in the gravel pit, while native vegetation extent in R35593 will be 88.41% post the clearing.

One fauna habitat in excellent condition is present in the Survey Area – low heathland. As the habitat in the Survey Area is part of a relatively large area of continuous habitat it is unlikely to be of particular importance as an ecological linkage. The faunal assemblages of the Survey Area are likely to be typical of the heathlands of the region and relatively intact for the same reason.

The results of the fauna database searches were reviewed and, given the habitat requirements of the conservation significant fauna species listed and the fauna habitat in the Survey Area, four conservation significant species could potentially occur in the Survey Area: Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Malleefowl (*Leipoa ocellata*), the Fork-tailed Swift (*Apus pacificus*) (all threatened species), and the Western Brush Wallaby (*Notamacropus irma*), a P4 species. The Malleefowl is likely to be an occasional foraging visitor to the Survey Area, but as the Survey Area would be a very small part of a much larger foraging range the loss of 8.72 ha of possible foraging habitat is unlikely to have a significant impact on the species. Carnaby's Cockatoo is likely to be a foraging visitor to the Survey Area, but not likely to breed or roost in the Survey Area. Clearing will result in the loss of 8.72 ha of low value foraging habitat that may be used by breeding birds, as breeding is known to occur with 12 km of the Survey Area. The Fork-tailed Swift (*Apus pacificus*) may overfly the Survey Area but is not likely to use the low heathland habitat. Therefore, clearing 8.72 ha of habitat is not likely to have a significant impact on this species. The Western Brush Wallaby is likely to occur in the Survey Area, the size of which is likely to represent the home-range of a single individual. Although some habitat for this species will be lost, clearing of 8.72 ha of low heathland is not likely to have a significant impact on the species.

Clearing of 8.72 ha of low heathland habitat will result in the loss of all native fauna habitat from the cleared area. However, populations of all species occurring in the Survey Area are likely to persist in the adjacent extensive area of habitat. The clearing is unlikely to result in an increase in habitat fragmentation in the area, as it is set within a large remnant of almost continuous vegetation.

When the 10 clearing principles are addressed, three are considered not to be at variance and seven are considered unlikely to be at variance.

Shire of Dandaragan: Gravel Pit Reserve R35593 – Area 2; Flora and Vegetation Reconnaissance Survey, Targeted Flora Survey and Desktop Fauna Assessment

VERSION 1

1 INTRODUCTION

The Shire of Dandaragan (the Shire) wishes to extend an existing gravel pit 18 km north-east of Jurien Bay, Western Australia (WA). The gravel pit is in Section 5(1)(g) Reserve R35593 (**Map 1, Section 11**). The reserve is vested in the Conservation Commission of WA for the designated purpose of "Gravel Resource Management, Restoration and Conservation" (Australian Government, 2021). The extraction of gravel from the reserve is covered by Gravel Lease 176: the lease expired in 2015 and is currently in the process of being renewed. A clearing permit is required as no exemption applies.

Maia Environmental Consultancy Pty Ltd (Maia) and Western Wildlife were engaged to carry out a flora and fauna desktop assessment, a flora and vegetation reconnaissance survey and a fauna desktop assessment. The area surveyed is referred to as the Survey Area in this report and it covers approximately 18.38 hectares (ha). The Shire plans to clear 8.72 ha of the 18.38 ha survey area for gravel extraction (**Map 1, Section 11**).

This report includes background information relevant to a Native Vegetation Clearing Permit (NVCP) application, flora and fauna database search results, survey methods, survey results and a table addressing the NVCP 10 clearing principles.

2 BACKGROUND

Information on the bioregion, sub-region, soil landscape units, geology, pre-European vegetation associations, protected and significant areas, any watercourses and wetlands and Phytophthora dieback information relating to the Survey Area is summarised in **Table 1**.

Table 1: Background information

Background information on the Survey Area	
IBRA bioregion and subregion (**Map 2A, Section 11**)	Geraldton Sandplains bioregion and Lesueur Sandplain subregion. Department of the Environment and Energy (DotEE) (2012).
Geology (**Map 2B, Section 11**)	One surface geology unit has been mapped in the Survey Area: • Czs: Sand or gravel plains; quartz sand sheets commonly with ferruginous pisoliths or pebbles, minor clay; local calcrete, laterite, silcrete, silt, clay, alluvium, colluvium, aeolian sand. Geoscience Australia (2012).

<table>
<tr><th colspan="2">Background information on the Survey Area</th></tr>
<tr><td>Soil landscape mapping units

(Map 2C, Section 11)</td><td>One soil landscape unit is mapped in the Survey Area:

• 222Ye_2: Plateau residuals, very gently to gently inclined hillcrest and hillslopes; pale sandy gravels, shallow gravel over duricrust, gravelly pale deep sand, pale and yellow deep sands.

Department of Agriculture and Food Western Australia (DAFWA) (2014).</td></tr>
<tr><td>Pre-European vegetation association and system association

(Map 2D, Section 11)</td><td>The Environmental Protection Authority's (EPA) broad principles for the protection of native terrestrial vegetation and flora indicate that biodiversity should be maintained at sustainable levels. This generally means that ecological communities should be retained at an overall level of at least 30% of the original extent of the ecological community in each region (EPA, 2000). This level is the threshold level below which species loss appears to accelerate exponentially at an ecosystem level. A level of 10% of the original extent is regarded as being a level representing "endangered" (EPA, 2000).

Currently 44.78% of the native vegetation in the Geraldton Sandplains remains, 34.48% in the Lesueur Sandplain and 44.21% in the Shire of Dandaragan (GoWA, 2019).

The Survey Area is in one pre-European vegetation association (VA) and system association (VSA) mapped in the Geraldton Sandplains (Department of Primary Industries and Rural Development (DPIRD), 2016):

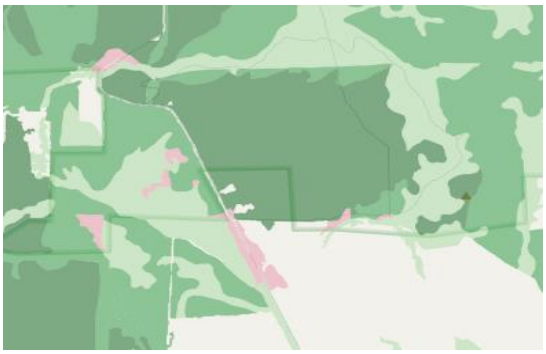
• VA 1031; VSA 1031 (Mosaic: Shrublands; hakea scrub-heath / Shrublands; dryandra heath).

The pre-European extent of the VA and VSA in the Geraldton Sandplains bioregion and Lesueur Sandplain subregion (Gairdner System), and the current extent, the percentage remaining, along with the current extent protected for conservation in the bioregion and subregion are listed in the following table.

<table>
<tr><th>Pre-European extent (ha)</th><th>Current extent (ha)</th><th>Remaining (%)</th><th>Current extent protected (IUCN 1-4) for conservation (proportion of pre-European extent) (%)</th></tr>
<tr><td colspan="4">Vegetation association 1031</td></tr>
<tr><td colspan="4">Geraldton Sandplains</td></tr>
<tr><td>241,349.97</td><td>83,217.27</td><td>34.48</td><td>14.72</td></tr>
<tr><td colspan="4">Lesueur Sandplain</td></tr>
<tr><td>241,349.97</td><td>83,217.27</td><td>34.48</td><td>14.72</td></tr>
<tr><td colspan="4">Vegetation system association 1031 (Gairdner System)</td></tr>
<tr><td colspan="4">Geraldton Sandplains</td></tr>
<tr><td>16,486.70</td><td>9,759.97</td><td>59.20</td><td>47.10</td></tr>
<tr><td colspan="4">Lesueur Sandplain</td></tr>
<tr><td>16,486.70</td><td>9,759.97</td><td>59.20</td><td>47.10</td></tr>
</table>
Source: GoWA, 2019.

Currently, 34.48% of VA 1031 remains in the Geraldton Sandplains bioregion and Lesueur Sandplain subregion, and 59.20% of VSA 1031 in the bioregion and subregion; 14.72% of VA 1031 is protected in the bioregion and subregion and 47.10% of VSA 1031.

The Shire of Dandaragan retains 29.52% of the original extent of VA 1031 (14.86% of which is in protected areas) and 66.60% of the VSA of the Gairdner System (55.31% of which is in protected lands (GoWA, 2019)).</td></tr>
</table>

Background information on the Survey Area	
Protected and significant areas (**Map 3, Section 11**)	• The Survey Area is in DBCA Legislated Lands and Waters (Department of Biodiversity, Conservation and Attractions (DBCA), 2017) i.e., in Section 5(1)(g) Reserve 35593. Reserve 35593 is bounded by Nature reserve 35594 (adjacent to its western boundary) and also by Lesueur National Park (adjacent to the northern and eastern boundaries). • The Survey Area is in an Environmentally Sensitive Area (Department of Water, Environment and Regulation (DWER), 2018). • The Survey Area lies in an EPA Redbook Recommended Conservation Reserves 1976-1991 area (including R35593, Nature Reserve R35594 and Lesueur National Park) (DBCA, 2015a).
Watercourses and wetlands (**Map 4, Section 11**)	• No watercourse areas and lines, lakes, waterholes, water points or springs cross or occur within the Survey Area (Geoscience Australia, 2006). • No Geomorphic Wetlands are mapped within the Survey Area (Cervantes Coastal (DBCA, 2015b) and Cervantes Eneabba (DBCA, 2015c)).
Dieback	As the long-term annual average rainfall in Jurien Bay is greater than 400 mm (531 mm; BoM, 2021), it is in an area where dieback could occur. Project Dieback (PD) has created a publicly available map showing locations of soils samples with a positive reading for *Phytophthora cinnamomi* in the southwest of WA (PD, 2014a). No known positive *Phytophthora* species points are located within the Survey Area (to 30 June 2018); however, one *P. arenaria* positive sample point occurs within 4 km to the south-west of the Survey Area (PD, 2014a). VSA 1031 is rated as having high susceptibility to dieback. Priority Protection Areas (PPAs) are areas representing significant biodiverse ecosystems and communities vulnerable to dieback in the south-west of WA and identified for state-level Dieback management and investment (PD, 2014b). The goal is to protect and conserve the most significant examples of biodiverse ecosystems and communities in the south-west, which are vulnerable to or threatened by dieback (PD, 2014b). Most of the Survey Area occurs within a PPA asset boundary and a PPA management boundary (**Figure 1**; PD, 2014a). It is also mapped in an Uninfested High Value Landscape. **Figure 2** is a disease confidence map current to 2008 for the Survey Area and surrounds (PD, 2014a). In 2008, Cockleshell Gully Road leading to the Survey Area was in a low confidence infested with *P. cinnamomi* area and the Survey Area was in a high confidence uninfested area.  **Figure 1**: Priority Protection Areas and the Survey Area (PD, 2014a). Yellow hexagon outline = Uninfested High Value Landscape, orange dotted line = PPA Asset Boundaries Refined, black dotted line = PPA Management Boundaries Refined).  **Figure 2**: Disease (*Phytophthora cinnamomi*) confidence mapping to 2008 (PD, 2014a) Dark green = high confidence uninfested to 2008, mid green = moderate confidence, pink = low confidence infested.

3 SURVEY METHODS

EPA 2016 and 2020 were used as guides for the level of survey required. Flora, vegetation and fauna desktop studies were carried out followed by a combined flora and vegetation reconnaissance survey and targeted flora survey.

The flora and vegetation survey was carried out by two botanists on October 25, 26 and 28, 2020. The botanists assessed three 10 m x 10 m quadrats in the Survey Area and walked traverses at approximately 15 m spacings over the Survey Area and surveyed a band of vegetation of approximately 6-10 m wide while walking (**Map 5, Section 11**). They also visited two other points to assess the vegetation and, as it was the same, took photographs and recorded them as photo points (**Map 5**).

The following parameters were recorded at the three quadrats assessed:

- Location details including Global Positioning System (GPS) co-ordinates (Geocentric Datum of Australia, 1994 (GDA94)).
- Site parameters such as soil description, topography and general habitat description, rock type and cover.
- Photographs of the quadrat.
- Vegetation condition using the scale and criteria in EPA, 2016.
- Notes on any disturbance to the vegetation.
- Fire history.
- A description of the vegetation structure including the height, percentage cover and dominant species within each stratum.
- The name, height, percentage cover and any other significant recording details for any other species located at the quadrat.

Conservation significant species known to occur in the area and surrounds, any unknown and novel species and introduced species were targeted while walking traverses within the Survey Area. When known or suspected conservation significant species were located the botanists recorded the location on a GPS and their numbers were counted. While walking traverses the botanists also collected specimens of any taxa not already collected at the quadrats assessed.

A vertebrate fauna reconnaissance survey was not carried out, because an adjacent site with the same vegetation was assessed in January 2020 (Maia and Western Wildlife, 2020). Western Wildlife used flora and vegetation data and photographs collected from the Survey Area to determine whether a site visit was needed.

4 DATABASE SEARCH RESULTS

Appendix 5 provides information on conservation significance of flora, fauna and vegetation and references for the relevant literature and current listings.

4.1 CONSERVATION SIGNIFICANT FLORA

Information on conservation significant flora (CSF) species that could occur in the area was collated via searches of the DBCA Threatened and Priority Flora List (TPFL) and DBCA WA Herbarium (WAHerb) databases requested in 2019 (DBCA search reference #46-0919FL) (**Map 6, Section 11**). The EPBC Act Protected Matters Search Tool (PMST) (DAWE, 2021a, search references PMST OVGE49) was used along with NatureMap (Department of Biodiversity, Conservation and Attractions (DBCA), 2007-). A 10 km radius search area was used for each search with the following coordinates for the centre point – 30.16751 S, 115.13933 E. The results from a survey carried out adjacent

to the Survey Area were also used (Maia and Western Wildlife, 2020). The collated results are listed in **Table 12, Appendix 1**.

4.1.1 Threatened Flora

While 21 Threatened flora species (or their habitats) protected by the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or by the WA *Biodiversity Conservation Act 2016* (BC Act) were listed in the search results for the 10 km radius search area, none of them have been found in the Survey Area or in reserve R35593 previously (**Table 12, Appendix 1**). The closest Threatened species record is a *Thelymitra stellata* record approximately 2.7 km east of the Survey Area (**Map 6, Section 11**).

4.1.2 Priority Flora

Seventy-nine Priority (P) flora species have records in the 10 km radius search area (**Table 12, Appendix 1**) – three P1 species, 27 P2 species, 33 P3 species and 16 P4 species. The DBCA database searches indicated that four of the 79 Priority species have been located previously in gravel pit Reserve R35593 - *Lasiopetalum rutilans*, *Leucopogon plumuliflorus* (both P2), *Gompholobium gairdnerianum* and *Hensmania stoniella* (both P3); however, none of the records are within the current Survey Area. The closest of these priority flora records to the Survey Area is *Acacia retrorsa* (P2) (approximately 0.6 km to the north-west of the centre of the Survey Area) (**Map 6**). In October 2019 a reconnaissance and targeted flora survey was carried out over a 7 ha polygon adjacent to and to the south-east of the current Survey Area (Maia and Western Wildlife, 2020). No threatened flora species and five Priority flora species were located in that Survey Area: *Synaphea lesueurensis* (P2), *Haemodorum loratum* (P3), *Patersonia argyrea* (P3), *Verticordia rutilastra* (P3) and *Xanthosia tomentosa* (P4) (**Table 12**). It is possible that *Lasiopetalum rutilans*, *Leucopogon plumuliflorus*, *Gompholobium gairdnerianum* and *Hensmania stoniella* and the five species located in the adjacent area could occur in the Survey Area.

4.2 Conservation Significant Fauna (Western Wildlife)

The following databases were used to gather background information on conservation significant fauna (CSFa) species that could potentially occur in the Survey Area - the EPBC Act Protected Matters Search Tool (PMST) (DAWE, 2021a, search reference PMST OVGE49 (10 km buffer) and NatureMap (DBCA, 2007-). A 10 km radius search was carried out using the following coordinates – 30°10'03" S, 115°08'22" E. The results are listed in **Table 13** (**Appendix 1**)**.**

4.2.1 Threatened Fauna

Ten Threatened fauna species protected by the EPBC Act were listed in the PMST search results. The type of presence for *Calyptorhynchus latirostris* (Carnaby's Cockatoo) is listed as 'breeding is known to occur in the area'. The type of presence for the remaining species is either listed as 'species or species habitat likely to occur within area' (three species) or 'species or species habitat may occur within area' (five species) (DAWE, 2021a).

Three Threatened fauna species protected by the EPBC Act and BC Act have been located previously within the search area – *Calyptorhynchus latirostris* (Carnaby's Cockatoo), *Leipoa ocellata* (Malleefowl) and *Macroderma gigas* (Ghost Bat) (DBCA, 2007-). One Threatened fauna species protected by the BC Act and not the EPBC Act was also listed in the NatureMap results - *Cyclodomorphus branchialis* (Gilled Slender Blue-tongue Skink).

Of the listed Threatened species only Carnaby's Cockatoo and the Malleefowl could potentially occur in the Survey Area. The remaining species are unlikely to occur due to lack of suitable habitat or local extinction. Carnaby's Cockatoo and Malleefowl are discussed further in Section 6.3.

4.2.2 Migratory Fauna

Ten Migratory Fauna species were listed in the PMST search results, and three of the 10 are also listed as Threatened (DAWE, 2021a).

Eight Migratory Birds (protected under international agreement) have been located previously within the 10 km search area: *Calidris acuminata* (Sharp-tailed Sandpiper), *Calidris alba* (Sanderling), *Hydroprogne caspia* (Caspian Tern), *Plegadis falcinellus* (Glossy Ibis), *Pluvialis squatarola* (Grey Plover), *Puffinus pacificus* (Wedge-tailed Shearwater), *Thalasseus bergii* (Crested Tern) and *Tringa glareola* (Wood Sandpiper) (DBCA, 2007-).

Apart from the Fork-tailed Swift (*Apus pacificus*), the Migratory species are all associated with beaches, lakes and/or offshore islands, and would not occur in the Survey Area due to a lack of suitable habitat. The Fork-tailed Swift is discussed further in Section 6.3.

4.2.3 Specially Protected Fauna

No Specially Protected Fauna species have been located previously within 10 km of the Survey Area (DBCA, 2007-).

4.2.4 Priority Fauna

One Priority fauna species has been located previously within 10 km of the Survey Area – *Notamacropus irma* (Western Brush Wallaby) (P4) (**Map 7, Section 11**; DBCA, 2007-). The nearest known record is approximately 4.6 km north north-west of the Survey Area (DBCA, 2007-). This species is discussed further in Section 6.3.

4.3 Ecological Communities

The following databases were used to gather information on significant ecological communities that could potentially occur in the Survey Area - EPBC Act Protected Matters Search Tool (DAWE, 2021a), Australian Government (2021), NatureMap (DBCA, 2007-) and DBCA Ecological Communities database (DBCA search reference, 53-0919EC; **Map 8, Section 11)**. A 10 km radius search area was used from the approximate centre of the Survey Area.

4.3.1 Threatened Ecological Communities

Two Threatened Ecological Communities (TECs) protected by the EPBC Act were listed in the PMST search results as 'may occur within the area' and 'likely to occur within the area', respectively – 'Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain' ecological community (Critically Endangered) and 'Banksia Woodlands of the Swan Coastal Plain' ecological community (Endangered) (DAWE, 2021a). However, neither of these TECs is currently known to occur in the Survey Area (DBCA search reference, 53-0919EC; **Map 8, Section 11**). The closest buffer for one of them is approximately 0.2 km west of the north-western corner of the Survey Area – and it is 'Banksia Woodlands of the Swan Coastal Plain'. This ecological community is listed as a TEC federally and as a Priority Ecological Community (PEC) in WA.

The most recent WA TEC list is correct to June 28, 2018 (DBCA, 2018d) and includes five TECs listed for the Geraldton Sandplains bioregion. The Survey Area does not lie within any of the current boundaries indicated for a known WA listed TEC (**Map 8, Section 11**).

4.3.2 Priority Ecological Communities

The most recent PEC list is dated July 28, 2020 (DBCA, 2021) and it includes 108 PECs for the Midwest region.

The Survey Area does not occur within the boundaries of a currently known PEC (**Map 8, Section 11**). The edge of the buffers for the closest PECs to the Survey Area are approximately 0.2 km to the west of the north-western corner of the Survey Area and 5.4 km east of the south-eastern corner of the Survey Area, respectively - 'Banksia dominated woodlands of the Swan Coastal Plain IBRA region' (P3(iii) PEC) and '*Petrophile chrysantha* low heath on Lesueur

dissected uplands (Gp200-170)' (P2 PEC). The ecological communities database search results were cross checked for currency on NationalMap and NatureMap (Australian Government, 2021; DBCA, 2007-).

5 RAINFALL

The closest Bureau of Meteorology (BoM) weather station to the Survey Area is Jurien Bay (BoM station number 9131) located approximately 18.5 km south-west of the Survey Area. Long-term (1968 to Feb 2021) and 2020 monthly total rainfall data collected at Jurien Bay are listed in **Table 2** (BoM, 2021).

At Jurien Bay most of the yearly rainfall is typically received from May to September (**Table 2**).

Rainfall received between January and September 2020 (327.4 millimetres (mm)) was lower than the annual long-term mean total for January to September (480.4 mm).

Total rainfall in the four months before the October survey (June, July, August, and September – 203.6 mm) was 136.0 mm lower than the long-term mean total for those months (339.6 mm).

Based on the rainfall data recorded in the months before the survey and the long-term records, the vegetation in the Survey Area could have been in below average condition in October 2020.

Table 2: Actual (January to December 2020) and long-term (1968-Feb 2021) monthly total rainfall (mm) at Jurien Bay (BoM, 2021)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall records (mm) from Jurien Bay (Station Number 9131, 1968 - 2020)													
L-t	7.9	16.4	14.3	29.1	74.8	104.7	111.4	80.4	43.1	25.1	17.7	6.5	531.4
2020**	-	41.8	8.2	9.0	64.8	82.2	25.6	80.4	15.4	-	42.6	1.2	371.2**

Note: L-t= long-term; **gaps in data are where there are missing daily observations within the month. Frequently associated with the observer being unavailable (when observations are manual) or an equipment failure, or when data is suspect.

6 SURVEY RESULTS

6.1 SURVEY COVERAGE ACHIEVED

In addition to the three 10 m x 10 m quadrats, approximately 15.66 km of traverses were walked over the Survey Area; and survey coverage achieved was approximately 87% (determined by buffering traverses walked by 5 m (i.e., a 10 m wide strip of vegetation). The information collected at the three quadrats is included as **Table 14, Appendix 2**. Photographs were taken at two photo points within the Survey Area and quadrat and photo point photographs are included in **Table 14**. Quadrat locations, photo point locations and traverses walked over the Survey Area are shown on **Map 5** (**Section 11**).

6.2 FLORA

6.2.1 GENERAL FLORA

One hundred and seven (107) taxa were collected from the Survey Area (**Table 15, Appendix 3**). The number of taxa recorded, the number of families and genera represented, the percentage of annual and perennial species and the percentage of the species located that were fertile when the survey was carried out is listed in **Table 3**.

Table 3: Flora information

Attribute	Number
Families	31
Genera	62
Taxa	107
Annual % / perennial %	1 / 99
Flowering % / fruiting % / flowering and fruiting % / fertile overall %	48 / 21 / 19 / 87

Species richness was 32, 38 and 41 at the three quadrats assessed in the Survey Area (**Table 14, Appendix 3**).

The Proteaceae (22 taxa), Myrtaceae (21 taxa) and Fabaceae (nine taxa) families accounted for just under half of the species list. The next most diverse families were the Haemodoraceae (eight taxa), Cyperaceae and Stylidiaceae (6 taxa each). The most diverse genera were *Banksia* and *Verticordia* (seven taxa each), *Stylidium* (six taxa) and *Hakea* (five taxa).

Two taxa could not be confirmed beyond genus (*Cassytha* sp. and *Schoenus* sp.) because they were not fertile. No conservation significant *Cassytha* species are known from the Geraldton Sandplains (WAH, 1998-). Five conservation significant *Schoenus* species have records in the Lesueur Sandplain subregion, but they have not been located within 24 km of the Survey Area and do not occur in similar habitat (WAH, 1998-). A *Thysanotus* specimen could be either *Thysanotus patersonii* or *T. manglesianus* (flowers are needed to determine which), and neither is a conservation significant species.

All taxa collected from the Survey Area were included in the counts above.

6.2.2 Conservation Significant Flora

No Threatened flora species protected by the EPBC Act (DAWE, 2021b) or the BC Act (GoWA, 2016) were recorded in the Survey Area.

Four live Priority flora species were recorded in the Survey Area: *Persoonia filiformis* (P3), *Persoonia rudis* (P3), *Verticordia rutilastra* (P3) and *Xanthosia tomentosa* (P4) (**Map 9, Section 11**). *Synaphea lesueurensis* (P2) was also located; however, all of the plants located had senesced and were dead.

Table 6 lists the number of plants and populations of these species recorded in the Survey Area and an estimate of the number of plants and populations currently known in WA; it also provides information on the distribution of each species in WA. Photographs of the CSF species are included in **Table 16 (Appendix 4)**.

6.2.3 Regional Endemics

Regional endemics are plants that are geographically restricted to a particular locality or region. Nine of the species recorded in the Survey Area are regional endemics based on current distribution records (and excluding widely disjunct records or any in the ocean; **Table 4**), and eight of the nine are endemic to the Lesueur Sandplain subregion (if the widely disjunct and ocean records are excluded).

Table 4: Regional endemic species collected from the Survey Area

Species	Bioregion and subregion	Spread of records
Banksia sclerophylla	Geraldton Sandplains, Lesueur Sandplain only	120 km by 40 km area
Banksia tridentata	Geraldton Sandplains, Lesueur Sandplain only	65 km by 60 km area
Darwinia sanguinea	Geraldton Sandplains, Lesueur Sandplain (excluding one record in the ocean)	80 km by 50 km area
Eremaea violacea subsp. *raphiophylla*	Geraldton Sandplains, Lesueur Sandplain only	80 km by 75 km area
Hibbertia robur	Geraldton Sandplains, Lesueur Sandplain and Geraldton Hills	85 km by 30 km area
Melaleuca zonalis	Geraldton Sandplains, Lesueur Sandplain only	80 km by 35 km area
Persoonia filiformis (P3)	Geraldton Sandplains, Lesueur Sandplain only	135 x 30 km area
Synaphea lesueurensis (P2)	Geraldton Sandplains, Lesueur Sandplain only	25 km by 25 km area
Xanthorrhoea sp. Lesueur (G.J. Keighery 16404)	Geraldton Sandplains, Lesueur Sandplain (excluding one disjunct record in the Perth subregion of the Swan Coastal Plain)	100 km by 45 km area

6.2.4 Range Extensions

Species have a typical range, which is indicated by their known distribution records. Sometimes species are recorded during a survey that have not been located previously in the area; these species are described as range extensions. In many cases a range extension species reflects a lack of survey effort in a particular area or lack of submissions of flora records to the WA Herbarium rather than a true range extension. One hundred km is used as the minimum distance from an existing record to define a range extension species. A species record can also fill a gap between existing distant records and when this occurs, they are called gap fillers. One range extension species was collected from the Survey Area and one gap filler species (**Table 5**) (excluding plant collections that could not be fully determined).

Table 5: Range extension or gap filler species located in the Survey Area

Species (range extension or gap filler)	Distance and direction of closest NatureMap record from the Survey Area
Cryptandra nutans (gap filler)	Approximately 85 km east-south-east
Petrophile brevifolia subsp. *brevifolia* (range extension)	Approximately 140 km south-south-east

6.2.5 Weeds

No weed species were found in the Survey Area.

Table 6: Known records for and distribution of conservation significant flora species recorded in the Survey Area

Species	Rank	Plants						Populations						
		WA (regional area) records known to Maia (#)	Local area records (#)	Current 2020 gravel pit survey area records (#)	Option 2 PCA records (#)	Regional impact from Option 2 PCA (%)	Local area impact from Option 2 PCA (%)	WA (regional) pops. known to Maia (#)	Local area pops. (#)	Current 2020 gravel pit survey area pops. (#)	Option 2 PCA pops. (#)	Regional impact from Option 2 PCA (%)	Local area impact from Option 2 PCA (%)	Local area populations protected in DBCA Legislated Lands and Waters (IUCN I-IV only) (%)
Synaphea lesueurensis	P2	356	343	9	1	0.28	0.29	11	8	1	1	9.09	12.50	62.50
Synaphea sp. Indet.	Potential CSF	0	0	0	0	0	0	1	1	0	0	0	0	0
Synaphea lesueurensis (live and dead) and *S.* sp. Indet.	P2	356	343	9	1	0.28	0.29	11	8	1	1	9.09	12.50	62.50
Persoonia filiformis	P3	315	84	77	35	11.11	41.67	23	4	1	1	4.35	25.00	50.00
Persoonia rudis	P3	99	42	20	2	2.02	4.76	49	6	1	1	2.04	16.67	66.67
Verticordia rutilastra	P3	943	48	34	31	3.29	64.58	34	9	1	1	2.94	11.11	88.89
Verticordia ? *rutilastra*	?P3	3	3	3	0	0	0	1	1	1	0	0	0	0
Verticordia rutilastra and *V. ? rutilastra*	P3	946	51	**37**	**31**	3.28	60.78	34	9	1	1	2.94	11.11	88.89
Xanthosia tomentosa	P4	4,857	1,803	154	75	1.54	4.16	32	13	1	1	3.13	7.69	76.92

Note:

Column 1: *Synaphea* sp. Indet. is likely another record for *Synaphea lesueurensis* and, using the Precautionary Principle, has been included in the impact calculations, as have the dead *Synaphea lesueurensis* plants located in the current Survey Area. Similarly, *Verticordia* ? *rutilastra* located in the Survey Area has been combined with *Verticordia rutilastra* for these impact calculations.

Column 2: = P2, P3, P4 = Priority 2, 3 and 4 species.

Column 3: = Includes FloraBase (WAH, 1998-), NatureMap (DBCA, 2007-), TPFL and WAHERB records (DBCA searches carried out for Shire of Dandaragan - search references #46-0919FL and #12-0416FL) as well as records from Maia's database (including those from the adjacent gravel pit area surveyed in spring 2019).

Column 4: Local area records = the number of plants known to Maia and occurring within 10 km of the centre of the proposed clearing area (PCA).

Column 5: Records from the current Survey Area.

Column 6: Two clearing area options were investigated by the Shire and Option 2, a smaller area with lower impacts, has been chosen.

Columns 7 and 8: Impact to *Synaphea lesueurensis*, *Verticordia rutilastra* and *Xanthosia tomentosa* from clearing approved under CPS 8859-1 in an adjacent gravel pit area has been included in these calculations.

Columns 9 to 12: Populations defined using DBCA's method i.e., plant locations were buffered by 500 m and discrete populations (those where there was no overlap) were counted.

Column 15: Number of populations within IUCN I-IV DBCA Legislated Lands and Waters (DBCA, 2017).

Verticordia rutilastra: At one location 29 *V. rutilastra* plants were recorded; however, both *V. rutilastra* (P3) and *V. nobilis* (not significant) occurred in the Survey Area and close to one another and it is likely that some of the 29 plants were *V. nobilis* and not *V. rutilastra.* Adopting the precautionary principle, the 29 plants have been listed as *V. rutilastra*.

6.3 Fauna Assessment (Western Wildlife)

6.3.1 Fauna Habitats

Based on the results of the vegetation survey, a single fauna habitat is present in the Survey Area:

- Low heathland.

The habitat is in excellent condition. As the habitat in the Survey Area is part of a relatively large area of continuous habitat it is unlikely to be particularly important as an ecological linkage.

6.3.2 Fauna Assemblages

The faunal assemblages of the Survey Area are likely to be typical of the heathlands of the region and relatively intact, as the Survey Area is set within a large tract of native vegetation. Nine frog, 47 reptile, 99 bird, nine native mammal and three introduced mammal species have records within 10 km of the Survey Area on NatureMap (excluding subspecies and records not identified to species level, **Appendix 1**). This list is unlikely to be complete, as not all species known from the area are necessarily represented by records, and the list includes many species that would not occur in the Survey Area due to a lack of suitable habitat.

The Survey Area lacks breeding habitat for most frogs, so only the Turtle Frog (*Myobatrachus gouldii*) is likely to be present as a breeding species, as its breeding cycle is entirely terrestrial. Other frogs may breed nearby, including in man-made depressions that hold water, and forage in the Survey Area.

The Survey Area is likely to support a diverse reptile assemblage, with almost all the listed species potentially occurring. The only exceptions are species that favour rocky habitats. The sandplains of the region are known to be a centre of high reptile diversity.

The birds are likely to be less diverse, with waterbirds and those relying on a eucalypt canopy generally absent. The low heathland is likely to support a suite of honeyeaters and small insectivores, which are likely to fluctuate in abundance seasonally. Honeyeaters are likely to move in response to the availability of nectar.

The mammal assemblage is likely to be similar to that in other heathlands and shrublands in the region. As the Survey Area is well connected with a larger area of native vegetation, the mammal fauna is likely to be relatively intact, missing only those species that are extinct in the bioregion. Several species of bat are likely to forage over the area, but the Survey Area lacks roosting habitat such as tree hollows or caves. Small mammals such as dunnarts, the Honey Possum (*Tarsipes rostratus*) and Bush Rat (*Rattus fuscipes*) are likely to dominate the mammal fauna.

6.3.3 Conservation Significant Fauna

Several species of conservation significant fauna have been identified as potentially occurring in the area based on the database searches and literature review (**Table 13, Appendix 1**). Of these, many are unlikely to occur as their habitat requirements are not met within the Survey Area. This includes almost all Migratory Birds protected under an International Agreement such as shorebirds, seabirds, and waterbirds, as they are reliant on coastal beaches or wetlands. The Dibbler (*Parantechinus apicalis*) occurs only on islands in this region and is not known to occur on the mainland. The Ghost Bat (*Macroderma gigas*) is locally extinct, only known from subfossil material collected from caves in the region. The Chuditch (*Dasyurus geoffroii*) is generally considered to be locally extinct in the area, also known from subfossil material in caves. The Gilled Slender Blue-tongue Skink (*Cyclodomorphus branchialis*) is an uncommon inhabitant of semi-arid shrublands on heavy red soils or rocky areas (Wilson and Swan, 2010). Although the nearest known record is 3.8 km north north-east of the Survey Area (**Map 7, Section 11**; DBCA, 2007-), this species is not likely to occur due to lack of suitable habitat.

The following four species potentially could occur in the Survey Area.

Carnaby's Cockatoo (*Calyptorhynchus latirostris*)

Carnaby's Cockatoo is listed as Endangered under both the EPBC Act and BC Act. Carnaby's Cockatoo typically nests in large hollows in smooth-barked eucalypts (e.g., Salmon Gum or Wandoo) in the inland Wheatbelt region, however, their breeding range is shifting westwards and birds potentially nest in any suitably sized hollow in their range. During the non-breeding season, birds move to the west and south (Johnstone and Storr, 1998; DPaW, 2013; DSEWPaC, 2012). No confirmed breeding area for Carnaby's Cockatoo intersects the Survey Area or is likely to occur in the Survey Area, however, confirmed breeding areas occur within 12 km of the Survey Area (**Map 7, Section 11**) (DBCA, 2018a).

The Survey Area does not lie in vegetation identified as requiring investigation for Carnaby's Cockatoo feeding habitat – the closest is 0.8 km northwest of the Survey Area (**Map 7, Section 11**) (DBCA, 2018b). The low heathland in the Survey Area is likely to provide low-value Carnaby's Cockatoo foraging habitat as it includes species that may be used for foraging; *Banksia armata*, *Banksia sclerophylla* and *Hakea prostrata*. The foraging habitat is considered low value as the vegetation is very low and although proteaceous species are present, they are not the key species known to be favoured by Carnaby's Cockatoo such as *Banksia menziesii* or *Banksia prionotes*, which occur in taller proteaceous shrublands and woodlands in the region. As the foraging habitat is within 12 km of confirmed breeding habitat, it is potentially used by breeding birds, however, no evidence of foraging was recorded during the 2019 (Maia and Western Wildlife, 2020) or 2020 site visits.

Carnaby's Cockatoo generally roost in tall native or introduced eucalypts or pines in riparian habitats or near permanent water (DSEWPaC, 2012). The Survey Area does not intersect with and is not close to a confirmed roosting site for Carnaby's Cockatoo (**Map 7, Section 11**) (DBCA, 2018c) and the vegetation of the Survey Area would not provide roosting habitat for Carnaby's Cockatoo.

Malleefowl (*Leipoa ocellata*)

The Malleefowl is listed as Vulnerable under both the EPBC Act and BC Act. Malleefowl are largely confined to woodlands of mallee eucalypts on sandy soils (Department of Environment and Conservation (DEC), 2012), shrublands dominated by acacias and woodlands dominated by eucalypts (e.g., Wandoo, Marri, Mallet) (Benshemesh, 2007). Malleefowl may also be found on coastal heath where shrubs produce sufficient leaf litter for use in nest mounds (DEC, 2012). The closest known record is 4.4 km north-west of the Survey Area (**Map 7, Section 11**). The Survey Area is unlikely to provide breeding habitat, as the vegetation is too low and litter-forming shrublands are absent. If Malleefowl still persist in the region they may occur as foraging visitors to the Survey Area, however, the likelihood is low.

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is listed under both the EPBC Act and the BC Act as a Migratory Bird protected under an International Agreement. The Fork-tailed Swift is a non-breeding visitor to Australia between September and April, and though it can be common further north, in south-west Australia this species is generally scarce (Boehm 1962, Johnstone and Storr 1998). Although a migratory species, the Fork-tailed Swift has a large range and a large population that appears to be stable (Birdlife International 2021). In Western Australia, the Fork-tailed Swift is a largely aerial species and unlikely to use terrestrial habitats in Survey Area, although it may overfly the area.

Western Brush Wallaby (*Notamacropus irma*)

The Western Brush Wallaby is listed as Priority 4 by DBCA. In the Action Plan for Australian Mammals 2012 it is listed as of Least Concern (Woinarski et al., 2014), as although this species has decreased in range its abundance

has increased within its remaining range due to fox control. The Western Brush Wallaby is endemic to the south-west of WA, favoring open forest and woodland, as well as seasonally wet flats with grasses and thickets (Van Dyck and Strahan, 2008). The home-range size of this species has been estimated at about 9.9 ha for males and 5.3 ha for females (Bamford and Bamford, 1999), so the Survey Area is likely to represent the home-range of a single individual. There are nearby database records for this species **(Map 7, Section 11)**, and the Western Brush Wallaby is likely to occur in the Survey Area.

6.4 Vegetation Type

One vegetation type (Mixed Heathland, MHL) occurs in the Survey Area (**Table 7**). The data collected on the flora in the quadrats assessed and the photographs taken are presented in **Table 14 (Appendix 2)**.

Vegetation type MHL does not resemble any TEC or PEC currently listed for the Geraldton Sandplains bioregion or DBCA Midwest Region, respectively.

As only one vegetation type occurs in the Survey Area a vegetation type map is not included in this report.

Table 7: Vegetation type recorded in the Survey Area

Vegetation type code (broad floristic formation) Full description Area mapped (ha) (percent of Survey Area)	Associated species
MHL (Mixed Heathland) Low mixed Heathland mainly of *Calothamnus sanguineus*, *Banksia shuttleworthiana* and *Daviesia epiphyllum* with a Sparse Shrubland of *Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) and an Open mixed Sedgeland of *Caustis dioica*, *Mesomelaena pseudostygia* and *Mesomelaena tetragona*. Covers 18.38 ha (100% of the Survey Area).	*Allocasuarina microstachya, A humilis, Babingtonia grandiflora, Banksia tridentata*, *Eremaea violacea* subsp. *raphiophylla*, *Georgeantha hexandra, Hibbertia striata, Isopogon dubius, Scaevola canescens, Stylidium diuroides* subsp. *paucifoliatum.*
	

6.5 Vegetation Condition

Vegetation condition was assessed using the vegetation condition scale for the South West and Interzone Botanical Provinces (**Table 8**) (EPA, 2016).

Vegetation condition in the Survey Area was rated as Excellent – there are several old gravel exploration pits scattered throughout the Survey Area, however, vegetation has mostly regrown in these areas. No weeds were recorded and there was no evidence of dieback or heavy grazing.

As only one vegetation condition occurs in the Survey Area a vegetation condition map is not included in this report.

Table 8: Vegetation condition scale (EPA, 2016)

Vegetation condition	South West and Interzone Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of 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. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Poor	
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. 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 and shrubs.

7 Impacts and Clearing Principles

7.1 Impacts

7.1.1 Flora

Potential impacts to the plants and populations of the five priority flora species that were recorded in the Survey Area (including the dead *Synaphea lesueurensis*) are listed in **Table 6**. The impacts have been estimated using publicly available information accessible to Maia. It is likely that more records for these species have been found but the information is not available to Maia. The current WA distribution of the five species is shown on **Map 10 (Section 11)**. Two options were selected for this gravel pit extension area (Option 2 and Option 3, **Map 9**) and potential impacts have been calculated using the 8.72 ha of vegetation that would be cleared for Option 2.

Regional impact estimates for plants known to Maia of the five CSF species range from approximately 0.3% (*Synaphea lesueurensis* (P2)) to 11.1% (*Persoonia filiformis* (P3)), while regional impact for plant populations known to Maia ranges from 2.0% (*Persoonia rudis* (P3)) to 9.1% (*Synaphea lesueurensis*).

Similarly, local area (within 10 km of the centre of the Survey Area) impact estimates to plants range from approximately 0.3% (*Synaphea lesueurensis* (P2)) to 60.8% (*Verticordia rutilastra / V. ? rutilastra* (P3 / ?P3)), while local area impact for plant populations known to Maia ranges from 7.7% (*Xanthosia tomentosa* (P4)) to 25.0% (*Persoonia filiformis* (P3)).

However, note that: population calculations in **Table 6** and discussed above include 1 population for each of the species to be impacted by the proposed gravel extraction area. Only part of the population would be impacted and not the whole population. If the impact calculations were redone post clearing the number of populations would not have decreased because plants of each species would still remain in the Survey Area and there would still be one population. See also the notes re *Synaphea lesueurensis* and *Verticordia rutilastra* beneath **Table 6**.

Approximately 62.5% of the eight *Synaphea lesueurensis* populations known to Maia in the local area is in DBCA IUCN I-IV Legislated Lands. The records for this species span approximately 25 km north-west to south-east (**Map 10**). Maia also recorded this species in the eastern section of the Jurien East Road reserve and in an adjacent gravel pit area, and it is likely that more records occur in similar habitat between these records and in the surrounding area.

Approximately 50.0% of the four *Persoonia filiformis* populations known to Maia in the local area occur within DBCA IUCN I-IV Legislated Lands. As this species' records span about 134 km (to the south and north of the Survey Area; **Map 10**), it is likely that the actual impact to this species will be much lower than that estimated because more records are likely to occur within its currently known distribution.

Approximately 66.7% of the six *Persoonia rudis* populations known to Maia in the local area occur within DBCA IUCN I-IV Legislated Lands. All records for this species occur up to 263 km to the north and south of the Survey Area (**Map 10**), and it is likely that more plants would occur in similar habitat in the surrounding local area.

Approximately 88.9% of the nine *Verticordia rutilastra* populations known to Maia in the local area occur within DBCA IUCN I-IV Legislated Lands. All records for this species span over 173 km (**Map 10**). Given the span of records for this species and their density around and to the east of the Survey Area it is likely that more plants occur in similar habitat in surrounding remnants.

Approximately 76.9% of the 13 *Xanthosia tomentosa* populations known to Maia in the local area occur within DBCA IUCN I-IV Legislated Lands. All records for this species span 72 km (excluding the sole record approximately 100 km south-east of Perth), and the NatureMap records are all around the Survey Area from approximately 3 km to 27 km away. Maia also recorded this species in the Jurien East Road reserve and in the adjacent gravel pit survey area. It is likely to occur in similar habitat in areas between the Survey Area and the furthest record.

Given the number of priority plants located in the area surveyed, and that the vegetation type recorded in the Survey Area probably extends over quite a large area around and beyond the Survey Area, it is likely that each of these species will occur in similar numbers in the surrounding vegetation.

7.1.2 VEGETATION

The Shire proposes to clear 8.72 ha of the vegetation in the 18.38 ha Survey Area.

One pre-European vegetation association (VA) and one vegetation system association (VSA, Gairdner System) occur in the Survey Area – VA 1031 and VSA 1031 (**Map 11, Section 11**). When the clearing of 5.0 ha of vegetation in an adjacent gravel extraction area approved under CPS 8859-1 is included in the calculations, the additional clearing of 8.72 ha for this project would reduce the VA's remaining extent in both the Geraldton Sandplains bioregion and the Lesueur Sandplain subregion by 0.004%, while the extent of the VSA (in bioregion and subregion) would be reduced by 0.053%.

Native vegetation extent in the local area (i.e., the area within a 10 km radius centred close to the middle of the Survey Area and with the 5 ha cleared under CPS 8859-1 removed) is currently 73.84% (DPIRD, 2015 and Maia digitising of disturbed gravel reserve areas), which would be reduced by 0.03% to 73.81% with the 8.72 ha of clearing for the gravel pit extension.

Native vegetation extent in gravel reserve R35593 is currently 316.53 ha (90.91% of it remains; DPIRD, 2015 plus Maia digitising of disturbed gravel reserve areas) and clearing of 8.72 ha for the gravel pit extension would reduce NVE in the reserve by 2.50% to 88.41%.

One vegetation type (Mixed Heathland, MHL) was mapped over the whole of the Survey Area and its condition was rated as Excellent. The Survey Area is on the footslopes of lateritic uplands, and the Mixed Heathland vegetation type is similar to Griffin's GFG 20-13 (Griffin, 1994), which is noted as occurring on uplands and well drained slopes of grey sandy lateritic gravel between Eneabba, Lesueur, Watheroo and Dandaragan i.e., the vegetation type is mapped in the local area and beyond. The vegetation type is not the same as any TEC (DAWE, 2021d; DBCA, 2018d) or PEC (DBCA, 2021) currently listed for the Geraldton Sandplains bioregion and Midwest region, respectively.

7.1.3 FAUNA (WESTERN WILDLIFE)

Clearing of 8.72 ha of low heathland habitat will result in the loss of all habitat for native fauna in the clearing area. Populations of all species in the Survey Area are likely to persist in the adjacent extensive area of similar habitat. The clearing is unlikely to result in an increase in habitat fragmentation in the area, as it is set within a tract of continuous vegetation.

Two species of Threatened fauna potentially occur in the Survey Area – Malleefowl and Carnaby's Cockatoo. The Malleefowl (*Leipoa ocellata*) is likely to be an occasional foraging visitor to the Survey Area and the Survey Area would be a very small part of a much larger foraging range. The loss of 8.72 ha of possible foraging habitat is unlikely to have a significant impact on the Malleefowl. Carnaby's Cockatoo (*Calyptorhynchus latirostris*) is likely to be a foraging visitor to the Survey Area, but not likely to breed or roost in the Survey Area. Clearing will result in the loss of 8.72 ha of low value foraging habitat. This may include foraging habitat that is used by breeding birds, as breeding is known to occur with 12 km of the Survey Area. Loss of foraging habitat within 6 – 12 km of breeding sites is considered a threat to Carnaby's Cockatoo.

One Migratory species potentially occurs in the Survey Area. The Fork-tailed Swift (*Apus pacificus*) may overfly the Survey Area but is not likely to use the low heathland habitat. Therefore, clearing 8.72 ha of habitat is not likely to have a significant impact on this species.

One Priority species potentially occurs in the Survey Area - the Western Brush Wallaby (*Notamacropus irma*). The Survey Area is likely to represent the home-range of a single individual, as home-range size has been estimated at about 9.9 ha for males and 5.3 ha for females. Therefore, although some habitat for this species will be lost, clearing of 8.72 ha of low heathland is not likely to have a significant impact on this species.

7.1.4 Impact Limitation

Avoidance

The Shire needs to quarry gravel from its R35593 gravel lease to use for local road upgrade works planned for mid-2021 onwards (e.g., upgrade of a section of Jurien East Road between Cockleshell Gully Road and Indian Ocean Drive). The Shire has no other gravel source close to this section of Jurien East Road. Whenever possible the Shire sources gravel from already cleared areas to avoid clearing native vegetation. Existing pits in cleared areas are too far from the western section of Jurien East Road to be economically and operationally feasible and therefore the Shire needs to extract gravel from its gravel lease area close to the proposed works.

The flora and vegetation survey was carried out over an 18.38 ha Survey Area and the Shire then selected an 8.72 ha area to be cleared within it. The 8.72 ha was positioned to avoid impact to as many as possible of the conservation significant flora species located in the Survey Area.

Minimisation

The 8.72 ha area needed by the Shire has been reduced to the minimum area possible to supply adequate gravel for the future works proposed in the local area.

Mitigation

The Shire plans to mitigate any impacts associated with the proposed vegetation clearing and gravel extraction by revegetating the area once the gravel has been extracted. Vegetation will not be permanently lost from the site and, with time, there should be no net loss of vegetation from the area to be cleared. Extracting the gravel over a relatively short time and then rehabilitating it soon after will reduce the potential for long-term wind and water erosion, reduce the time that piles of topsoil are exposed to weed seeds, and ensure that the seed bank in the topsoil is not old.

The rehabilitation methods used by the Shire will ensure that water drains adequately, infiltrates into the rehabilitated areas and does not pond. To minimize the potential for the spread of weeds into a weed free area the Shire will adopt good weed management practices when extracting the gravel, when trucking it from the gravel pit and when carrying out the rehabilitation. Weed control will also be carried out as necessary post rehabilitation. No fill will be brought into the area to ensure that weed and non-provenance species are not introduced with fill.

The Shire will ensure that it uses appropriate dieback management measures when carrying out gravel extraction and when rehabilitating the area. Access will be from Jurien East Road onto Cockleshell Gully Road and into the gravel pit. There are no known dieback records along Cockleshell Gully Road; however, there is one disease positive sample point for *Phytophthora arenaria* along Jurien East Road between Indian Ocean Drive and Cockleshell Gully Road. Clearing and extracting activities will be scheduled for low rainfall months and they will not be carried out in wet or muddy conditions. Vehicles will be cleaned before accessing the gravel pit area.

7.2 Clearing Principles

Under the *Environmental Protection Act 1986* (EP Act), clearing of native vegetation requires a permit unless its purpose is exempt. Any vegetation clearing requiring a NVCP needs to address 10 clearing principles as part of the permitting process. **Table 9** addresses the 10 clearing principles with respect to the Survey Area.

Table 9: Clearing principles and the Survey Area

	Clearing principle	Proposed gravel extraction – Gravel Reserve 35593, Shire of Dandaragan
A	Native vegetation should not be cleared if it comprises a high level of biological diversity.	**Unlikely to be at variance to this principle** The Survey Area lies in an area of moderate plant species richness (DBCA, 2007-; Hopper and Gioia, 2004). It is on the Peron Slopes of the Lesueur Area (Martinick and Associates, 1988) and a mean species richness has been calculated for that area varying from 82.5 species on Sand Heath to 95.3 species on one of the three Laterite Heath vegetation types (from 10 m x 10 m quadrats or similar sized relevés). Species richness at the three 10 m x 10 m quadrats assessed in the Survey Area in October 2020 was 32, 38 and 41 (mean richness of 37.0).
B	Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	**Unlikely to be at variance to this principle** Two threatened fauna species potentially occur in the Survey Area: *Calyptorhynchus latirostris* (Carnaby's Cockatoo) and *Leipoa ocellata* (Malleefowl). Other Threatened fauna species are known from the region but are not likely to occur in the Survey Area due to lack of suitable habitat or local extinction. • Carnaby's Cockatoo: No confirmed breeding area for Carnaby's Cockatoo occurs in the Survey Area (DBCA, 2018a), and no breeding habitat is present. No confirmed Carnaby's Cockatoo roosting sites occur in the Survey Area (DBCA, 2018c) and no roosting trees are present in the Survey Area. Based on the vegetation recorded in the Survey Area it is likely that low value Carnaby's Cockatoo foraging habitat is present, as potential food-plants are present (*Banksia armata* and *Banksia sclerophylla*); although, more favoured food-plants that occur in the region are absent. No evidence of foraging activity was observed in the Survey Area during a January 2020 fauna reconnaissance survey carried out over a block of the same vegetation adjacent to the current Survey Area, and no Carnaby's Cockatoo. No Carnaby's Cockatoo were seen in the area when the botanists were carrying out the flora and vegetation survey in October 2020 or in the adjacent area in October 2019. • Malleefowl: Typically, the Malleefowl is found in woodlands of mallee eucalypts on sandy soils (DEC, 2012), shrublands dominated by acacias and woodlands dominated by eucalypts (Benshemesh, 2007). Malleefowl may also be found on coastal heath where shrubs produce sufficient leaf litter for use in nest mounds (DEC, 2012). It is unlikely the Survey Area contains important habitat for Malleefowl. The nearest known record is approximately 4.2 km north-west of the centre of the Survey Area (DBCA, 2007-). Ten Migratory Fauna were listed in the PMST search results and three of the 10 are also Threatened species. Eight Migratory Birds (protected under international agreement) have been recorded in the local area (DBCA, 2007-). The Migratory species are largely associated with marine and / or aquatic environments, which do not occur in the Survey Area. Only the Fork-tailed Swift (*Apus pacificus*) may occur. As this species is entirely aerial in WA it is unlikely to use the terrestrial habitat present in the Survey Area. No Specially Protected Fauna species have been recorded in the local area previously (DBCA, 2007-).

	Clearing principle	Proposed gravel extraction – Gravel Reserve 35593, Shire of Dandaragan
		One priority fauna species could occur in the Survey Area – *Notamacropus irma* (Western Brush Wallaby) (P4) (DBCA, 2007-). • The Survey Area is likely to represent the home-range of a single individual, as home-range size has been estimated at about 9.9 ha for males and 5.3 ha for females (Bamford and Bamford, 1999). Therefore, although some habitat for this species will be lost, clearing of 8.72 ha of low heathland is not likely to have a significant impact on this species. Based on the information above, the relatively small area to be cleared, the habitat and vegetation described in the Survey Area, and the fact that the vegetation is well represented in the surrounding area, clearing of 8.72 ha of vegetation in the Survey Area is unlikely to impact on significant habitat for most fauna species indigenous to Western Australia. Clearing of 8.72 ha of low value foraging habitat may impact on Carnaby's Cockatoo, however, there is uncertainty around the value of that habitat for foraging, and an extensive area of habitat will remain in the surrounding local area.
C	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	**Unlikely to be at variance to this principle** No Threatened flora species were recorded in the Survey Area. Four priority species were located: *Persoonia filiformis, P. rudis and Verticordia rutilastra* (all P3) and *Xanthosia tomentosa* (P4). Dead / senesced *Synaphea lesueurensis* (P2) plants were also recorded in the Survey Area. The current distribution of these species is discussed below. *Synaphea lesueurensis* (P2): 9 dead plants were recorded in the Survey Area (part of one population). Approximately 62.5% of the currently known local populations are protected in DBCA IUCN I-IV Legislated Lands. A maximum of 0.3% of all plants known to Maia and 9.1% of all populations would be impacted by the 8.72 ha of clearing in the Survey Area (the calculations include impacts from the adjacent area clearing). *Persoonia filiformis* (P3): 77 plants were recorded in the Survey Area. Approximately 50.0% of the local populations known to Maia are protected within DBCA IUCN I-IV Legislated Lands. A maximum of 11.1% of all plants known to Maia and 4.4% of all populations would be impacted by clearing of the 8.72 ha of the Survey Area. *Persoonia rudis* (P3): 20 plants were recorded in the Survey Area. Approximately 66.7% of the local populations known to Maia are protected within DBCA IUCN I-IV Legislated Lands. A maximum of 2.0% of all plants known to Maia and 2.0% of all populations would be impacted by clearing of the 8.72 ha of the Survey Area. *Verticordia rutilastra* and *V.* ? *rutilastra* (P3 / ?P3): 34 *V. rutilastra* and 3 *V.* ? *rutilastra* plants (combined as one population) were recorded in the Survey Area. Approximately 88.9% of the currently known local populations are protected within DBCA IUCN I-IV Legislated Lands. A maximum of 3.3% of all plants known to Maia and 11.1% of all populations would be impacted by clearing of the 8.72 ha of the Survey Area (the calculations include impacts from the adjacent clearing). *Xanthosia tomentosa* (P4): 154 plants (one population) were recorded in the Survey Area. Approximately 76.9% of the local populations known to Maia are protected within DBCA IUCN I-IV Legislated Lands. A maximum of 1.5% of all plants known to Maia and 3.1% of all populations would be impacted by clearing of the 8.72 ha of the Survey Area (the calculations include impacts from the adjacent clearing). No threatened flora species were recorded in the Survey Area. Based on records for the CSF currently in the conservation estate and Survey Area, the Survey Area is unlikely to be necessary for the continued existence of these species.

	Clearing principle	Proposed gravel extraction – Gravel Reserve 35593, Shire of Dandaragan
		The areas adjacent to (R35594) and north and east of (Lesueur National Park) R35593 are a Nature Reserve and National Park respectively and any so far unrecorded plants and populations of these species occurring in these areas would be protected. Based on the information above, there are no threatened flora species known in the Survey Area and, while four live and one dead priority flora species were located within it, the Survey Area would not be necessary for their continued existence. Note re calculations in **Table 6** and included above: Adopting the precautionary principle, impact calculations include the dead *Synyaphea lesueurensis* plants located in the Survey Area and the *Synaphea* sp. plant recorded in the adjacent Survey Area. They also include *Verticordia* ? *rutilastra* plants. The population calculations include 1 population of each of the species to be impacted by the proposed gravel extraction impact area; however, only part of the population would be impacted and not the whole population. If the impact calculations were redone post any clearing, the number of populations would not have decreased because plants would still remain in the Survey Area.
D	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a TEC.	**Not at variance to this principle** The vegetation of the Survey Area does not comprise the whole or part of a TEC. The Mixed Heathland vegetation type mapped in the Survey Area is not similar to any of the currently listed TECs. The closest occurrence of a conservation significant ecological community is the 'Banksia Woodlands of the Swan Coastal Plain' Endangered TEC, and its buffer is approximately 0.2 km west of the north-western corner of the Survey Area. This ecological community is listed as a TEC under the EPBC Act and as a 'Priority 3(iii)' PEC by DBCA (Banksia dominated woodlands of the Swan Coastal plain IBRA region). Therefore, the vegetation type mapped within the Survey Area does not comprise the whole or a part of a TEC and it is not necessary for the maintenance of a TEC.
E	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	**Unlikely to be at variance to this principle** The Survey Area is in the Geraldton Sandplains IBRA bioregion and Lesueur Sandplains subregion. Currently 44.78% of the native vegetation in the Geraldton Sandplains remains, 34.48% in the Lesueur Sandplain and 44.21% in the Shire of Dandaragan. One pre-European vegetation association (VA)- 1031 – is mapped in it and one vegetation system association (VSA) - 1031. In the Geraldton Sandplains and the Lesueur Sandplain 34.48% of VA 1031 remains: and 14.72% of the remaining extent is protected for conservation. With the clearing of 8.72 ha of VA 1031 in the Survey Area its current extent in the bioregion and subregion would decrease by 0.004%. Similarly, 59.20% of VSA 1031 currently remains in the bioregion and subregion and 47.10% is protected. Its area would decrease by 0.05% with the proposed clearing. Native vegetation extent (NVE) in the local area (with the 5 ha cleared under CPS 8859 1 also removed) is currently 73.84%. This would decrease by 0.03% to 73.81% with the 8.72 ha of proposed clearing for the gravel pit extension. When the same intersects are carried out for R35593, it currently retains 90.91% native vegetation. When the 5 ha cleared under CPS 8859-1 and the 8.72 ha to be cleared under this application are removed, NVE in R35593 would decrease by 2.50% to 88.41%.

	Clearing principle	Proposed gravel extraction – Gravel Reserve 35593, Shire of Dandaragan
		Locally, the Survey Area is not significant as a remnant in an area that has been extensively cleared because approximately 74% of the NVE would remain in the local area and 88% of NVE in R35593. [Note: local area = 10 km buffered search area around approximate centre of Survey Area. The local area then intersected with Native Vegetation Extent (DPIRD, 2015) and with areas digitised by Maia.]
F	Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	**Not at variance to this principle** There are no defined watercourses or wetlands in or close to the Survey Area. The closest is a paluslope wetland and a creek (DBCA, 2015b) located approximately 1.1 km to the south-west of the south-western corner of the Survey Area. The proposed clearing should not impact on these areas.
G	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	**Unlikely to be at variance to this principle** One soil landscape unit is mapped in the Survey Area – 222Ye_2 (described as pale sandy gravels, shallow gravel over duricrust, gravelly pale deep sand, pale and yellow deep sands) (DAFWA, 2014). The unit has a high to extreme wind erosion risk. Wind erosion could occur if the soil is left exposed, particularly if subject to strong prevailing winds. The proposed clearing may therefore cause land degradation in the form of soil erosion. However, given the extent of the proposed clearing and the fact that the Shire of Dandaragan will extract the gravel over a relatively short time span and then rehabilitate the cleared area, potential degradation should be kept to a minimum. Clearing and gravel extraction already carried out in this reserve does not appear to have caused appreciable land degradation around the existing pit area and previously cleared areas.
H	Native vegetation should not be cleared if the clearing of vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	**Unlikely to be at variance to this principle** The Survey Area is located within the Section 5(1)(g) Gravel Reserve R35593, which is listed as IUCN VI (a protected area with sustainable use of natural resources). Nature Reserve R35594 abuts the western boundary of R35593. R35594 is an IUCN I-IV listed reserve (IUCN IA) and its eastern boundary is approximately 0.1 km west of the western boundary of the Survey Area. Lesueur National Park (R42032, IUCN II) abuts the northern and eastern boundaries of R35593, and the Survey Area is approximately 0.5 km at its closest to the south of the northern boundary. The proposed works should not affect the environmental values of R42032. The access road from Cockleshell Gully Road to the gravel pit area goes through a section of R35594; however, the gravel pit has been in use since the late 1970s, gravel has been extracted from both sides of the access road in the past, and only one small section close to Cockleshell Gully Road has intact native vegetation either side of it. This intact vegetation does not appear to have been impacted by use of the access track to date. The vegetation association of the Survey Area is rated as having high susceptibility to dieback, but no known positive *Phytophthora* species points are located within or close to the Survey Area (30 June 2018) (PD, 2014a). No weeds were found in the Survey Area.

	Clearing principle	Proposed gravel extraction – Gravel Reserve 35593, Shire of Dandaragan
		The Shire will use appropriate weed and dieback management practices to address the risk of the spread of weeds and dieback to adjacent areas while carrying out the works. No fill will be brought to the area once the gravel has been extracted to lessen the chance of introducing weed species. Access will be via Cockleshell Gully Road and Jurien East Road and both are existing roads.
I	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	**Unlikely to be at variance to this principle** Given that the clearing depth will be shallow (approximately 1 m), the absence of wetlands and watercourses in the area, the proposed clearing is unlikely to cause long-term deterioration in the quality of surface or underground water.
J	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	**Not at variance to this principle** Given the sandy/gravelly soils in the area, the proposed clearing should not cause or exacerbate the incidence or intensity of flooding. In addition, there are no watercourses or wetlands in the Survey Area (DBCA, 2015b) and less than 3% of the one soil landscape unit that occurs in the Survey Area (222Ye_2) is rated as having a moderate to high hazard for flood risk (DPIRD, 2017).

8 Project Personnel, Licences and Limitations

8.1 Project Personnel

The survey was carried out and the report prepared by the personnel listed in **Table 10**. A Regulation 4 Permit was applied for through DBCA and the botanical survey on 5(1)(g) Reserve R35593 was carried out under authority number CE006240.

Table 10: Project personnel and licences

Botanist	Flora licence number
Christina Cox (survey and report)	FB62000152
Scott Hitchcock (survey and report)	FB62000064-2
Rochelle Haycock (report)	Not applicable
Jen Wilcox, Western Wildlife (report)	Not applicable
Conrad Slee (plant identifications and report)	Not applicable

8.2 LIMITATIONS

Technical Guidance, Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016) and Technical Guidance, Terrestrial Fauna Surveys (EPA, 2020), state that any survey-specific issues / limitations should be addressed in a limitations section and that the limitations should be addressed as standard, whether they were a limitation of survey or not. **Table 11** addresses any survey-specific issues / limitations.

Table 11: Limitations

Limitation	Comment
Availability of contextual information at a regional and local scale	**No limitation**
	A desktop study was carried out to gather contextual information at a regional and local scale. The EPBC Act Protected Matters search tool, NatureMap and NationalMap were used to gather information, along with data from DBCA's threatened and priority flora and ecological communities databases. Relevant environmental GIS layers were downloaded and Beard's pre-European vegetation mapping, soil landscape mapping units and GoWA's vegetation statistics were used to provide context. Information was available on other flora and vegetation surveys conducted for the Shire of Dandaragan adjacent to or close to the current Survey Area. The databases and results of the flora and vegetation information were used to inform the fauna desktop study along with the results of a fauna reconnaissance survey carried out in early 2020. The Survey Area and proposed clearing area were digitised by Maia using Landgate's Locate Imagery uploaded through ESRI ArcGIS and the Shire of Dandaragan approved the digitised area.
Competency /experience of the team carrying out the survey, including experience in the bioregion surveyed	**No limitation**
	Scott and Christina have more than 11 years of experience in carrying out botanical surveys in WA, including in the Geraldton Sandplains bioregion. One or more specimens for each of the species encountered during the survey were collected for formal identification using the resources of the WA Herbarium in Perth. The specimens were identified by Conrad Slee, a botanist with more than 20 years of experience in the taxonomy of the flora of WA. Jen Wilcox has more than 21 years of experience in carrying out fauna surveys in WA, including in the Geraldton Sandplains bioregion.
Proportion of flora or fauna recorded and/or collected, any identification issues	**No limitation**
	One hundred and seven (107) taxa from 31 families and 62 genera were recorded from the 18.38 ha Survey Area: 1% of the 107 taxa were annual species and 99% perennial; 87% of the species list was identified from fertile specimens (with flowers/fruit). As 165 specimens were collected, and 107 taxa identified, more than one specimen was collected for some taxa. Two taxa could not be confirmed beyond genus (*Cassytha* sp. and *Schoenus* sp.) because they were not fertile. No conservation significant *Cassytha* species are known from the Geraldton Sandplains. Five conservation significant *Schoenus* species have records in the Lesueur Sandplain subregion, but they have not been located within 24 km of the Survey Area and do not occur in similar habitat. A *Thysanotus* specimen collected could be either *Thysanotus patersonii* or *T. manglesianus*, and neither species is conservation significant. The proportion of the flora collected and identified based on sampling, survey time, area surveyed, and intensity of survey effort was good.

Limitation	Comment
Was the appropriate area fully surveyed (effort and extent)	**No limitation**
	A flora and vegetation reconnaissance survey and a targeted flora survey were conducted over the Survey Area by two botanists over three days (October 25, 26 and 28). The botanists walked traverses at approximately 12-13 m spacings and surveyed a band of vegetation approximately 6-10 m wide. The flora was also sampled at three 10 m x 10 m quadrats. About 87% of the Survey Area was assessed (via the three quadrats and traverses walked). Plants of known or suspected conservation significance were targeted and counted, and their locations recorded on a GPS. Opportunistic collections were made of any species encountered that had not been recorded in quadrats. A fauna reconnaissance survey was conducted in an adjacent survey area by one zoologist in January 2020. As the habitat in the current Survey Area is the same as that in the adjacent survey area no fauna survey was carried out in the current Survey Area. The botanists saw no CBC in the Survey Area while carrying out the survey.
Access restrictions within the survey area	**No limitation**
	There were no access problems. The Survey Area is within an existing gravel pit lease adjacent to Cockleshell Gully Road with tracks to the existing gravel area. The botanists walked the short distance from the existing cleared area to the Survey Area.
Survey timing, rainfall, season of survey	**No limitation**
	The flora and vegetation survey was conducted in October 2020 (spring). The spring survey was timed to coincide with flowering times for threatened flora (particularly annual species) that have been recorded in the surrounding area. Rainfall at Jurien Bay over the four months before the survey was 136.0 mm less than the long-term (1968 to 2021) average. Therefore, the flora and vegetation could have been in below average condition in October 2020. Approximately 1% of the species recorded were annual species and approximately 87% of the flora taxa recorded were fertile when the survey was carried out (flowering, fruiting or both flowering and fruiting).
Disturbances (fire, flood, accidental human intervention etc.)	**No limitation**
	No major disturbances were evident or noted by the botanists while carrying out the survey. No floods, severe storms or fires had occurred in the weeks or months before the survey was carried out. The Survey Area is adjacent to a disturbed area – recent and past gravel extraction areas. Small and shallow test pits have been dug in the Survey Area in the past and the vegetation had mostly grown back in these areas.

9 CONCLUSIONS

The Survey Area is in the Lesueur Sandplain subregion of the Geraldton Sandplains bioregion. Currently, 34.48% of pre-European vegetation association 1031 remains in both the Geraldton Sandplains bioregion and Lesueur Sandplain subregion and 14.72% of its current extent is protected in the conservation estate. Vegetation system association 1031 is rated as having high susceptibility to dieback; however, no known positive *Phytophthora* species points are located within 2 km of the Survey Area.

The Survey Area is in Section 5(1)(g) reserve R35593. R35593 is bounded by Nature Reserve 35594 (adjacent to the reserve's western boundary) and by Lesueur National Park (adjacent to the reserve's northern and eastern boundaries). The designated purpose of the R35593 is "Gravel Resource Management, Restoration and

Conservation". The reserve is in an environmentally sensitive area. It is not in a Geomorphic Wetlands wetland or in or close to any other watercourses or wetlands.

The Survey Area is in an area of moderate plant species richness. It is in the Peron Slopes landform and species richness in the three 10 m x 10 m quadrats assessed in the Survey Area was lower than that recorded during other surveys carried out elsewhere on this landform.

No Threatened flora species protected by the federal EPBC Act or by the WA BC Act were recorded in the Survey Area.

Four live priority flora species were located during the survey - *Persoonia filiformis*, *Persoonia rudis*, *Verticordia rutilastra* (all P3) and *Xanthosia tomentosa* (P4) – and one dead / senesced priority flora species - *Synaphea lesueurensis* (P2).

Nine regional endemic species were collected from the Survey Area (when ocean and very disjunct records are excluded for two of the species), one range extension species and one range gap filling species. No weed species were located in the Survey Area.

One vegetation type in excellent condition was mapped over the Survey Area – Mixed Heathland. The vegetation type does not resemble any of the TECs or PECs currently listed for the Geraldton Sandplains bioregion or for the DBCA Midwest Region, respectively.

An impact assessment was carried out for the priority species located in the Survey Area (including the dead *Synaphea lesueurensis*). Regional impacts estimated for the plants located in the Survey Area range from 0.3% (*Synaphea lesueurensis*) to 11.1% (*Persoonia filiformis*), while impact to plant populations in the local area known to Maia ranges from 2.0% (*Persoonia rudis*) to 9.1% (*Synaphea lesueurensis*); 50.0% of the *Persoonia filiformis* local populations known to Maia are in protected lands and 62.5% of the *Synaphea lesueurensis* populations. Given the number of priority plants located in the 18.38 ha area surveyed, and that the vegetation type recorded in the Survey Area extends over quite a large area around and beyond the Survey Area, it is likely that the five priority species recorded in the Survey Area occur in similar numbers and densities in the surrounding vegetation.

The flora and vegetation survey was carried out over the 18.38 ha Survey Area and the Shire then selected a 8.72 ha area to be cleared within the Survey Area. The 8.72 ha area was selected to minimise impact to the conservation significant flora species located in the Survey Area and to be a manageable shape to clear.

Clearing of 8.72 ha of vegetation association 1031 in the Survey Area would reduce its remaining extent in the Geraldton Sandplains bioregion (and the Lesueur Sandplain subregion) by 0.004% and that of vegetation system association 1031 by 0.053%. The local area (the area within a 10 km radius of the Survey Area) will retain approximately 73.81% native vegetation extent after the 8.72 ha of proposed clearing in the gravel pit, while native vegetation extent in R35593 would be 88.41% post clearing.

Clearing of 8.72 ha of low heathland habitat will result in the loss of all native fauna habitat from that cleared area. Populations of all fauna species in the Survey Area are likely to persist in the adjacent extensive area of habitat. The clearing is unlikely to result in an increase in habitat fragmentation in the area, as it is set within a tract of continuous vegetation.

Two species of threatened fauna potentially occur in the Survey Area. The Malleefowl (*Leipoa ocellata*) is only likely to be an occasional foraging visitor to the Survey Area, and the Survey Area would be a very small part of a much larger foraging range; therefore, the loss of 8.72 ha of possible foraging habitat is unlikely to have a significant impact on the species. Carnaby's Cockatoo (*Calyptorhynchus latirostris*) is likely to be a foraging visitor to the Survey Area, but not likely to breed or roost in the Survey Area. The foraging habitat may be used by breeding birds, as

breeding is known to occur within 12 km of the Survey Area. Loss of foraging habitat within 6 – 12 km of breeding sites is considered a threat to Carnaby's Cockatoo. Clearing will result in the loss of 8.72 ha of low value foraging habitat.

No evidence of Carnaby's Cockatoo foraging was observed in the Survey Area during the spring 2019 botanical survey or the January 2020 reconnaissance survey of the adjacent area (Maia and Western Wildlife, 2020), and no Carnaby's Cockatoo were seen in the area when the botanical survey was carried out in October 2020.

One Migratory species potentially occurs in the Survey Area. The Fork-tailed Swift (*Apus pacificus*) may overfly the Survey Area but is not likely to use the low heathland habitat. Therefore, clearing 8.72 ha of habitat is not likely to have a significant impact on this species.

One P4 fauna species is likely to occur in the Survey Area - the Western Brush Wallaby (*Notamacropus irma*). The Survey Area is likely to represent the home-range of a single individual, as home-range size has been estimated at about 9.9 ha for males and 5.3 ha for females. Therefore, although some habitat for this species will be lost, clearing of 8.72 ha of low heathland is not likely to have a significant impact on the species.

When the 10 clearing principles are addressed, three are considered not to be at variance and seven are considered unlikely to be at variance.

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11 MAPS

Location Map

Karratha
Newman
Wiluna
Geraldton
Kalgoorlie
Perth

Localities (Geoscience Australia, 20020101)
Road Network (Main Roads, 20190516)

The Survey Area

maia

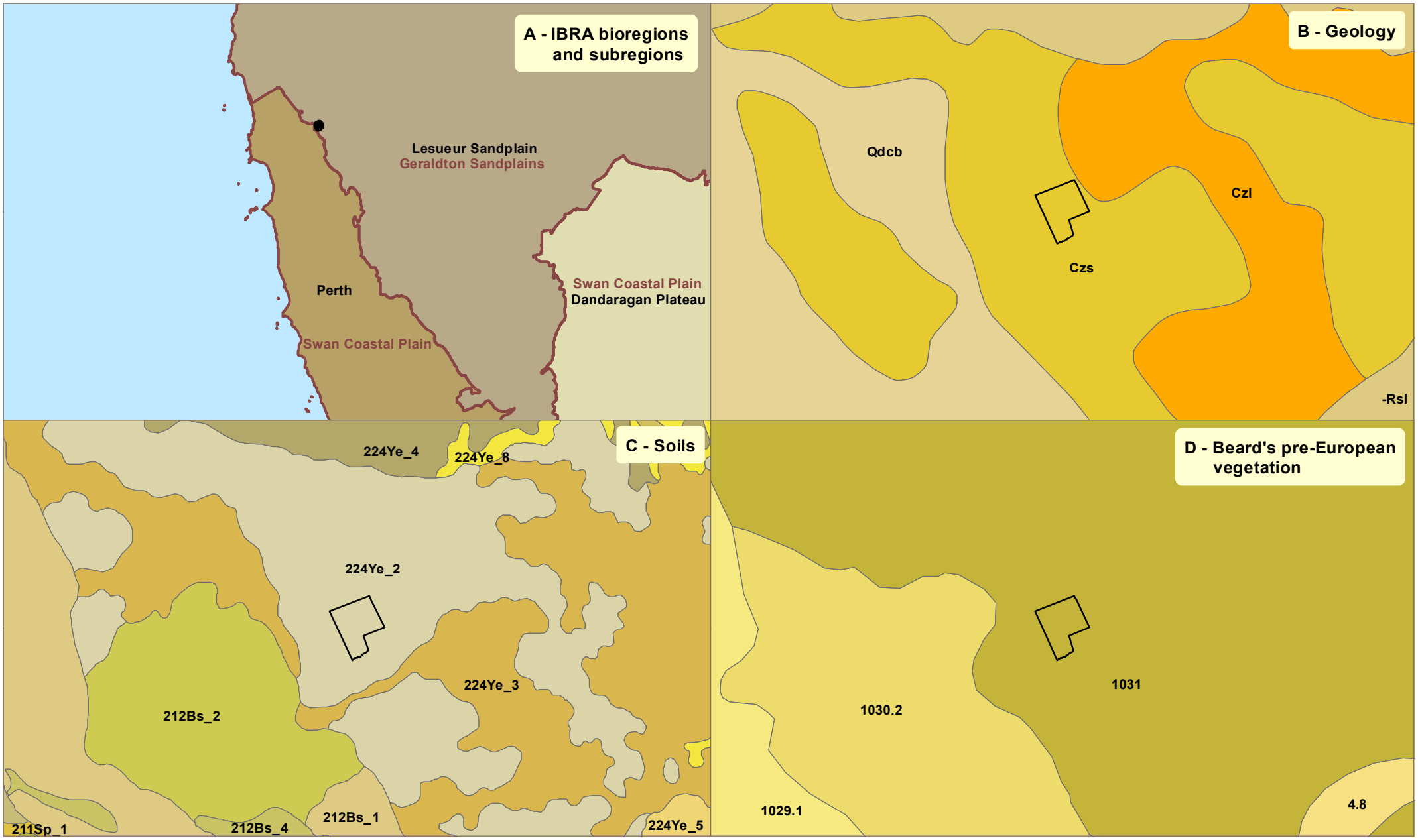
N

0 0.1

Kilometres

Datum: GDA 1994, MGA 50

Map: 1
Prepared for: SofD
Drawn by: RH
Date: 25/02/2021
Version: 1 **Size:** A4



Location Map

- Karratha
- Newman
- Wiluna
- Geraldton
- Kalgoorlie
- Perth

Survey Area

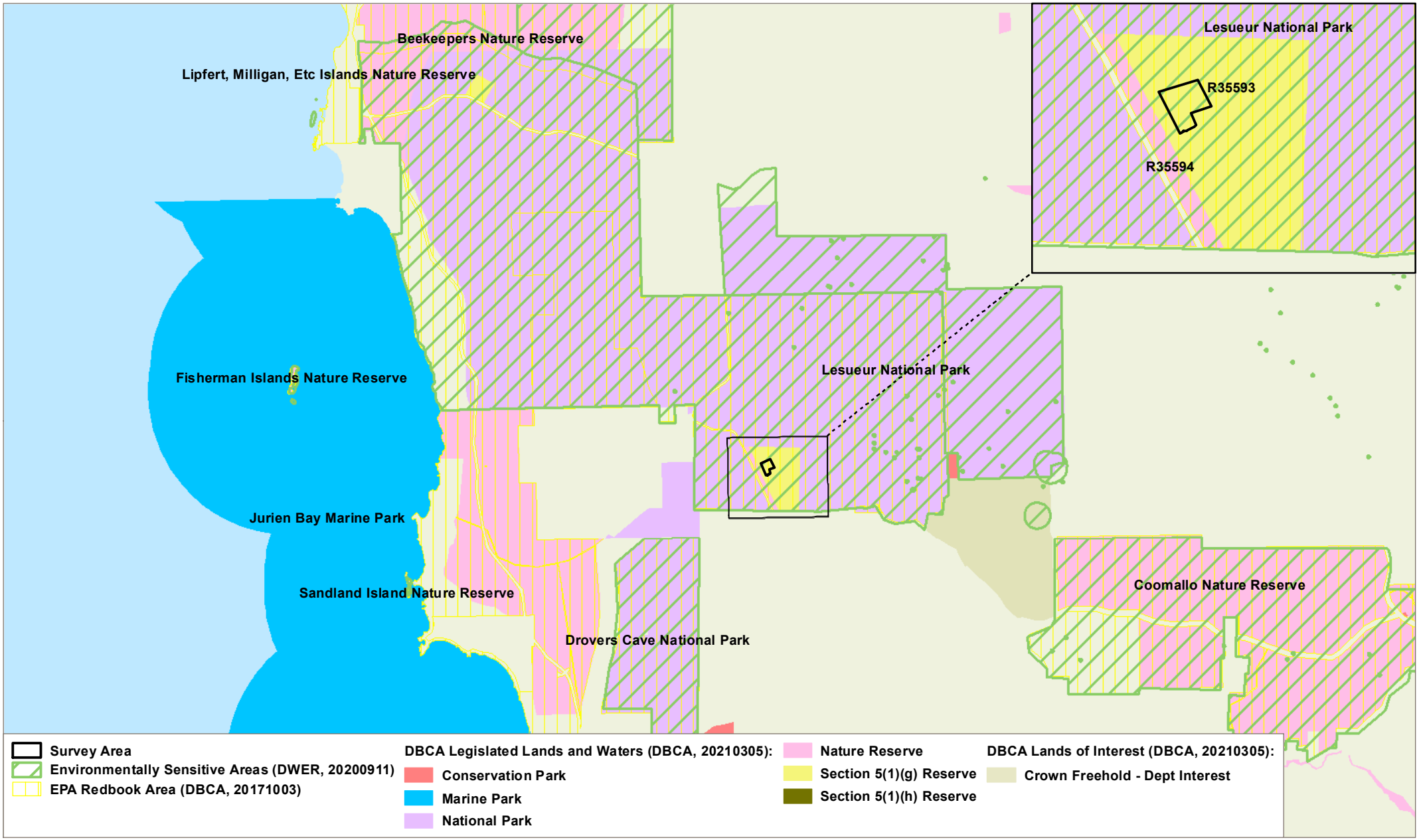
IBRA Bioregions and Subregions, Geology, Soil Landscape Units and Beard's Pre-European Vegetation (Vegetation System Associations)

maia

N

Datum: GDA 1994, MGA 50

Map: 2
Prepared for: SofD
Drawn by: RH
Date: 25/02/2021
Version: 1 **Size:** A4



Protected and Significant Areas

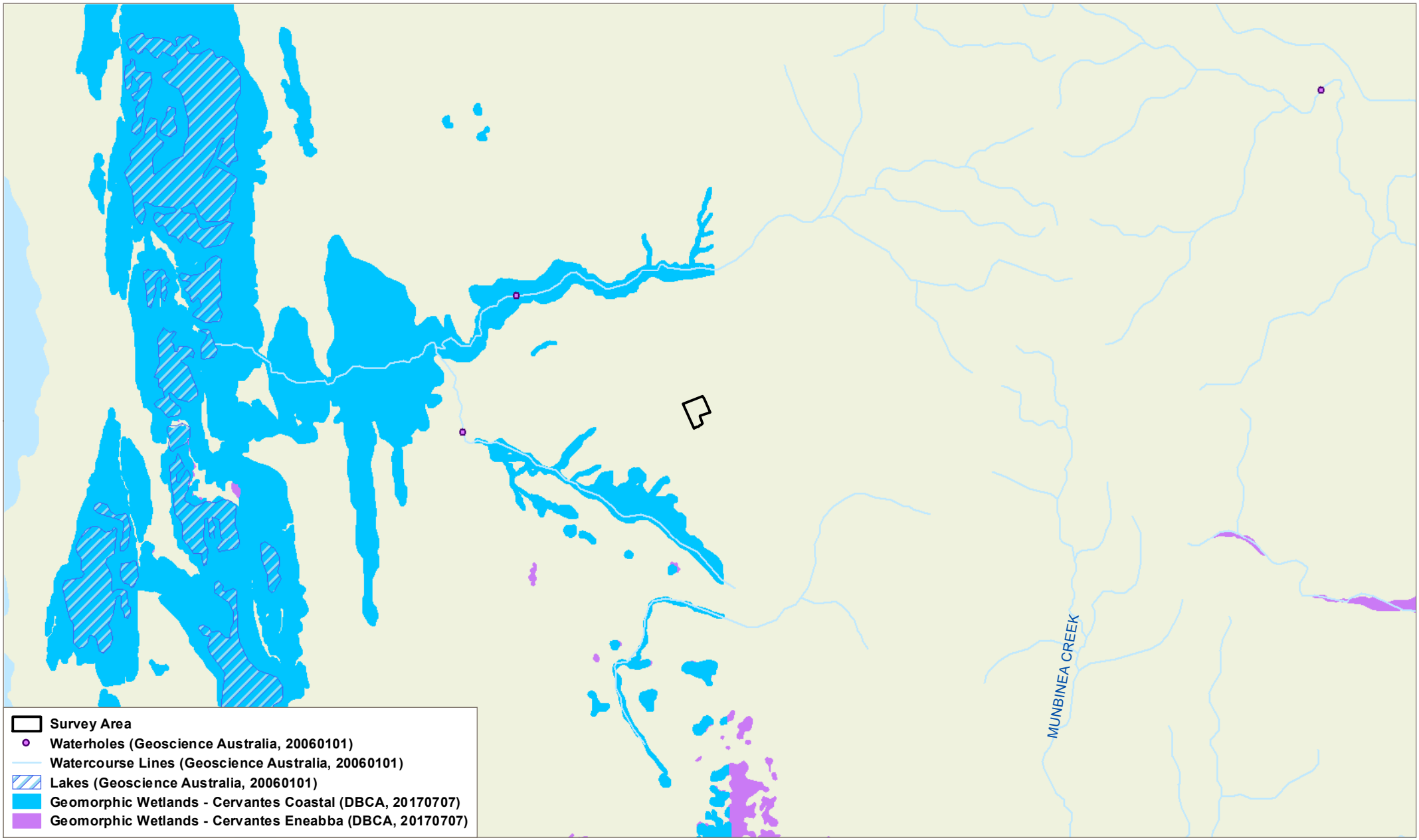
N

0 4.25

Kilometres

Datum: GDA 1994, MGA 50

Map: 3
Prepared for: SofD
Drawn by: RH
Date: 17/03/2021
Version: 1 **Size:** A4



Location Map

Watercourses and Wetlands

maia

N

0 2

Kilometres

Datum: GDA 1994, MGA 50

Map: 4
Prepared for: SofD
Drawn by: RH
Date: 25/02/2021
Version: 1 **Size:** A4

Location Map

Quadrats and Traverses

maia

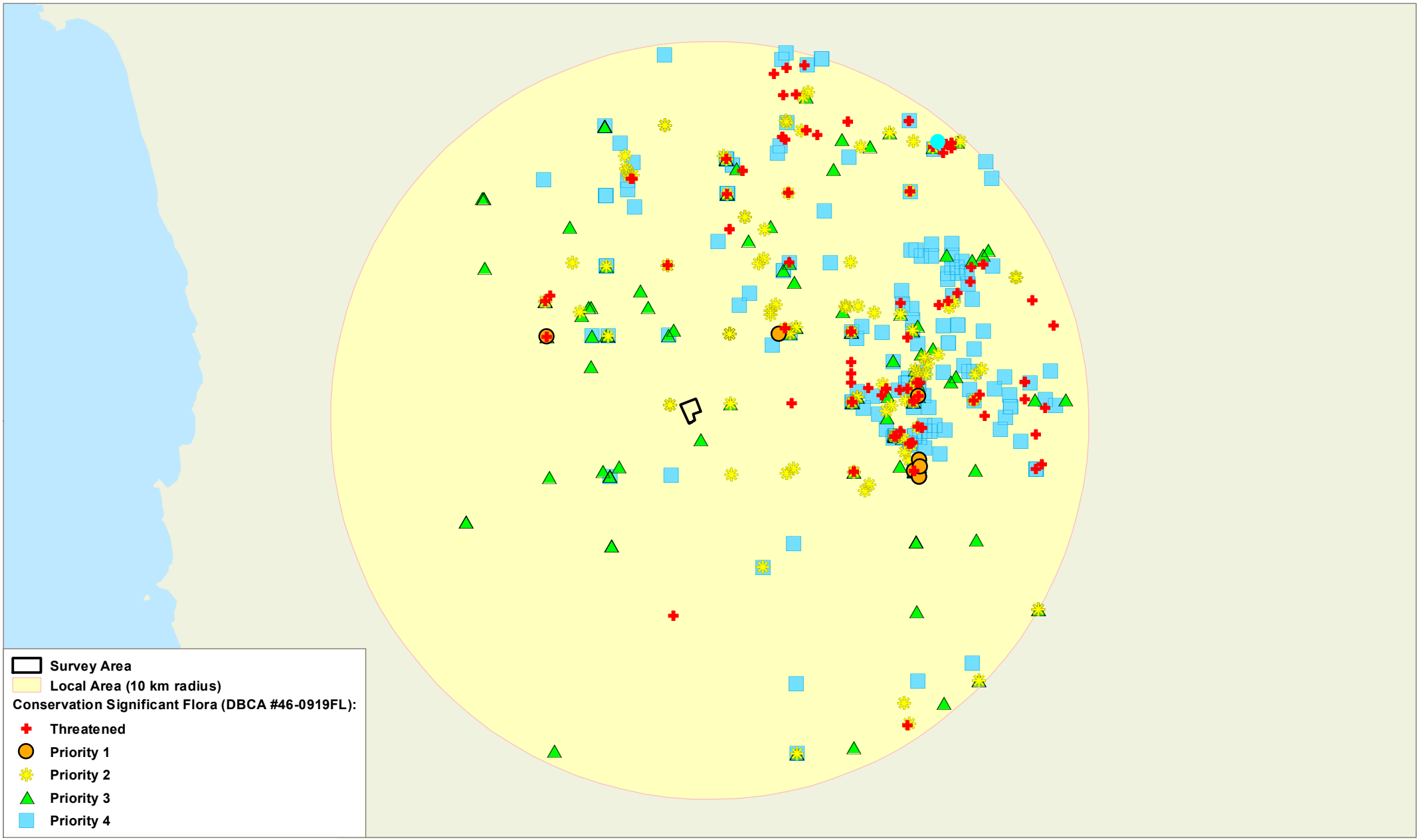
N

0 0.075

Kilometres

Datum: GDA 1994, MGA 50

Map: 5	
Prepared for: SofD	
Drawn by: RH	
Date: 25/02/2021	
Version: 1	**Size:** A4



Conservation Significant Flora - DBCA (search reference #46-0919FL)

maia

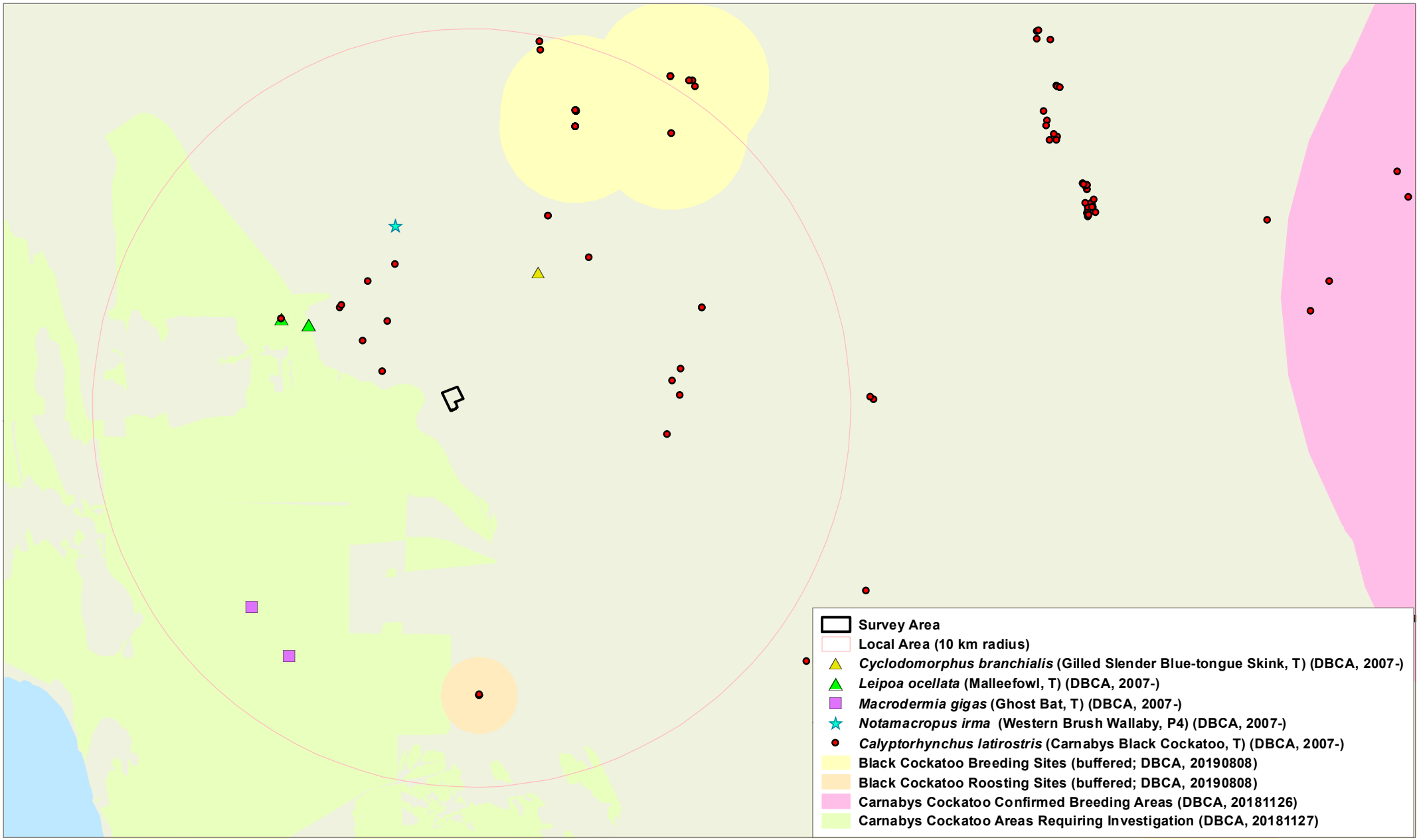
N

0 3

Kilometres

Datum: GDA 1994, MGA 50

Map: 6
Prepared for: SofD
Drawn by: RH
Date: 25/02/2021
Version: 1 **Size:** A4



Conservation Significant Fauna - DBCA and NatureMap Records

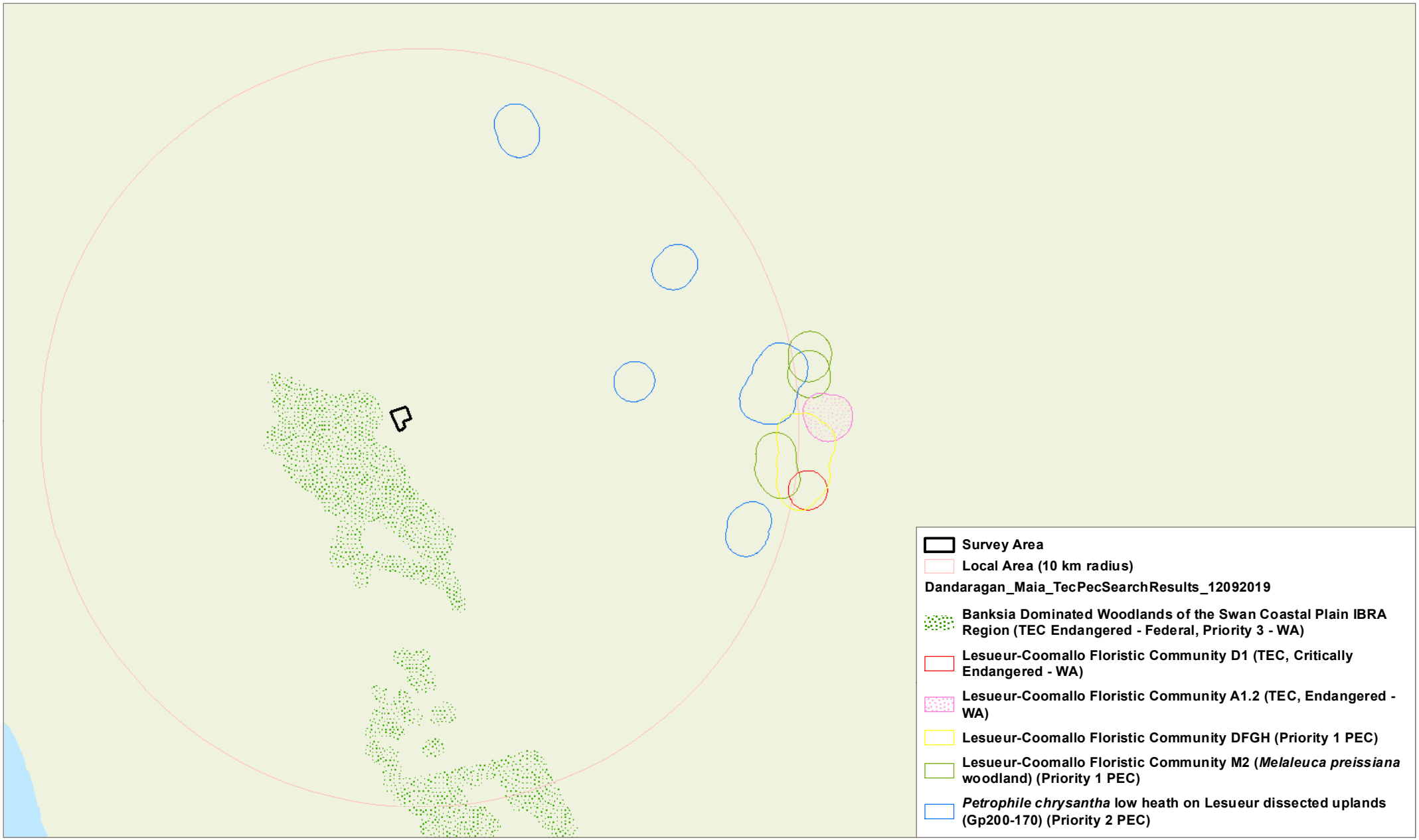
N

0 3

Kilometres

Datum: GDA 1994, MGA 50

Map: 7
Prepared for: SofD
Drawn by: RH
Date: 25/02/2020
Version: 1 **Size:** A4



Threatened and Priority Ecological Communities (DBCA search reference #53-0919EC)

maia

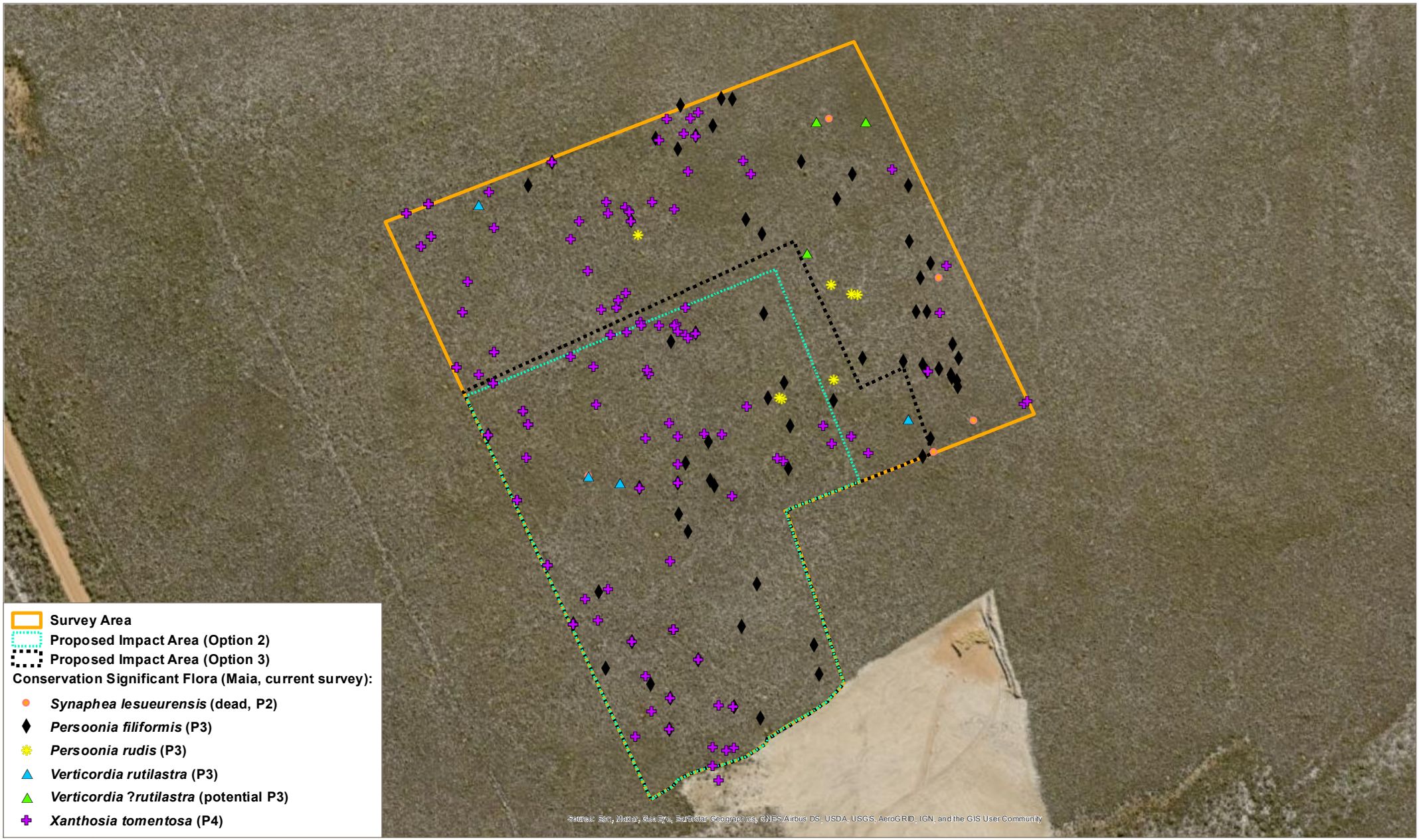
N

0 3

Kilometres

Datum: GDA 1994, MGA 50

Map: 8
Prepared for: SofD
Drawn by: RH
Date: 25/02/2021
Version: 1 **Size:** A4



Location Map

Conservation Significant Flora (Survey Results)

maia

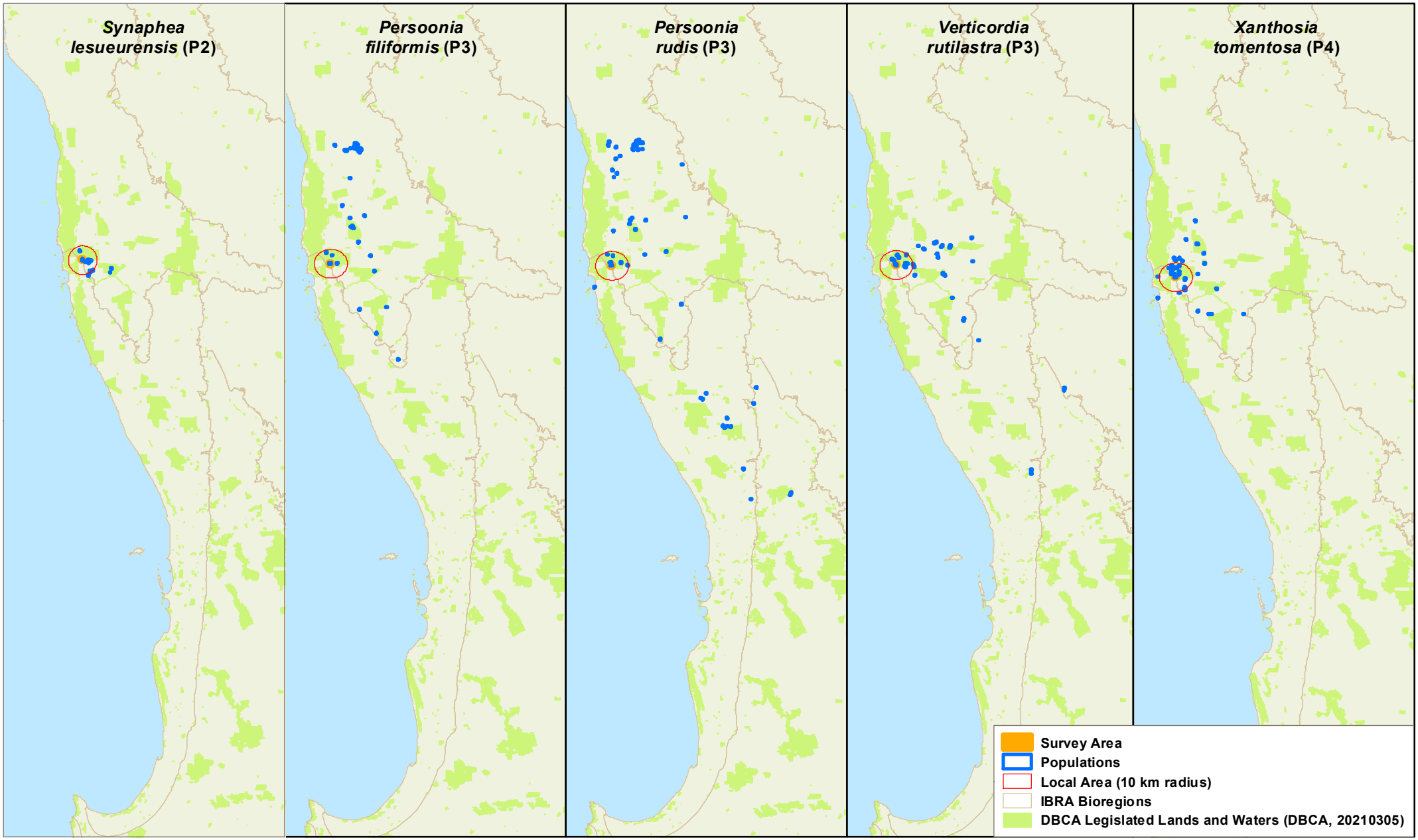
N

0 0.075

Kilometres

Datum: GDA 1994, MGA 50

Map: 9	
Prepared for: SofD	
Drawn by: RH	
Date: 25/02/2021	
Version: 1	**Size:** A4



Distribution of Conservation Significant Flora in WA

maia

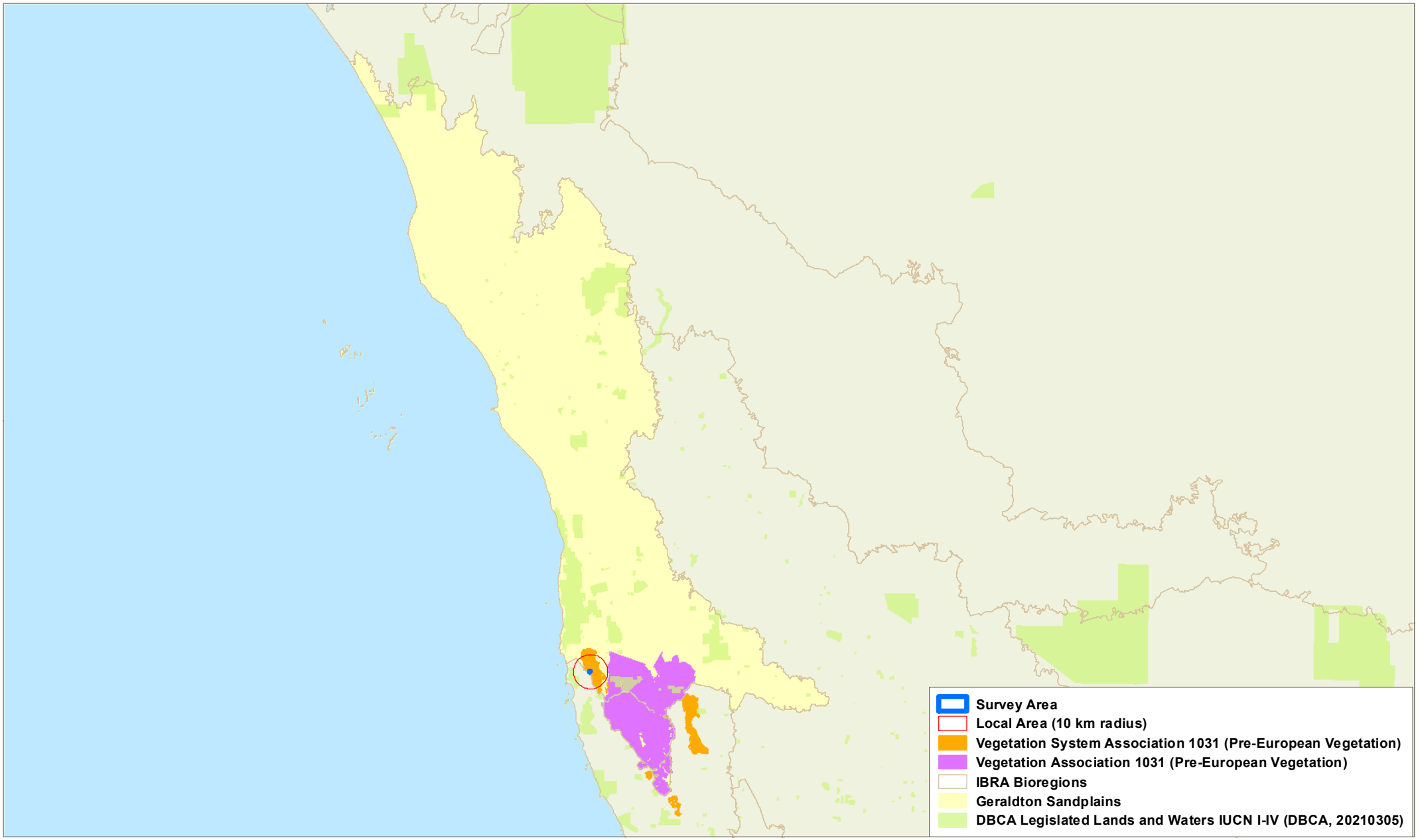
N

0 50

Kilometres

Datum: GDA 1994, MGA 50

Map: 10
Prepared for: SofD
Drawn by: RH
Date: 17/03/2021
Version: 1 **Size:** A4



Distribution of Vegetation Association 1031 (Pre-European Extent) in the Geraldton Sandplains bioregion

maia

N

0 50

Kilometres

Datum: GDA 1994, MGA 50

Map: 11
Prepared for: SofD
Drawn by: RH
Date: 16/03/2021
Version: 1 **Size:** A4

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APPENDIX 1: SEARCH RESULTS

These results were collated from NatureMap searches carried out over 10 km from the approximate centre of the Survey Area (flora and fauna) and EPBC Act searches using the Protected Matters Search Tool (search refs OVGE49 (fauna and flora, 10 km buffer). The significant flora species located during a flora and vegetation survey carried out over an adjacent area are also listed.

Table 12: Conservation significant flora database searches and previous survey results

Species	Conservation Code	PMST	NM	TPFL	WAHERB	M & WW
Acacia forrestiana	T (EPBC VU, BC VU)	•	•	•	•	
Andersonia gracilis	T (EPBC EN, BC VU)	•				
Anigozanthos viridis subsp. *terraspectans*	T (EPBC VU, BC VU)	•				
Banksia catoglypta	T (EPBC VU, BC VU)	•	•		•	
Caladenia hoffmanii	T (EPBC EN, BC EN)	•				
Drakaea elastica	T (EPBC EN, BC CR)	•				
Eleocharis keigheryi	T (EPBC VU, BC VU)	•	•	•	•	
Eucalyptus argutifolia	T (EPBC VU, BC VU)	•				
Eucalyptus impensa	T (EPBC EN, BC CR)	•				
Eucalyptus johnsoniana	T (EPBC VU, BC VU)	•	•	•		
Eucalyptus lateritica	T (EPBC VU, BC EN)	•	•	•	•	
Eucalyptus leprophloia	T (EPBC EN, BC EN)	•				
Eucalyptus suberea	T (EPBC VU, BC VU)	•	•	•	•	
Grevillea batrachioides	T (EPBC EN, BC CR)	•	•	•	•	
Grevillea humifusa	T (EPBC EN, BC CR)	•	•		•	
Hakea megalosperma	T (EPBC VU, BC VU)	•	•	•	•	
Hemiandra gardneri	T (EPBC EN, BC CR)	•	•	•	•	
Leucopogon obtectus	T (EPBC EN, BC EN)	•				
Paracaleana dixonii	T (EPBC EN, BC VU)	•	•	•	•	
Tetratheca nephelioides	T (EPBC CR, BC EN)	•				
Thelymitra stellata	T (EPBC EN, BC EN)	•	•	•	•	
Drosera pedicellaris	P1		•		•	
Stylidium carnosum subsp. Narrow leaves (J.A. Wege 490)	P1		•		•	
Tetratheca remota	P1		•			
Acacia carens	P2		•	•	•	
Acacia lasiocarpa var. *lasiocarpa* Cockleshell Gully variant (E.A. Griffin 2039)	P2		•		•	
Acacia retrorsa	P2		•		•	
Andersonia sp. Mt Lesueur (E.A. Griffin 5536)	P2		•	•	•	
Banksia fraseri var. *effusa*	P2		•		•	
Beyeria similis	P2		•		•	
Boronia ramosa subsp. *lesueurana*	P2		•		•	
Boronia scabra subsp. *condensata*	P2		•		•	

Species	Conservation Code	PMST	NM	TPFL	WAHERB	M & WW
Cristonia biloba subsp. *pubescens*	P2		•		•	
Dampiera sp. Jurien (G. Lullfitz s.n. 10/7/1986)	P2		•		•	
Daviesia debilior subsp. *debilior*	P2		•	•	•	
Eucalyptus abdita	P2		•		•	
Goodenia xanthotricha	P2		•		•	
Grevillea delta	P2		•		•	
Hypocalymma sp. Gairdner Range (C.A. Gardner 9091)	P2		•		•	
Hypocalymma tenuatum	P2		•	•	•	
Lasiopetalum rutilans	P2		•		•	
Lepyrodia curvescens	P2		•		•	
Leucopogon plumuliflorus	P2		•	•	•	
Phlebocarya pilosissima subsp. *teretifolia*	P2		•		•	
Ptilotus clivicola	P2		•		•	
Stenanthemum limitatum	P2		•		•	
Stylidium diplotrichum	P2		•		•	
Synaphea lesueurensis	P2		•		•	•
Thelymitra pulcherrima	P2		•		•	
Thysanotus sp. Badgingarra (E.A. Griffin 2511)	P2		•			
Walteranthus erectus	P2		•		•	
Acacia epacantha	P3		•		•	
Acacia plicata	P3		•		•	
Allocasuarina grevilleoides	P3		•		•	
Banksia fraseri var. *crebra*	P3		•		•	
Banksia kippistiana var. *paenepeccata*	P3		•		•	
Calytrix ecalycata subsp. *brevis*	P3		•		•	
Daviesia pteroclada	P3		•	•	•	
Drosera prophylla	P3		•		•	
Gompholobium gairdnerianum	P3		•	•	•	
Grevillea uniformis	P3		•		•	
Guichenotia alba	P3		•		•	
Haemodorum loratum	P3		•	•	•	•
Hakea longiflora	P3		•		•	
Hensmania stoniella	P3		•		•	
Hypocalymma gardneri	P3		•	•	•	
Isopogon drummondii	P3		•		•	
Lepidobolus quadratus	P3		•		•	
Patersonia argyrea	P3		•		•	•
Persoonia filiformis	P3		•		•	
Persoonia rudis	P3		•	•	•	

Species	Conservation Code	PMST	NM	TPFL	WAHERB	M & WW
Stackhousia sp. Red-blotched corolla (A. Markey 911)	P3		•		•	
Stylidium maritimum	P3		•	•	•	
Stylidium nonscandens	P3		•		•	
Stylidium periscelianthum	P3		•		•	
Stylidium torticarpum	P3		•		•	
Styphelia filifolia	P3		•		•	
Tetratheca angulata	P3		•		•	
Tetratheca retrorsa	P3		•			
Thysanotus anceps	P3		•	•	•	
Thysanotus vernalis	P3		•		•	
Verticordia amphigia	P3		•	•	•	
Verticordia insignis subsp. *eomagis*	P3		•	•	•	
Verticordia rutilastra	P3		•	•	•	•
Asterolasia drummondii	P4		•	•	•	
Banksia chamaephyton	P4		•		•	
Banksia elegans	P4		•		•	
Banksia tricuspis	P4		•	•	•	
Drosera occidentalis	P4		•			
Eucalyptus exilis	P4		•	•	•	
Eucalyptus macrocarpa subsp. *elachantha*	P4		•		•	
Grevillea olivacea	P4		•		•	
Hakea neurophylla	P4		•		•	
Hemiandra sp. Watheroo (S. Hancocks 4)	P4		•		•	
Hypolaena robusta	P4		•		•	
Stylidium aeonioides	P4		•		•	
Stylidium inversiflorum	P4		•		•	
Thelymitra apiculata	P4		•		•	
Thysanotus glaucus	P4		•	•		
Xanthosia tomentosa	P4		•		•	•

Note: PMST = EPBC Act Protected Matters Search Tool (DAWE, 2021a; search reference PMST OVGE49); NM = NatureMap search (DBCA, 2007-); TPFL = DBCA Threatened and Priority Flora List (search reference #46-0919FL); WAHERB = DBCA Western Australian Herbarium (search reference #46-0919FL); T = Threatened, P1 – P4 = Priority 1 to Priority 4 species, EPBC = species listed under the Commonwealth's EPBC Act, BC = species listed under the Western Australian BC Act, CR = Critically Endangered, EN = Endangered, VU = Vulnerable. Orange highlighted rows = species or species habitat known to occur within the 10 km buffered search area, green rows = likely and blue rows = may occur within area (re PMST search result listings). M & WW = Maia and Western Wildlife (2020).

Table 13: Conservation significant fauna database search results

Species	Conservation Code	EPBC	NM
Threatened Fauna			
Calidrus canutus (Red Knot)[2]	T (EPBC – EN, BC – EN)	•	
Callidrus ferruginea (Curlew Sandpiper)[2]	T (EPBC – CR, BC – CR)	•	
Calyptorhynchus latirostris (Carnaby's Cockatoo)	T (EPBC – EN, BC – EN)	•	•
Cyclodomorphus branchialis (Gilled Slender Blue-tongue Skink)	T (BC – VU)		•
Dasyurus geoffroii (Chuditch)	T (EPBC – VU, BC – VU)	•	
Leipoa ocellata (Malleefowl)	T (EPBC – VU, BC – VU)	•	•
Macroderma gigas (Ghost Bat)	T (EPBC – VU, BC – VU)		•
Numenius madagascariensis (Eastern Curlew)[2]	T (EPBC – CR, BC – CR)	•	
Parantechinus apicalis (Dibbler)	T (EPBC – EN, BC – EN)	•	
Rostratula australis (Australian Painted Snipe)	T (EPBC – EN, BC – EN)	•	
Sternula nereis nereis (Australian Fairy Tern)	T (EPBC – VU, BC – VU)	•	
Migratory Fauna			
Actitis hypoleucos (Common Sandpiper)		•	
Apus pacificus (Fork-tailed Swift)		•	
Calidris acuminata (Sharp-tailed Sandpiper)		•	•
Calidris alba (Sanderling)			•
Calidris melanotos (Pectoral Sandpiper)		•	
Hydroprogne caspia (Caspian Tern)			•
Motacilla cinerea (Grey Wagtail)		•	
Pandion haliaetus (Osprey)		•	
Plegadis falcinellus (Glossy Ibis)			•
Pluvialis squatarola (Grey Plover)			•
Puffinus pacificus (Wedge-tailed Shearwater)			•
Thalasseus bergii (Crested Tern)			•
Tringa glareola (Wood Sandpiper)			•
Tringa nebularia (Common Greenshank)		•	
Priority Fauna			
Notamacropus irma (Western Brush Wallaby)	P4		•

Note: PMST = EPBC Act Protected Matters Search Tool (DAWE, 2021a; search reference PMST OVGE49); NM = NatureMap search (DBCA, 2007-); T = Threatened, P4 = Priority 4 species, EPBC = species listed under the Commonwealth's EPBC Act, BC = species listed under the Western Australian BC Act, CR = Critically Endangered, EN = Endangered, VU = Vulnerable; [2] = Threatened and Migratory Fauna species; purple = breeding known to occur within the 10 km buffered search area, green = likely and blue = may occur within area.

APPENDIX 2: QUADRAT DATA AND PHOTO POINTS

Table 14: Quadrat data and photo point photographs

Quadrat	GP-2	Surveyed by:	S Hitchcock and C Cox		Date:	25/10/2020	Photo:
Location (GDA94):		MGA50	320776	mE	6661056	mN	
Habitat:		Gentle west south-west facing slope (midslope)					
Soil:		White fine sand loose soil (40%)					
Rocks:		Laterite stones (1%)					
Described as:		MHL (Mixed Heathland)					
Vegetation type:		Low mixed Heathland mainly of *Calothamnus sanguineus*, *Banksia shuttleworthiana* and *Daviesia epiphyllum* with a Sparse Shrubland of *Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) and an Open mixed Sedgeland of *Caustis dioica*, *Mesomelaena pseudostygia* and *Mesomelaena tetragona*.					
Vegetation condition:		Excellent					
Disturbances:		Animal tracks					
Fire age:		No signs of fire					
Species: **Species richness - 32**		*Allocasuarina microstachya, Babingtonia grandiflora, Banksia shuttleworthiana, Banksia tridentata* **(REn)**, *Calectasia narragara, Calothamnus sanguineus, Cassytha* sp., *Conostylis setigera* subsp. *setigera, Cristonia biloba, Dampiera spicigera, Daviesia epiphyllum, Daviesia nudiflora, Gastrolobium plicatum, Georgeantha hexandra, Haemodorum venosum, Hakea conchifolia, Hakea incrassata, Hibbertia robur* **(REn)**, *Isopogon dubius, Lysinema pentapetalum, Melaleuca trichophylla, Mesomelaena tetragona, Orianthera spermacocea, Persoonia filiformis* **(P3, REn)**, *Petrophile macrostachya, Stylidium cygnorum, Stylidium diuroides* subsp. *paucifoliatum, Thysanotus patersonii, Tricoryne tenella, Verticordia pennigera, Xanthorrhoea sp*. Lesueur (G.J. Keighery 16404) **(REn)**, *Xanthosia tomentosa* **(P4)**.					
Quadrat	**GP-3**	**Surveyed by:**	**S Hitchcock and C Cox**		**Date:**	**25/10/2020**	**Photo:**
Location (GDA94):		MGA50	320933	mE	6661247	mN	
Habitat:		Gentle west south-west facing slope (midslope)					
Soil:		White fine sand loose soil (40%)					
Rocks:		Laterite stones (5%)					
Described as:		MHL (Mixed Heathland)					
Vegetation type:		Low mixed Heathland mainly of *Calothamnus sanguineus*, *Banksia shuttleworthiana* and *Daviesia epiphyllum* with a Sparse Shrubland of *Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) and an Open mixed Sedgeland of *Caustis dioica*, *Mesomelaena pseudostygia* and *Mesomelaena tetragona*.					
Vegetation condition:		Excellent					
Disturbances:		Animal tracks					
Fire age:		No signs of fire					
Species: **Species richness - 38**		*Acacia auronitens, Allocasuarina humilis, Allocasuarina microstachya, Anigozanthos humilis* subsp. *humilis, Babingtonia grandiflora, Banksia armata* var. *armata, Banksia dallanneyi* subsp. *dallanneyi* var. *dallanneyi, Banksia micrantha, Banksia sclerophylla* **(REn)**, *Calothamnus sanguineus, Caustis dioica, Conostylis canteriata, Conostylis setigera* subsp. *setigera, Conostylis teretifolia* subsp. *teretifolia, Daviesia incrassata* subsp. *incrassata, Daviesia nudiflora, Desmocladus lateriticus, Eremaea violacea* subsp. *raphiophylla* **(REn)**, *Gastrolobium plicatum, Georgeantha hexandra, Hakea incrassata, Hakea neospathulata, Hibbertia robur* **(REn)**, *Hibbertia striata, Isopogon dubius, Lepidosperma pubisquameum, Melaleuca trichophylla, Melaleuca zonalis* **(REn)**, *Mesomelaena pseudostygia, Orianthera spermacocea, Pimelea sulphurea, Scaevola canescens, Stylidium diuroides* subsp. *paucifoliatum, Tricoryne tenella, Verticordia densiflora* var. *densiflora, Verticordia pennigera, Verticordia picta, Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) **(REn)**.					

Quadrat	GP-5	Surveyed by:	S Hitchcock and C Cox		Date:	25/10/2020	Photo:
Location (GDA94):		MGA50	320682	mE	6661209	mN	
Habitat:		Gentle west south-west facing slope (midslope)					
Soil:		White fine sand loose soil (40%)					
Rocks:		Laterite stones (1%)					
Described as:		MHL (Mixed Heathland)					
Vegetation type:		Low mixed Heathland mainly of *Calothamnus sanguineus*, *Banksia shuttleworthiana* and *Daviesia epiphyllum* with a Sparse Shrubland of *Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) and an Open mixed Sedgeland of *Caustis dioica*, *Mesomelaena pseudostygia* and *Mesomelaena tetragona*.					
Vegetation condition:		Excellent					
Disturbances:		None evident					
Fire age:		No evidence of fire					
Species: **Species richness - 41**		*Acacia auronitens, Acacia sphacelata* subsp. *verticillata, Allocasuarina humilis, Anigozanthos humilis* subsp. *humilis, Babingtonia grandiflora, Banksia shuttleworthiana, Banksia tridentata* **(REn)**, *Calothamnus sanguineus, Caustis dioica, Comesperma confertum, Conospermum boreale* subsp. *ascendens, Conostylis canteriata, Conostylis setigera* subsp. *setigera, Conostylis teretifolia* subsp. *teretifolia, Darwinia sanguinea* **(REn)**, *Daviesia epiphyllum, Daviesia nudiflora, Daviesia pedunculata, Eremaea violacea* subsp. *raphiophylla* **(REn)**, *Goodenia coerulea, Hakea flabellifolia, Hakea incrassata, Hakea prostrata, Hibbertia robur* **(REn)**, *Hibbertia striata, Isopogon dubius, Melaleuca platycalyx, Melaleuca trichophylla, Mesomelaena tetragona, Orianthera spermacocea, Petrophile brevifolia* subsp. *brevifolia* **(REx)**, *Scaevola canescens, Schoenus brevisetis, Schoenus* sp., *Stylidium diuroides* subsp. *paucifoliatum, Stylidium repens, Thysanotus patersonii, Tricoryne tenella, Verticordia pennigera, Verticordia picta, Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) **(REn)**.					

Photo points

Photo point GP4

Photo point GP1

Note: see **Map 5** (Section 11) for photo point and quadrat locations. REn = regional endemic species; REx = range extension species; P3 and P4 = Priority Three and Priority Four species.

APPENDIX 3: SPECIES LIST

Table 15: Species list

Family	Taxa	FlFr	Quadrat	OppColl
Apiaceae	*Xanthosia tomentosa* **(P4)**	Fl	•	
Asparagaceae	*Thysanotus patersonii*	FlFr	•	
Asparagaceae	*Thysanotus patersonii/manglesianus*			•
Asparagaceae	*Thysanotus thyrsoideus*	Fl	•	
Asteraceae	*Pterochaeta paniculata*	Fl		•
Casuarinaceae	*Allocasuarina campestris*			•
Casuarinaceae	*Allocasuarina humilis*	Fr	•	
Casuarinaceae	*Allocasuarina microstachya*		•	
Celastraceae	*Tripterococcus brunonis*	FlFr		•
Cupressaceae	*Callitris acuminata*	FlFr		•
Cyperaceae	*Caustis dioica*		•	
Cyperaceae	*Lepidosperma pubisquameum*	Fl	•	
Cyperaceae	*Mesomelaena pseudostygia*	FlFr	•	
Cyperaceae	*Mesomelaena tetragona*	FlFr	•	
Cyperaceae	*Schoenus brevisetis*	FlFr	•	
Cyperaceae	*Schoenus* sp.		•	
Dasypogonaceae	*Calectasia narragara*	Fl	•	
Dasypogonaceae	*Dasypogon obliquifolius*			•
Dilleniaceae	*Hibbertia hypericoides* subsp. *hypericoides*	Fl		•
Dilleniaceae	*Hibbertia robur* **(REn)**		•	
Dilleniaceae	*Hibbertia striata*	Fl	•	
Ecdeiocoleaceae	*Georgeantha hexandra*	FlFr	•	
Ericaceae	*Andersonia lehmanniana* subsp. *lehmanniana*	Fl		•
Ericaceae	*Lysinema pentapetalum*		•	
Fabaceae	*Acacia auronitens*	FlFr	•	•
Fabaceae	*Acacia sphacelata* subsp. *verticillata*		•	
Fabaceae	*Cristonia biloba*		•	
Fabaceae	*Daviesia epiphyllum*		•	
Fabaceae	*Daviesia incrassata* subsp. *incrassata*	Fr	•	
Fabaceae	*Daviesia nudiflora*		•	
Fabaceae	*Daviesia pedunculata*	FlFr	•	•
Fabaceae	*Gastrolobium plicatum*	Fr	•	•
Fabaceae	*Jacksonia restioides*	Fl		•
Goodeniaceae	*Dampiera spicigera*	Fl	•	•
Goodeniaceae	*Goodenia coerulea*	Fl	•	
Goodeniaceae	*Scaevola canescens*		•	
Haemodoraceae	*Anigozanthos humilis* subsp. *humilis*	FlFr	•	•
Haemodoraceae	*Conostylis canteriata*	Fl	•	
Haemodoraceae	*Conostylis setigera* subsp. *setigera*	Fl	•	
Haemodoraceae	*Conostylis teretifolia* subsp. *teretifolia*	Fl	•	
Haemodoraceae	*Haemodorum discolor*	Fl		•
Haemodoraceae	*Haemodorum spicatum*	Fl		•

Family	Taxa	FlFr	Quadrat	OppColl
Haemodoraceae	*Haemodorum venosum*	FlFr	•	
Haemodoraceae	*Macropidia fuliginosa*	Fl		•
Haloragaceae	*Glischrocaryon aureum*	FlFr		•
Hemerocallidaceae	*Tricoryne tenella*	Fl	•	•
Iridaceae	*Patersonia occidentalis var. occidentalis*	Fl		•
Lamiaceae	*Hemiphora bartlingii*	Fl		•
Lauraceae	*Cassytha* sp.		•	
Loganiaceae	*Orianthera spermacocea*	Fl	•	
Malvaceae	*Lasiopetalum drummondii*	Fl		•
Myrtaceae	*Babingtonia grandiflora*	FlFr	•	•
Myrtaceae	*Beaufortia bracteosa*	Fl		•
Myrtaceae	*Calothamnus sanguineus*	FlFr	•	•
Myrtaceae	*Calothamnus torulosus*	Fr		•
Myrtaceae	*Calytrix aurea*	Fl		•
Myrtaceae	*Calytrix depressa*	Fl		•
Myrtaceae	*Darwinia sanguinea* **(REn)**	Fl	•	•
Myrtaceae	*Eremaea violacea* subsp. *raphiophylla* **(REn)**	FlFr	•	•
Myrtaceae	*Eucalyptus gittinsii* subsp. *illucida*	Fr		•
Myrtaceae	*Eucalyptus macrocarpa* subsp. *macrocarpa*	Fr		•
Myrtaceae	*Leptospermum spinescens*	FlFr		•
Myrtaceae	*Melaleuca platycalyx*	Fr	•	
Myrtaceae	*Melaleuca trichophylla*	Fr	•	
Myrtaceae	*Melaleuca zonalis* **(REn)**	FlFr	•	•
Myrtaceae	*Verticordia brachypoda*	Fl		•
Myrtaceae	*Verticordia densiflora* var. *densiflora*	Fl	•	
Myrtaceae	*Verticordia grandis*	Fl		•
Myrtaceae	*Verticordia nobilis*	Fl		•
Myrtaceae	*Verticordia pennigera*	Fl	•	
Myrtaceae	*Verticordia picta*		•	
Myrtaceae	*Verticordia rutilastra* **(P3)**	Fl		•
Poaceae	*Neurachne alopecuroidea*	Fl		•
Polygalaceae	*Comesperma confertum*	Fl	•	•
Proteaceae	*Banksia armata* var. *armata*		•	•
Proteaceae	*Banksia bipinnatifida* subsp. *multifida*			•
Proteaceae	*Banksia dallanneyi* subsp. *dallanneyi* var. *dallanneyi*	FlFr	•	•
Proteaceae	*Banksia micrantha*	FlFr	•	•
Proteaceae	*Banksia sclerophylla* **(REn)**	FlFr	•	•
Proteaceae	*Banksia shuttleworthiana*		•	
Proteaceae	*Banksia tridentata* **(REn)**		•	
Proteaceae	*Conospermum boreale* subsp. *ascendens*	Fr	•	
Proteaceae	*Grevillea synapheae* subsp. *pachyphylla*	Fr		•
Proteaceae	*Hakea conchifolia*		•	
Proteaceae	*Hakea flabellifolia*		•	
Proteaceae	*Hakea incrassata*		•	
Proteaceae	*Hakea neospathulata*		•	

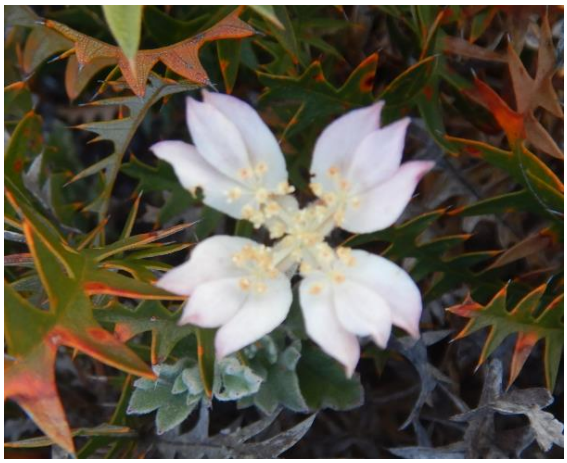
Family	Taxa	FlFr	Quadrat	OppColl
Proteaceae	*Hakea prostrata*		•	
Proteaceae	*Isopogon dubius*	FlFr	•	•
Proteaceae	*Lambertia multiflora* var. *multiflora*	Fl		•
Proteaceae	*Persoonia filiformis* **(P3, REn)**	Fl	•	•
Proteaceae	*Persoonia rudis* **(P3)**	FlFr		•
Proteaceae	*Petrophile brevifolia* subsp. *brevifolia* **(REx)**	FlFr	•	•
Proteaceae	*Petrophile macrostachya*	FlFr	•	•
Proteaceae	*Synaphea lesueurensis* (dead) **(P2, REn)**	Fr		•
Proteaceae	*Synaphea spinulosa* subsp. *spinulosa*	FlFr		•
Restionaceae	*Desmocladus lateriticus*	Fl	•	
Rhamnaceae	*Cryptandra nutans* **(GF)**			•
Rutaceae	*Diplolaena ferruginea*			•
Stylidiaceae	*Stylidium cygnorum*	FlFr	•	•
Stylidiaceae	*Stylidium diuroides* subsp. *paucifoliatum*	Fl	•	
Stylidiaceae	*Stylidium maitlandianum*	Fl		•
Stylidiaceae	*Stylidium piliferum*	Fr		•
Stylidiaceae	*Stylidium purpureum*	FlFr		•
Stylidiaceae	*Stylidium repens*		•	
Thymelaeaceae	*Pimelea sulphurea*	Fl	•	
Xanthorrhoeaceae	*Xanthorrhoea* sp. Lesueur (G.J. Keighery 16404) **(REn)**		•	

Note: P2, P3, P4 = Priority 2, 3 and 4 species; REn = regional endemic, REx = range extension, GF = gap filler; sp. = species, subsp. = subspecies, var. = variety; Fl = flowering, Fr = fruiting; OppColl = opportunistic collection.

APPENDIX 4: CONSERVATION SIGNIFICANT FLORA PHOTOGRAPHS

Table 16: Priority flora species recorded in the Survey Area

***Persoonia filiformis* (Priority 3)**	
	
***Persoonia rudis* (Priority 3)**	
	
***Verticordia rutilastra* (Priority 3)**	
	Photography by E.A. Berndt & M. Pieroni. Image used with the permission of the Western Australian Herbarium, Department of Biodiversity, Conservation and Attractions (https://florabase.dpaw.wa.gov.au/help/copyright). Accessed on Tuesday, 23 March 2021.

***Xanthosia tomentosa* (Priority 4)**	
	

APPENDIX 5: CONSERVATION SIGNIFICANCE FLORA, FAUNA AND ECOLOGICAL COMMUNITIES

Threatened Flora

Some flora species can be protected by Australian Government legislation (*Environment Protection and Biodiversity Conservation Act 1999*, EPBC Act) or by WA legislation (*Biodiversity Conservation Act 2016*, BC Act) (DAWE, 2021b; GoWA, 2016). Species specially protected by these acts are referred to as threatened species and can be listed as critically endangered, endangered, or vulnerable.

On 1 January 2019, the BC Act and *Biodiversity Conservation Regulations 2018* replaced both the *Wildlife Conservation Act 1950* and the *Sandalwood Act 1929* and their associated regulations (DBCA, 2019b; GoWA, 2016 and 2018). The new BC Act and regulations provide greater protection for threatened species and ecological communities.

Priority Flora

Possible threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Flora List under Priorities (P) 1, 2, 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species list for other than taxonomic reasons, are placed in Priority 4 and require regular monitoring (DBCA, 2019a).

Threatened Fauna

Threatened Fauna are those listed as such under the EPBC Act or BC Act and can be listed as critically endangered, endangered, or vulnerable.

Migratory Fauna

Migratory Fauna are those listed as such under the EPBC Act or the BC Act.

Specially Protected Fauna

Specially Protected Fauna are those listed as such under the BC Act and may be either other specially protected fauna (OS) or conservation dependent fauna (CD).

Priority Fauna

Possible threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna List under Priorities (P) 1, 2, 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring (DBCA, 2019a).

Threatened Ecological Communities

Some ecological communities are protected by Australian Government legislation (the EPBC Act) based on the perceived levels of threat to the community or species population at a national level. They are listed as threatened

ecological communities – TECs – and can be listed as Critically Endangered, Endangered or Vulnerable (DAWE, 2021c). The communities are listed by state on the DAWE website (DAWE, 2021c; DAWE, 2021d).

In WA, the Minister for Environment previously listed ecological communities as threatened through a non-statutory process if the community was presumed to be totally destroyed or at risk of becoming totally destroyed. The BC Act provides for the statutory listing of TECs by the Minister. The new legislation also describes statutory processes for preparing recovery plans for TECs, the registration of their critical habitat, and penalties for unauthorised modification of TECs. These TECs are listed as presumed totally destroyed, critically endangered, endangered, or vulnerable (DEC, 2013).

Priority Ecological Communities

Ecological communities with insufficient information available to be considered a TEC, or which are rare but not currently threatened are placed on a priority list and are referred to as priority ecological communities (PECs; DBCA, 2021). Definitions, categories, and criteria for threatened and priority ecological communities can be found on the DBCA's website (DEC, 2013).

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