Interim Recovery Plan No. 354

Clay pans of the Swan Coastal Plain

(Community types 7, 8, 9 and 10a - Gibson *et al.* 1994 and Clay pans with mid dense shrublands of *Melaleuca lateritia* over herbs)

2015-2020

Department of Parks and Wildlife

October 2015

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Parks and Wildlife Policy Statements Nos. 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

The department is committed to ensuring that threatened ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by the department's Director of Science and Conservation.

This IRP will operate from October 2015 but will remain in force until withdrawn or replaced. It is intended that, if the ecological communities are still ranked Vulnerable or Endangered after five years, this Recovery Plan will be replaced or updated.

This IRP was approved by the Director of Science and Conservation on 14 October 2015. The provision of funds identified in this IRP is dependent on budgetary and other constraints affecting the department, as well as the need to address other priorities.

Information in this IRP was accurate as at September 2015.

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CITATION

This Interim Recovery Plan should be cited as:

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SUMMARY

Name: This plan encompasses the clay pans of the Swan Coastal Plain that includes the following four Western Australia listed threatened ecological communities (TECs):

- Herb rich saline shrublands in clay pans (Swan Coastal Plain community type 7 as identified in Gibson *et al.* 1994 (SCP07))
- Herb rich shrublands in clay pans (SCP08 – Swan Coastal Plain community type 8)
- Dense shrublands on clay flats (SCP09 – Swan Coastal Plain Community type 9)
- Shrublands on dry clay flats (SCP10a – Swan Coastal Plain Community type 10a)

The plan also covers the 'Clay pans with mid dense shrublands of *Melaleuca lateritia* over herbs' (hereafter termed the 'Clay pans with shrubs over herbs') that is ranked Priority 1 in Western Australia.

These four TECs and one PEC comprise the 'Clay pans of the Swan Coastal Plain' that is listed as a critically endangered TEC under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). There are 114 occurrences of the five clay pan communities that cover a total of about 909 ha.

Description: The clay pan communities occur where clay substrate is low in the landscape and forms an impermeable layer close to the surface. These wetlands that rely on rainfall and local surface drainage to fill are considered unlikely to be connected to groundwater. The clay pans then dry out to form a relatively impervious substrate in summer. A suite of perennial plants that propagate by underground bulbs, tubers or corms (geophytes), and annual herbs flower sequentially as the clay pans dry out. The clay pans are the most diverse of the Swan Coastal Plain wetlands and contain a number of local endemic flora.

Department of Parks and Wildlife Regions: Swan, South West, Midwest and Wheatbelt

Department of Parks and Wildlife Districts: Swan Coastal, Perth Hills, Wellington, Blackwood, and Moora Districts.

Local Government Authorities: Serpentine–Jarrahdale, Harvey, Murray, Armadale, Gosnells, Swan, Waroona, Gingin, Beverley, Bunbury, Busselton, Capel, Dardanup, Kalamunda, Boyup Brook, Toodyay and Kojonup.

Conservation status: Community types 7, 8 and 9 were endorsed by the WA Minister for Environment in November 2001 as Vulnerable, and community type 10a as Endangered. Clay pans with mid dense shrublands of *Melaleuca lateritia* over herbs was ranked Priority 1 in Western Australia in May 2006. The umbrella type 'Clay pans of the Swan Coastal Plain' was listed as Endangered under EPBC Act in March 2012.

Habitat requirements: These communities typically occur on clay soils in low lying flats that are seasonally wet or inundated.

Habitat critical to survival: The critical habitat for this community is the clay soils on which the community occurs, and the fresh surface water that helps to sustain key species in this community, and the catchment for this surface water.

The habitat critical to survival is: The area of occupancy of known occurrences; similar habitat adjacent to important occurrences (i.e. within approximately 200m), i.e. poorly drained flats, depressions or winter wet clay flats; remnant vegetation that surrounds or links several occurrences (this is to provide habitat for pollinators or

to allow them to move between occurrences); and the local catchment for the surface and potentially groundwater that maintains the winter-wet habitat of the communities (these clay pan communities would be dependent on maintenance of the local hydrological conditions).

Important occurrences: Occurrences that provide for representation of the community across its geographic range and that can be managed for conservation and/or with conservation included in their purpose are considered important occurrences of this community. Occurrences within conservation reserves and Bush Forever sites, and occurrences with comparatively large intact areas of the community that are in relatively good condition outside of Bush Forever, are considered important occurrences.

Affected interests: Land owners and managers of all occurrences may be affected by actions in this plan, in particular on those lands not managed by Parks and Wildlife or intended to be transferred to the department's management. Occurrences are within the Shires of Armadale, Busselton, Boyup Brook, Capel, Gosnells, Murray, Serpentine-Jarrahdale, Swan, Waroona, Gingin, Bunbury, Capel, Dardanup, Kalamunda, Toodyay and Kojonup. They occur on land managed by Main Roads WA, Parks and Wildlife, Water Corporation, University of WA, WA Planning Commission, local governments, and on private land.

Indigenous interests: An Aboriginal Sites Register is kept by the Department of Indigenous Affairs, and lists one Artifact/Scatter site and a Ceremonial and Morphological site within the vicinity of the occurrences. The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. Appendix 1 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. Actions identify the intention to continue liaison with relevant groups, including indigenous groups.

Social and economic impacts and benefits: The implementation of this recovery plan has the potential to have some social and economic impact, where occurrences are located on lands not specifically managed for conservation, such as road reserves and private property. Recovery actions refer to continued liaison between stakeholders with regard to these areas. Negotiations will continue with land managers with respect to the future management of occurrences not in conservation estate.

Related biodiversity impacts and benefits: Thirteen other TECs co-occur within remnant vegetation that contains the clay pan communities, and will benefit from their management.

Twelve declared rare flora (DRF) are known from the clay pan communities: *Calytrix breviseta* subsp. *breviseta*, *Verticordia plumosa* var. *vassensis, Verticordia densiflora* var. *pedunculata*, *Chamelaucium* sp. S Coastal Plain (previously *Chamelaucium roycei* ms*), Diuris purdiei, Grevillea curviloba* subsp*. incurva, Lepidosperma rostratum, Ptilotus pyramidatus, Synaphea stenoloba, Trithuria occidentalis, Eleocharis keigheryi* and *Synaphea* sp. Fairbridge Farm; and 42 priority flora taxa also occur in the communities. Recovery actions implemented to improve the quality or security of the community are also likely to improve the status of component species.

There are three critically endangered fauna known to be dependent on clay pans and the surrounding communities for a portion of their life/breeding cycle. These are *Pseudemydura umbrina (*Western Swamp Tortoise) and two native bees: *Leioproctus douglasiellus* and *Neopasiphae simplicior*.

Term of plan: The plan will operate from 2015 to 2020 but will remain in force until withdrawn or replaced. It is intended that, if the ecological communities are still ranked vulnerable or endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated.

IRP Objective(s): To maintain or improve the overall condition of the clay pan communities and reduce the level of threat.

Criteria for success:

- 90% or more of the aerial extent of occurrences of each clay pan type covered by this recovery plan maintained at the same condition rank, or improved (Bush Forever condition scales) over the life of the plan, excluding effects of drying climate that are outside the scope of this plan.
- An increase in the number of occurrences of the clay pan types managed for conservation and/or with conservation included in the purpose.
- Representative areas of the clay pan types across their geographical range maintained in the same or improved condition (Bush Forever condition scales).

Criteria for failure:

- Decline in condition rank to a lower category (Bush Forever condition scales) of 10% or more of the total aerial extent of the sub-communities covered by this plan, excluding effects of drying climate that are outside the scope of this plan.
- Failure to achieve an increase in the area managed for conservation for the communities covered by this plan.

Summary of Recovery Actions:

Liaise with stakeholders to implement recovery	Identify potential new occurrences
Monitor extent and boundaries of occurrences	Map habitat critical to survival
Encompass monitoring in an adaptive management framework	Seek to minimise direct clearing and hydrological change
Develop and implement fire management strategy	Implement disease hygiene procedures
Implement weed control	Seek long term protection for conservation
Investigate, monitor and manage water quality and hydrology	Ensure best practice land management in areas of competing interests
Implement and monitor control of feral and grazing animals	Develop management guidelines
Protect clay pans from physical damage	Report on recovery plan implementation

1. BACKGROUND

1.1 History, defining characteristics and conservation significance

The clay pan basins and clay flats of south western Australia are collectively termed clay pans, and occur where clay soils form an impermeable layer close to the surface. Wetlands in clay pans rely on rainfall and surface runoff to fill and are probably not connected to groundwater. These wetlands contain a rich suite of geophytes and annual species that flower at different times as the clay pans dry towards summer. The clay pans are the most diverse of the Swan Coastal Plain wetlands and contain high numbers of local endemics. There are no specific suites of flora that characterise all the clay pans, but they share general characteristics of substrate, landform, hydrology and vegetation structure. They also all meet Keeley and Zedler's (1998) definition of vernal pools; 'precipitation-filled seasonal wetlands inundated during periods when temperature is sufficient for plant growth, followed by a brief waterlogged-terrestrial stage and culminating in extreme desiccating soil conditions of extended duration.'

The clay pans are comprised of reasonably productive agricultural soils and many were cleared and drained soon after European settlement. Other areas were mined for clay for brick and tile manufacture. Remnant vegetation in clay pans was largely on the Swan Coastal Plain close to metropolitan Perth including in some areas that have been cleared more recently for urban development.

Gibson *et al.* (1994) defined a series of floristic community types across the southern Swan Coastal Plain based on analysis of 509 quadrats. This included four units that occurred on clay substrates, and that varied in floristic composition due to a suite of factors including substrate and rainfall. These are:

- Herb rich saline shrublands in clay pans (Swan Coastal Plain community type 7 as identified in Gibson *et al.* 1994 (SCP07))
- Herb rich shrublands in clay pans (SCP08 – Swan Coastal Plain community type 8)
- Dense shrublands on clay flats (SCP09 – Swan Coastal Plain Community type 9)
- Shrublands on dry clay flats (SCP10a – Swan Coastal Plain Community type 10a)

All of these clay pan types were listed as threatened ecological communities (TECs) in Western Australia in the 1990s.

Data for the vegetation of the seasonal clay-based wetlands across the extent of south western Australia were analysed by Gibson *et al.* (2005) and vegetation units were identified based on floristic patterning. An additional clay pan type named 'Clay pans with mid dense shrublands of *Melaleuca lateritia* over herbs' was identified through the analysis, and was included on the Priority ecological community list for Western Australia in 2006. In 2012 the four clay pan types identified by Gibson *et al.* (1994) and the 'Clay pans with mid dense shrublands of *Melaleuca lateritia* over herbs' were listed as a critically endangered community under the EPBC Act, under the umbrella title 'Clay pans of the Swan Coastal Plain'.

There are 114 occurrences of the clay pan communities in 50 separate locations that occupy a total of about 909 ha. The communities are highly fragmented, with about 60% of occurrences under 10 ha in size. The clay pan communities occur in significant bushland including Ellenbrook, Forrestdale Lake, Moore River, Byrd Swamp, Austin Bay, Drummond and Kooljerrenup Nature Reserves; Wandoo National Park, the Greater Brixton Street Wetlands, Anstey-Keane damplands, Jandakot Regional Park, and Brickwood Reserve (See Appendix 1, 3).

A summary of total areas in land management categories for the clay pan types occurs in Table 1.

Table 1: Land management categories for clay pan communities

Community	**Conservation reserves (ha)**	**Other state, local government reserves** (eg road, rail, recreation etc) (ha)	**C'mwealth lands (ha)**	**Private lands (ha)**	**Bush Forever (ha)**	**Total (ha)**
SCP 07	124.6	70	7.1	14.4	35.9	216.1
SCP08	116.6	168.5	0.1	12.9	127.3	298.1
SCP09	195.4	23.1	0	0	3.4	218.5
SCP10a	24.8	62.9	0	5	35.4	92.7
Clay pans with shrubs over herbs	82.9	1.2	0	0	0	84.1
Total (ha)	**544.3**	**325.7**	**7.2**	**32.3**	**202**	**909.5**

Areas of the clay pans are listed as Wetlands of National Significance, including Brixton Street Wetlands, Ellen Brook swamp systems, and Forrestdale Lake Nature Reserve which is also a Ramsar site (Environment Australia, 2001). The threatened and priority flora that occur in the clay pan communities are listed in Table 2. Some of the clay pan sites were identified through surveys completed for Bush Forever, and some also occur in Bush Forever sites (Keighery *et al.* 2012; Government of Western Australia 2000; see Appendix 1). The aim of Bush Forever is to seek to protect listed sites through a specified planning process.

A suite of fauna depend on the vegetation and surface water habitat, and seasonal changes in the clay pans communities. Three species listed under the EPBC Act are dependent on clay pans and adjacent areas. These are the critically endangered western swamp tortoise *(Pseudemydura umbrina)*, and two species of native bee; *Leioproctus douglasiellus* (endangered) and *Neopasiphae simplicior* (critically endangered).

Appendix 1 provides a summary of information about the occurrences including land tenure, extent, soils and condition.

1.2 Biological and ecological characteristics

Seasonal wetlands occur on the clay flats as the clay impedes water movement horizontally and vertically. Rainfall therefore collects on the surface and soils become waterlogged. These wetlands tend to dry soon after the rain stops in the late spring and early summer.

The hydrology is the main driver of the ecological functions of the assemblages that occur in clay pans. Variations in depth and timing of inundation have a major influence over the suites of flora that occur in a particular location and this explains some of the variation in the community's composition across its extent. Changes in hydrological status will significantly alter the assemblages in the communities. More than 90% of the clay pan communities have been lost through clearing and drainage of their habitat since European settlement.

Much of the high species richness arises from geophytes and annual flora that flower sequentially as the clay pans dry. Perennial shrubs and herbs contribute less to total species richness (Gibson *et al.* 2005). The shrubs in clay pans may appear stressed or dead over summer with leaves yellowing, but can recover when water is again

added to the system.

The clay pans contain a rich and variable flora including a series of wetland genera that are widespread such as *Isoetes, Myriophyllum, Cotula* and *Eryngium* and a suite that are characteristic of southern Australia including *Stylidium, Tribonanthes, Drosera* and *Centrolepis*. The clay pans also include a series of terrestrial taxa (Gibson *et al*. 2005).

There is a high variability in composition in the clay pan wetlands and this may be related to their naturally highly fragmented distribution, and a highly randomised recruitment of flora taxa (Gibson *et al*. 2005).

Gibson *et al*. (1994) defined four clay pan and clay flat communities based on different species composition, with a significant increase in species richness with rainfall, and higher species richness in flat clay pans as compared to clay basins. This probably relates to a shorter period of inundation and longer time when soils are wet but when there is no surface water present ('wet terrestrial phase'). Both clay pan types are typically completely dry by mid-summer (Gibson *et al*. 2005).

Habitat and Floristics

The clay substrate that occurs in these communities is a fine-grained material that combines one or more clay minerals with traces of metal oxides and organic matter. Clays are plastic due to their water content and become hard, brittle and non–plastic when dry. The clays that occur in this community can appear in various colors, from dull grey to brown.

Clays are distinguished from other fine-grained soils by differences in size and mineralogy. Silts, which are fine-grained soils that do not include clay minerals, tend to have larger particle sizes than clays. There is some overlap between clays and silts in particle size and other physical properties, and many naturally occurring deposits include both silts and clay. The proportion of silt and clay will influence the properties of the substrate, and both light clays with a higher proportion of silt, and heavy clay substrates with low levels of silt can occur in the clay pan communities. The composition, properties and consistency of the substrate can also vary within any one occurrence of the community.

The five clay pan communities that are considered in this plan are described below (see Appendix 2 for lists and characteristics of common taxa):

Herb rich saline shrublands in clay pans (Community Type 7 (SCP07))

The community occurs on heavy clay soils that are generally wet, and may have surface water present, from winter to mid-summer. Many locations hold water up to 30cm deep in early spring, and early flowering aquatic species are common. A succession of species including *Centrolepis* spp. and *Stylidium* spp. flower as the clay pans dry over a period of up to three months.

The community can occur under a shrub layer comprising *Melaleuca viminea, M. osullivanii, M. cuticularis* or *Casuarina obesa* or other shrubs but can also occur as woodlands or herblands. Some areas such as where *Melaleuca cuticularis* or *Casuarina obesa* occur as an overstorey may be saline for part of the year due to evaporation resulting in increased salinity.

A suite of herbs such as *Philydrella pygmaea*, *Brachyscome bellidioides*, *Centrolepis aristata, Centrolepis polygyna*, *Pogonolepis stricta* and *Cotula coronopifolia*; frequently occur in the community. Species such as *Angianthus drummondii*, *Eryngium pinnatifidum* subsp. *palustre* and *Blennospora drummondii* occur in low frequency and

were not recorded in community types 8 to 10 (Gibson *et al.* 1994).

Two Department of Water (DoW) bores occur within about 50m of this clay pan community and groundwater level data are available over extended periods (Yoongarillup and Bambun reserves (Occurrences 1, 5 – see Appendix 1) (DoW 2014)). For Bambun reserve, the groundwater has varied seasonally from 4-2.5m below ground surface since 2012. The Yongarillup bore level varied from two metres below ground to the ground surface between 2008 and 2013. The soils in the latter occurrence have a higher proportion of sand and a lower clay component than most other locations. This may result in greater interaction of groundwater and surface water at this location.

Herb rich shrublands in clay pans (Community Type 8 (SCP08))

The surface pools in this community do not generally contain water to the same depth or for as long as in community type 7, but aquatic annuals are still common. In the most recent analysis of a more comprehensive dataset of clay pan data by Gibson *et al*. (2005) that included areas outside of the Swan Coastal Plain, however, sites in these deeper basin clay pans grouped separately into the community 'Clay pans with shrubs over herbs', described below. This includes clay pans in the Brixton St wetlands (occurrences 35, 53), Bandicoot Brook (occurrence 37), Pursers (occurrences 102, 103, 106, 107), Julimar (occurrence 101), and Drummond (occurrences 99, 100).

Viminaria juncea, *Melaleuca viminea*, *M. lateritia* or *M. osullivanii* and occasionally *Eucalyptus wandoo* generally dominate this community. *Hypocalymma angustifolium*, *Acacia lasiocarpa* var. *bracteolata* (long peduncle form P1) and *Verticordia huegelii* can also occur. Typical herbs include *Centrolepis aristata*, *Chorizandra enodis, Drosera menziesii* subsp. *menziesii, Drosera rosulata* and *Hyalosperma cotula*. This community included a relatively high proportion of weeds due to historical disturbance (Gibson *et al.* 1994).

A DoW bore occurs in Hay Park in Bunbury bushland in this clay pan type (occurrence 48 – see Appendix 1), and is screened in the superficial aquifer. Water levels at this location varied seasonally in a range from 1.7 and 5.8m below ground between 2009 and 2014 (DoW 2014). A private bore occurs in this community in Kenwick, and had a static water level of 3.5m below ground when drilled in November 2011.

Dense shrublands on clay flats (Community Type 9 (SCP09))

The shrublands or open woodlands of this community are inundated for longer periods and have lower species richness and numbers of weed taxa than the other clay pan types. Sedges including *Chorizandra enodis*, *Cyathochaeta avenacea*, *Lepidosperma longitudinale* and *Meeboldina coangustata* are more common in this community. Shrubs including *Hakea varia, Melaleuca viminea* and *Eutaxia virgata* are common.

There are no high quality bore data available for locations near this clay pan type. Only one bore had publicly available data, near Wellard Nature Reserve (occurrence 69 – see Appendix 1). The readings were taken during winter 1962 and summer 1974, with the level varying from about 1.9m to 2.1m below the surface.

Shrublands on dry clay flats (Community Type 10a (SCP10a))

The community occurs on skeletal soils that have shallow microtopography and the habitat is the most rapidly drying of the four clay pans identified in Gibson *et al*. (1994). Shrubs in the community include *Hakea sulcata*, *Hakea varia*, *Pericalymma ellipticum* and *Verticordia densiflor*a. Herbs and sedges that are also common include *Schoenus rigens*, *Aphelia cyperoides, Centrolepis aristata, Schoenolaena juncea, Drosera gigantea* subsp. *gigantea*,

and *Drosera menziesii* subsp. *menziesii*.

There are three bores which occur within 20m of the community. These are railway reserves Capel (BY25B, BY25A occurrence 95) and a private bore in Capel (occurrence 87). The range of the static water level is between 2.01m to 9.35m from top of casing with the recording taken at the end of autumn (27/05/2009); with one recording showing levels dropping to 1.22 m from ground level but with no date provided.

Clay pans with shrubs over herbs (See also Appendix 3 for list of common taxa)

These clay pans are usually dominated by a shrubland of *Melaleuca lateritia* (robin red breast bush) with dense herbs. This community is known from the Swan Coastal Plain and Jarrah Forest IBRA regions.

The clay pans are characterised by taxa that are adapted to presence of surface water such as *Hydrocotyle lemnoides* or to a combination of terrestrial and wet phases such as *Glossostigma diandrum*, *Villarsia capitata*, and *Eleocharis keigheryi* (Gibson *et al*. 2005).

Forbes and Vogwill (2012) studied water relations in a clay pan of this type in Drummond Nature Reserve. They found evidence that there is little connection between the surface and groundwater systems. There is one private bore within or in the 20m buffer zone of the community (SWAMP 117).

Hydrology

There are few data available on surface water characteristics of the clay pan communities, however V & C Semeniuk Research Group (2001) completed detailed hydrological studies of the Brixton Street wetlands in Kenwick that are dominated by clay pans (including occurrences 35, 53-56, 92). They noted that discharge of ponded water can occur through slow infiltration or evapo-transpiration, with slow rainfall runoff from former natural channels and constructed tracks occurring at 0.002-0.006 m^3/second for several days to weeks after rain. Sumplands (primarily clay pans) are inundated at the Brixton Street site for three to five months a year and reach a maximum depth of 40-50cm, with tracks holding water for longer periods (V & C Semeniuk Research Group 2001).

V & C Semeniuk Research Group (2001) note that groundwater in the muds (clays) and muddy sands was hyposaline and increased with depth. Water in adjacent drains that were probably mainly collecting surface water was fresh. Moisture contents were highest during maximum rainfall with wetlands that contained muds (clays) retaining moisture for longest in the Brixton St wetlands (V & C Semeniuk Research Group 2001). The amount of moisture in the top 15cm of soil was low across the site, but greatest in muds (clays), then muddy sands, then sands. The sands therefore had the lowest moisture retention rate and highest porosity. Differences in soil moisture retention have implications for drought tolerance of the associated vegetation, with greater impacts of drought occurring in vegetation on sandy clay soils than on clays due to high porosity and lower moisture retention. Lower rainfall periods can cause reduced flowering seasons and stunted growth, decreased recruitment of less drought tolerant taxa such as some annuals and increases in more drought tolerant flora, and death of more drought susceptible taxa (V & C Semeniuk Research Group 2001).

The hydrographs for a drain adjacent to the Brixton St wetlands during below average rainfall were below groundwater level, so this drain primarily affects surface water (V & C Semeniuk Research Group 2001). In periods of below average rainfall, regional groundwater therefore has minor influence on the Brixton St wetlands with the major influences being direct rainfall, ponding, infiltration and sub-surface perching. In wetter periods,

groundwater levels may reach the drains. The effect of drains is, however, to shorten periods of inundation and waterlogging of surface sediments and the potential for infiltration.

Studies of linkages between groundwater and surface water in the south west Australian clay pans are very limited, but where completed generally indicate a lack of connection between the two systems. For example Forbes and Vogwill (2012) studied two clay pans in Drummond Nature Reserve, including an occurrence of the Clay pans with shrubs over herbs. They found evidence that there is little connection between the surface and groundwater systems. V & C Semeniuk Research Group (2001) also concluded that there is no relationship between groundwater and wetlands at some of the Greater Brixton Street sites, that includes several clay pan types.

In addition there are data for a few bores that occur close to or within the clay pan communities, and the bore data for these have been extracted from Department of Water (2014) Water INformation (WIN) database. The figures below provide data about changes in groundwater depth over time beneath examples of the clay pan communities. In each case, zero metres represents ground surface. The figures indicate the seasonal nature of the superficial watertable, and the lack of connection of groundwater to surface in each case.

Figure 1: Bore data from 2003 to 2014 for occurrences 99, 100 of clay pans with shrubs over herbs in Drummond Nature Reserve. Water depth below ground, adapted from Forbes and Vogwill 2011 and Department of Parks and Wildlife unpublished data. The base of the bore is at 5.4m, and the bore is dry when level is -5.4m.

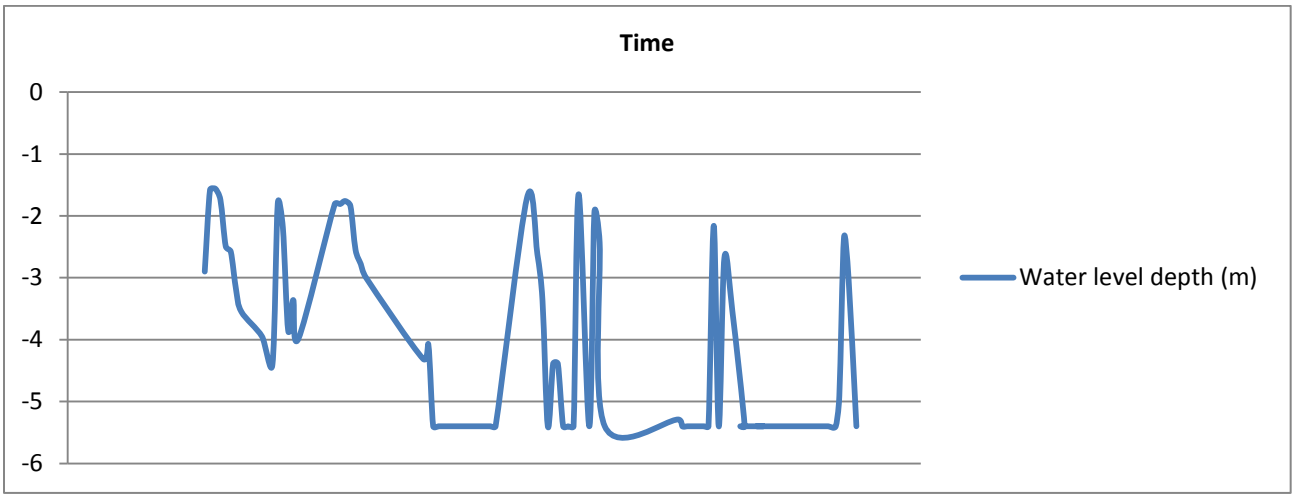


Figure 2: Bore data 2012-2013 for a clay pan type SCP07 in Bambun reserve (depth below ground, occurrence 5; data from DoW 2014)

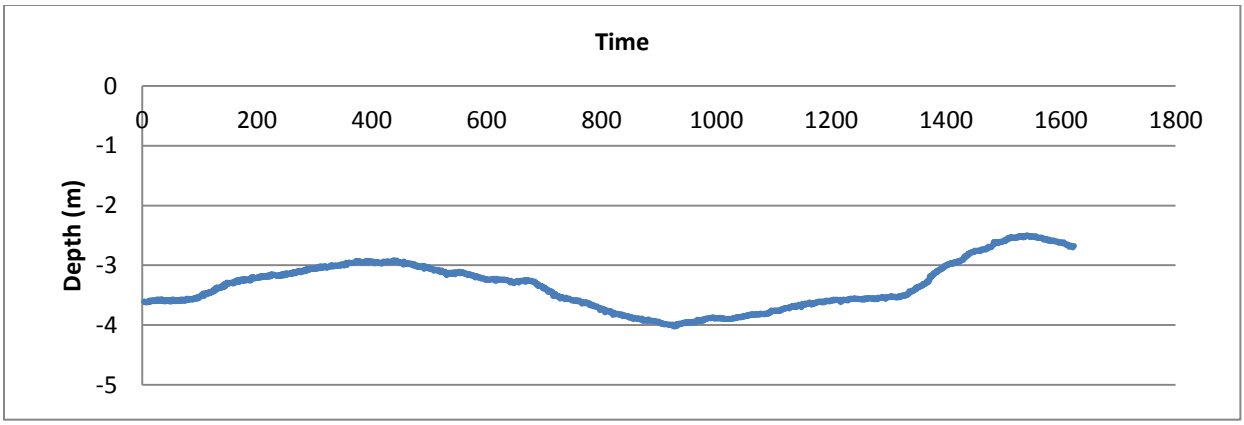


Figure 3: Bore data for Hay Park SCP08 clay pan for 2009-2014 (depth below ground; occurrence 48; data from DoW 2014)

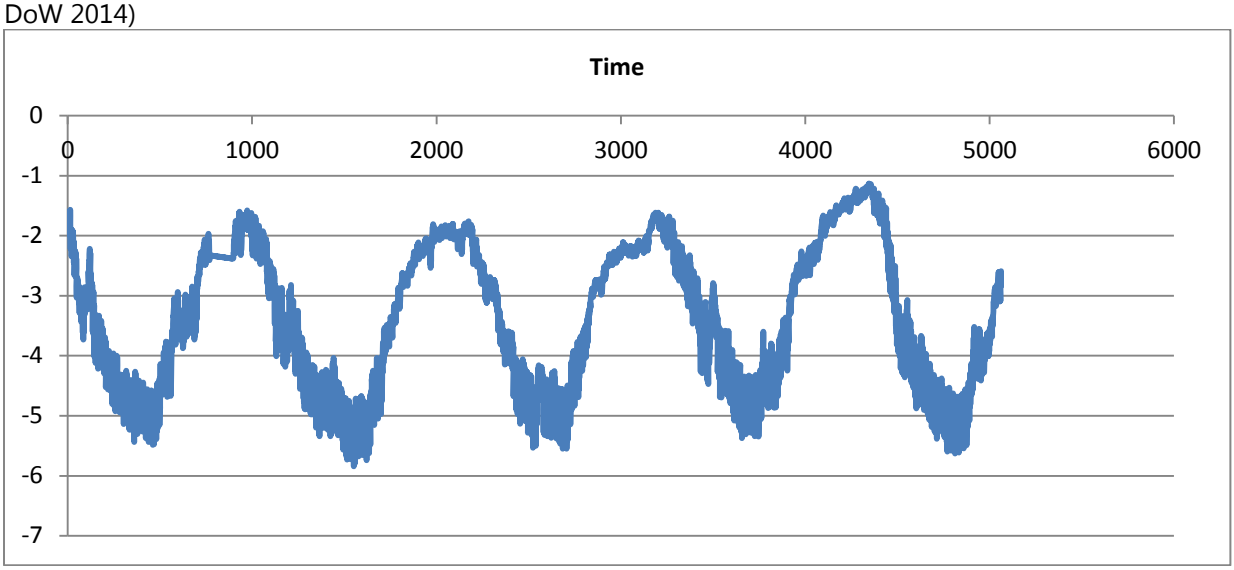
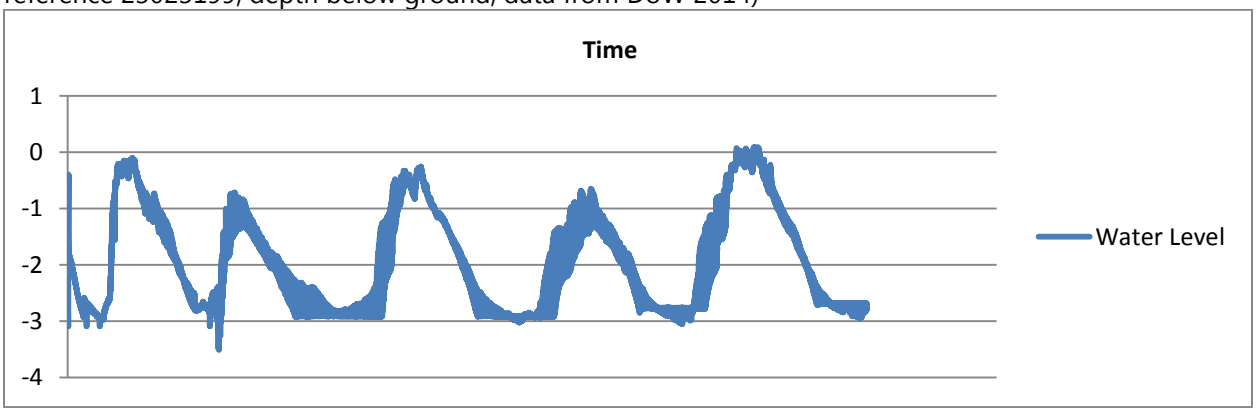


Figure 4: Bore data for 2009-2013 for Yoongarillup clay pan community type SCP07 (occurrence 1; WIN site reference 23023199, depth below ground; data from DoW 2014)



Indirect evidence suggests that evaporation of surface waters can result in increases in salinity in clay pan substrates. For example, samphires and *Casuarina obesa*, that are adapted to saline soils, are recorded from a

suite of locations, in particular, of the Herb rich saline shrublands in clay pans. Locations that have samphires in the clay pans include Bullsbrook Nature Reserve (occurrence 8) and Brixton St wetlands (occurrences 35, 53).

Related biodiversity impacts and benefits

Other TECs, declared rare and priority flora, and threatened fauna, either occur in the remnant vegetation containing the clay pan communities or within the communities themselves, and will benefit from recovery actions implemented to improve the quality or security of the community.

Other TECs co-occurring within remnant vegetation that contains the clay pan communities are:

- Southern wet shrublands, Swan Coastal Plain (community type 2 endangered)
- Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) (community type 10b, critically endangered)
- *Corymbia calophylla* woodlands on heavy soils of the southern Swan Coastal Plain (community type 1b, vulnerable)
- *Corymbia calophylla - Kingia australis* woodlands on heavy soils, Swan Coastal Plain (community type 3a critically endangered)
- *Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands (community type 3c, critically endangered)
- *Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain (community type 3b vulnerable)
- Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (Plain (community type 15 vulnerable)
- Shrublands on calcareous silts of the Swan Coastal Plain (community type 18 vulnerable)
- *Banksia attenuata* woodlands over species rich dense shrublands (community type 20a, endangered)
- Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (community type 20b, endangered)
- Shrublands and woodlands on Muchea Limestone (endangered)
- Whicher Scarp Paluslope wetlands (priority 1)
- Wandoo woodland over dense low sedges of *Mesomelaena preisii* on clay flats (priority 2)

A list of the 12 declared rare flora and 42 priority taxa that occur with the clay pan communities is presented in Table 2.

Table 2: Threatened and priority flora that occur in the clay pan TEC

Species name	Conservation status (WA)	Conservation status (EPBC Act 1999)
Acacia flagelliformis	P4	
Acacia inops	P3	
Amperea micrantha	P2	
Angianthus drummondii	P3	
Aponogeton hexatepalus	P4	
Banksia meisneri subsp. *ascendens*	P4	
Blennospora doliiformis	P3	
Boronia anceps	P3	

Boronia tetragona	P3	
Calytrix breviseta subsp. *breviseta*	DRF (CR)	EN
Centrolepis caespitosa	P4	EN
Chamaescilla gibsonii	P3	
Chamelaucium sp. S coastal plain	DRF (VU)	VU
Chordifex gracilior	P3	
Diuris purdiei	DRF (EN)	EN
Eleocharis keigheryi	DRF (VU)	VU
Eryngium pinnatifidum subsp. *Palustre*	P3	
Eryngium sp. Ferox	P3	
Eryngium sp. Subdecumbens (G.J. Keighery 5390)	P3	
Gastrolobium sp. Yoongarillup	P1	
Grevillea brachystylis subsp. *brachystylis*	P3	
Grevillea curviloba subsp. *incurva*	DRF (EN)	EN
Grevillea thelemanniana subsp. *thelemanniana*	P2	
Hakea oldfieldii	P3	
Hydrocotyle lemnoides	P4	
Hemigenia microphylla	P3	
Isotropis cuneifolia subsp. *glabra*	P2	
Isopogon formosus subsp. *dasylepis*	P3	
Laxmannia jamesii	P4	
Lepidosperma rostratum	DRF (EN)	EN
Lepyrodia heleocharoides	P3	
Loxocarya magna	P3	
Montia australasica	P2	
Meionectes tenuifolia (formerly Haloragis tenuifolia)	P3	
Myriophyllum echinatum	P3	
Ornduffia submersa	P4	
Schoenus benthamii	P3	
Schoenus capillifolius	P3	
Schoenus natans	P4	
Schoenus sp. Waroona	P3	
Ptilotus pyramidatus	DRF (CR)	CR

Stylidium longitubum	P3	
Stylidium roseonanum	P3	
Synaphea hians	P3	
Synaphea sp. Fairbridge Farm	DRF (CR)	CR
Synaphea petiolaris subsp. *simplex*	P2	
Synaphea stenoloba	DRF (CR)	EN
Tribulus minutus	P1	
Trichocline sp. Treeton	P2	
Trithuria occidentalis	DRF (CR)	EN
Verticordia densiflora var. *pedunculata*	DRF (EN)	EN
Verticordia lehmannii	P4	
Verticordia lindleyi subsp. *lindleyi*	P4	
Verticordia plumosa var. *vassensis*	DRF (EN)	EN

There are three critically endangered fauna known to be dependent on clay pans and the surrounding communities for a portion of their life/breeding cycle. These are *Pseudemydura umbrina (*Western Swamp Tortoise) and two native bees: *Leioproctus douglasiellus* and *Neopasiphae simplicior*.

Leioproctus muelleri is a recently discovered native bee that is only known from Keane Rd (Occurrences 88 and 89) but is not listed as threatened fauna.

Habitat critical to survival, and important occurrences

Habitat critical to survival includes the area of occupancy of known occurrences; similar habitat adjacent to important occurrences (i.e. within approximately 200m), i.e. poorly drained flats, depressions or winter wet flats with shallow sands and loams; remnant vegetation that surrounds or links several occurrences (this is to provide habitat for pollinators or to allow them to move between occurrences); and the local catchment for the surface, and potentially groundwater, that maintains the winter-wet habitat of the community. The plant assemblages are dependent on maintenance of the local hydrological conditions.

Occurrences that provide for representation of one of the clay pan communities across its geographic range and that can be managed for conservation and/or with conservation included in their purpose are considered critical to the survival of the clay pan communities and are therefore important occurrences. Occurrences within conservation reserves and Bush Forever sites (eg Brixton St wetlands occurrences 4, 35, 53-56; Forrestdale Nature Reserve occurrences 34, 51; Moore River Nature Reserve occurrence 22; Byrd Swamp occurrence 70; Drummond Nature Reserve occurrences 99, 100; Lake Wannamal Nature Reserve occurrences 102, 103, 106, 107; Wandoo National Park occurrence 111, Fish Road Nature Reserve occurrences 2, 76, and Tuart Forest eastern wetlands occurrences 113, 114); and occurrences with comparatively large intact areas of the community that are in relatively good condition outside of Bush Forever, are considered important occurrences (eg Austin Cove occurrences 26-29; Vasse-Yallingup rail reserve occurrence 74; Waroona occurrence 81).

1.5 International Obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. This community is not listed under any specific international treaty, however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

1.6 Indigenous interests

An Aboriginal Sites Register is kept by the Department of Aboriginal Affairs, and lists Artifact/Scatter and Ceremonial and Morphological sites in the vicinity of occurrences. The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. Appendix 1 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. Actions identify the intention to continue liaison with relevant groups, including indigenous groups.

1.7 Social and economic impacts and benefits

The implementation of this recovery plan has the potential to have some social and economic impact, where occurrences are located on lands not specifically managed for conservation, such as road reserves and private property. Recovery actions refer to continued liaison between stakeholders with regard to these areas. Negotiations will continue with land managers with respect to the future management of occurrences not in conservation estate.

Where specific active recreational pursuits such as four wheel driving and motorbike riding are prevented through access control, this may be perceived as a social impact, however, such access control also helps to prevent the continued degradation of the community and maintain other social benefits.

Occurrences may be threatened by proposals to clear for various developments or from hydrological change following clearing and development of adjacent land. Implementation of actions such as seeking to protect the hydrological processes in the areas adjacent to the community may result in a perceived impact on development.

1.8 Affected interests

Occurrences occur within the Shires of Armadale, Busselton, Carpel, Gosnells, Murray, Serpentine- Jarrahdale, Waroona, Gingin, Bunbury, Beverley, Capel, Dardanup, Kalamunda, Toodyay and Kojonup. They occur on land managed by local governments, administrators of railways, Public Transport Authority of Western Australia, Western Australian Planning Commission/ Department of Regional Development and Lands, Main Roads WA, Parks and Wildlife, Perth Airports Corporation, Conservation Commission, Water Corporation, University of WA, WA Planning Commission, and on private property.

1.9 Term of plan

The plan will operate from 2015 to 2020 but will remain in force until withdrawn or replaced. It is intended that, if the ecological communities are still ranked vulnerable or endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated.

1.10 Strategies for recovery

To identify, and influence the management of the areas in which the community occurs, so maintaining natural biological and non-biological attributes of the sites and the current area covered by the community.

To conduct appropriate research into the ecological characteristics of the community to develop further understanding about the management actions required to maintain or improve its condition.

2. THREATENING PROCESSES

Clearing

The seasonal clay-based wetland communities of the south west are amongst the most threatened assemblages in Western Australia. It is estimated that >90% of the original extent of these wetlands has been cleared for agricultural use (Gibson *et al.* 2005). Clay pans in the Perth area have also historically been cleared and quarried for clay for use in manufacturing bricks and tiles.

Hydrological changes

Altered hydrology due to anthropogenic causes, in urbanised areas in particular, is likely to be an increasing threat to the clay pans. Drainage to lower watertables, clearing resulting in a decline in evapotranspiration and increased surface runoff, and water quality declines are likely to increasingly impact the hydrologic regimes of the clay pan communities. Altered periods of ponding may affect the timing of growth of herbs in the understorey, and may also affect the species composition of the community by favoring different taxa. Any changes to the natural hydrology of the clay pans can affect composition as they are dependent on the timing of filling and drying at appropriate times of the year.

Increased nutrient levels in surface water in occurrences adjacent to areas such as farm lands and residential areas is likely to favour weeds as weeds are adapted to higher nutrient levels than native flora.

Hydrological changes such as increased depth or period of inundation may cause salt accumulation near the surface. This has been noted in areas of the southern Swan Coastal Plain since around the 1950s as a result of clearing (Smith and Ladd 1994). Due to the widespread clearance of native perennial vegetation and its replacement with urban areas and farmlands, rising groundwater in the surrounding region may result in increased surface water into clay-based wetlands (Gibson *et al.* 2005). Salinity risk mapping indicates that many clay pans are in susceptible areas (National Land and Water Resources Audit 2001).

Salinisation may increase as a result of evaporation of surface water. If increased ponding occurs in the community due to urbanisation or clearing in the catchment, evaporation of a greater volume of water may result in larger amounts of residual salt. This is especially true for clay soils, which inhibit rainfall infiltration and result in high evaporation rates and concentration of salts (Davidson 1995).

Salinisation and increased nutrients have been observed at a clay pan in Drummond Nature Reserve (Chow *et al.*, 2010). There is currently no hydrological connection between the surface water in the clay pan and groundwater at this site, however evidence suggests increased volumes of nutrient enriched water in the clay pan as a result of regional clearing.

In some other areas groundwater is very close to the surface. At clay pans in Brixton Street, groundwater is 0–3 metres below the surface at the end of spring (Davidson, 1995). Surface waters may link to groundwater in winter and may influence the quantity and quality of water on the surface of the sites.

The levels of salinity in the community will need to be monitored to determine if salinisation poses a major threat to the communities, and the sources determined.

Weed invasion

Weeds change the natural diversity and balance of ecological communities and are a major threat to the clay pans. About 16% of the flora for the clay pans are weeds (Gibson *et al.,* 2005) and some are particularly aggressive.

Weeds displace native plants, particularly following disturbances such as too frequent fire, grazing or partial clearing, and compete with them for light, nutrients and water. They can also prevent recruitment, cause changes to soil nutrients, and affect abundance of native fauna. They can also impact on other conservation values by harbouring pests and diseases, and increasing the fire risk.

Introduced South African bulbous plants are a particularly serious group of weeds in clay pans. As the taxa occur in similar habitat in South Africa, many have the ability to invade relatively undisturbed clay pan habitat and displace the rich herbaceous flora. *Watsonia meriana, Sparaxis bulbifera* (harlequin flower), *Moraea flaccida* (one leafed cape tulip), *Hesperantha falcata* and *Freesia alba x lechtlinii* (freesia) are of particular concern. Seed and cormels are spread into undisturbed areas in sheet waterflow across wetlands (Brown and Brooks 2003b, Brown *et. al*., 2008). South African perennial grasses are another serious group of weeds that also occur in similar habitat in South Africa and have the ability to invade clay pans in good condition following disturbance events such as fire. *Tribolium uniolae* (haas grass), *Eragrostis curvula* (lovegrass) and *Hyparrhenia hirta* (tambookie grass) are of particular concern and are a priority for control. The impacts of annual weeds are less well known but many move into intact vegetation following a disturbance event and appear to displace the native annual flora. These include *Cyperus hystrix, Parentucellia viscosa* (bartsia) and *Hypochaeris glabra* (flat weed) (see also Appendix 2).

Sources of weed invasion include adjoining areas of urban and agricultural use, drains, and tracks within and near the clay pans. All these sources increase vulnerability to weed invasion following any type of disturbance. The clay pans appear reasonably resistant to weed invasions due to seasonal inundation and hardness of soils in the summer and changes to these elements may alter their ability to resist weed invasion (Keighery 1996).

Grazing

Grazing of native vegetation causes alterations to species composition through selective removal of edible species, the introduction and enhancement of weeds by the addition of dung, and through trampling and general disturbance. The presence of feral animals such as rabbits (*Oryctolagus cuniculus)* and pigs (*Sus scrofa*) is a concern as they disturb the vegetation by grazing and burrowing.

Occurrences at Fish Road (Occurrence 2, 76), Forrestdale Lake (Occurrences 33, 34, 46, 47, 80, 86), Nicholson Road (Occurrences 43, 44, 82), Karnup Road (Occurrence 45), Plantation Road (Occurrence 87), Keane Road (Occurrences 88 and 89), Brixton St (rabbits, occurrences 35, 50, 53), Ellen Brook (rabbits are fenced in, foxes are fenced out, occurrence 31), Bullsbrook (occurrence 8), Austin Bay (occurrence 12) have all been threatened by grazing to some degree, namely by rabbits, horses and kangaroos. The significance of the impact, however, has not been quantified through monitoring. Pigs have been recorded at Goonaping, and Moore River and Drummond Nature Reserves (occurrences 22, 111, 99 and 100).

Altered fire regimes

Inappropriate fire regimes are a significant threat to the clay pan communities. Historically, fire within the clay pans was probably only very occasional. It is likely that some of the clay pan types such as the Shrublands on dry

clay flats may be adapted to occasional fire as they contain species that will easily carry fire when vegetation is dry, and some component shrubs would reproduce from seed following fire. The fire response of the major types of clay pan vegetation needs to be determined however.

The risk of fire is generally increased by the presence of urban areas nearby. In addition, grassy weeds in the understorey are often more flammable than many of the original native species in the herb layer. Many of the occurrences have been burnt recently, including the occurrences on Fish Road (Occurrence 2, 76) and Nicholson Road (Occurrences 43, 44, 82). The fire responses of the typical and common vascular plants in the clay pan types (from Gibson *et al.* 1994) occur in Appendices 2 and 3.

Anecdotal evidence indicates that fire may exacerbate the impact of drying climate in clay pan communities. For example, following fire in Ambergate reserve (encompasses occurrence 21) community structure altered and reduced rainfall is believed to be a contributing factor. Shrub species such as *Pericalymma ellipticum* and *Verticordia plumosa* subsp. *ananeotes* have not recovered well post-fire and there has been a notable increase in sedge cover ([1]B. Lullfitz personal communication).

Disease

Soil types have a clear correlation with the occurrence of dieback disease caused by the water moulds *Phytophthora* species around the Perth metropolitan area. Davison and Tay (1986) state 'Increased sporulation and growth of *P. cinnamomi* will not occur in waterlogged soil because aeration is inadequate'. The clay pan communities occur on heavier soils that are thus probably a less susceptible habitat, resulting in a reduced susceptibility of the communities to the disease, although the disease has been recorded at Bullsbrook Nature Reserve (contains occurrence 8). In order for the disease to take hold within the occurrences a combination of factors such as temperature and rainfall need to be optimal for the spread of dieback. Regardless the risk of disease introduction should be minimized by ensuring good hygiene procedures. This includes adequately washing down any equipment used on or adjacent to the community and restricting access by vehicles and machinery to dry soil conditions.

Phytophthora dieback disease particularly affects Proteaceae and Myrtaceae families that are floristically and structurally dominant in some areas of the clay pan communities.

Plant species growth form may influence susceptibility to *Phytophthora* dieback disease, with the herbaceous perennials, annuals and geophytes that are common in these clay pans being apparently unaffected. Woody perennials are generally found to be the most susceptible. Monocotyledons generally have low susceptibility to the disease, as their density increases in sites with historical infections as compared with healthy uninfected areas. As the clay pan communities generally have a high proportion of their diversity associated with the annual herb and sedge layers, these particular communities may be less affected than other sites that are dominated by other structural formations such as woodlands and forests.

The disease Myrtle Rust (*Puccinia psidii sens. lat*) also has potential to impact the clay pans if it becomes established in Western Australia, as it may affect some of the dominant myrtaceous shrubs in the community (Australian Network for Plant Conservation 2012).

Loss of overstorey including taller shrubs caused by either *Phytophthora* species or Myrtle Rust may lead to a change in the herb layers as a result of increased sun penetration and decreased shading.

[1] Ben Lullfitz, Department of Parks and Wildlife, Busselton

Disturbance from recreational activities

Inappropriate recreational uses such as four wheel drive vehicles and dirt bikes pose a risk to the clay pan communities. Rubbish dumping also occurs in clay pans that are close to urban areas such as Brixton St Wetlands. These activities cause direct damage to vegetation, and can lead to weed, or disease introductions such as *Phytophthora* species.

Drying climate

The clay pans are at risk from a drying climate with effects such as reduced surface water due to significantly less rainfall. As winter rainfall declines over the Swan Coastal Plain there may be a significant impact to the clay pans and component species that are dependent on particular water regimes. The drying trend in the south-west of Australia is forecast to significantly worsen (Western Australia Climate Science Centre, 2010). It is noted, however, that a drying climate as a threatening process is outside the scope of this recovery plan.

3. GUIDE FOR DECISION-MAKERS

Any on-ground works (significant clearing, burns, proposals with potential to alter drainage or water quality) within or in the immediate vicinity of the clay pans will require assessment. Proponents should demonstrate that on-ground works will not have a significant impact on the clay pan communities, or on their habitat or potential habitat:

- land clearing leading to loss of locations defined as 'core areas' of the clay pans
- clearing leading to significant increase in fragmentation of the communities
- a significant increase in opportunity for introduction or increase in density of weeds or introduced /feral animals known to damage the communities
- proposals that will result in a significant increase in fire frequency
- proposals that will modify the hydrological regime of the clay pans.

4. CONSERVATION STATUS

Four components of the community are listed as threatened ecological communities (TECs) endorsed by the WA Minister for the Environment. They are:

- Herb rich saline shrublands in clay pans (Community Type 7 (SCP07)) – Vulnerable
- Herb rich shrublands in clay pans (Community Type 8 (SCP08)) – Vulnerable
- Dense shrublands on clay pans (Community Type 9 (SCP09)) – Vulnerable
- Shrublands on dry clay flats (Community Type 10a (SCP10a)) – Endangered.

The fifth component of the community, 'Clay pans with shrubs over herbs', is listed as Priority 1 by Department of Parks and Wildlife.

The umbrella type 'Clay pans of the Swan Coastal Plain' is ranked Critically Endangered under the EPBC Act.

Components of the clay pan communities are in Wetlands of National Significance, including Brixton Street Wetlands, the Ellen Brook Swamps Systems; and Ramsar sites, including Forrestdale Lake Nature Reserve and the Peel-Yalgorup System (Environment Australia, 2001).

5. RECOVERY OBJECTIVES AND CRITERIA

5.1. Objectives

To conserve the ecological and conservation values of the clay pan communities of the Swan Coastal Plain by:

- Maintaining or improving the overall condition of each of the clay pan communities.
- Reducing the level of threat to each of clay pan communities.

5.2 Criteria for success:

- 90% or more of the aerial extent of occurrences of each clay pan type covered by this recovery plan, maintained at the same condition rank, or improved (Bush Forever condition scales) over the life of the plan, excluding effects of drying climate that are outside the scope of this plan.
- An increase in the number of occurrences of the clay pan types managed for conservation and/or with conservation included in the purpose.
- Representative areas of the clay pan types across their geographical range maintained in the same or improved condition (Bush Forever condition scales).

5.3 Criteria for failure:

- Decline in condition rank to a lower category (Bush Forever condition scales) of 10% or more of the total aerial extent of the communities covered by this plan, excluding effects of drying climate that are outside the scope of this plan.
- Failure to achieve an increase in the area managed for conservation for the communities covered by this plan.

6. RECOVERY ACTIONS

The responsible authority is frequently listed as the relevant Parks and Wildlife District. This refers largely to initiating and guiding actions. However, in general the relevant Parks and Wildlife District, in liaison with the Species and Communities Branch and the relevant Recovery Team share the primary responsibility for securing funds for, and/or coordinating the implementation of, recovery actions.

6.1. Existing recovery actions

Many recovery actions have been completed for the clay pan communities:

- The extent and boundaries of all known occurrences have been mapped.

- Since the State listings of the clay pan communities as TECs in 2001 a series of occurrences, or portions of occurrences of the clay pan communities have been acquired for the purpose of conservation as follows. Some locations have not yet been officially included in conservation tenure:
    - Occurrence 6; CR 46414 on Cockram Rd, Gingin
    - Occurrence 15, 16; 85 Rapids Rd, Serpentine
    - Occurrences 26-29 South Yunderup
    - Occurrence 30 Roselands Rd, Boyanup
    - Occurrence 36 Pinjarra Williams Rd, Meelon

- Occurrence 42 Abernethy Rd, Oakford
- Occurrences 54-56, 92 Wanaping Rd, Kenwick

- TEC markers have been installed at Hall Road (Occurrence 14), Boyanup West Rd and Roselands Rd (occurrence 30), Turner Rd, Byford (occurrence 67), Bradbury Nature Reserve (occurrence 83, 84) and on Western Power poles to indicate the TEC occurrence at Karnup Road (occurrence 45).

- All relevant managers of lands that contain the clay pan communities have been notified of the importance of the communities.

- Several occurrences have been fenced to prevent damage and help minimise spread of disease. To date, the occurrences at Forrestdale Lake (myFL07, myFL06 and FL02 – occurrences 33, 34, 46, 47, 80, 86), Nicholson Rd (Occurrences 43, 44, 82), Hall Rd (Occurrences 14, 83, 84), Austin Bay Nature Reserve (occurrences 9, 10, 11, 12), Kenwick Rd, Kenwick (occurrences 13, 23, 24, 41), Bickley Rd, Boundary Rd, Brook Rd, Kenwick (occurrences 4, 60, 62, 63, 79, 97), Moore River Nature Reserve (occurrence 22), Ellen Brook Reserve (occurrence 31), Brixton St and Albany Hwy, Kenwick (occurrence 35, 50), Meelon Nature Reserve (occurrence 36), Nicholson Rd and Woodmore St (occurrence 43, 44, 82), Hensbrook Loop, Forrestdale (occurrence 51), Mundijong Rd, Peel Estate (occurrence 66), Turner Rd, Byford (occurrence 67), Kooljerrenup Nature Reserve (occurrence 78), Bradbury Nature Reserve (occurrence 83, 84), Drummonds Nature Reserve (occurrence 99, 100), Julimar (occurrence 101), and Keane Rd (occurrences 88 and 89) have been fenced, and Fish Rd (occurrences 2, 76) has been partially fenced.

- Weed control has been undertaken at Fish Rd (Occurrences 2, 76) in ongoing perimeter weed management by spraying of African lovegrass (*Eragrostis curvula)* and annual grasses. Weed control including of watsonia (*Watsonia meriana* var. *bulbillifera)* has also been completed at several other sites; at Bullsbrook Nature Reserve (occurrence 8), Austin Bay Nature Reserve (occurrences 9, 10, 11, 12), Ellen Brook Reserve (occurrence 31); and arum lily (*Zantedeschia aethiopica)* control at Brixton St and Albany Hwy, Kenwick (occurrences 35, 50), Meelon Nature Reserve (occurrence 36), Hensbrook Loop, Forrestdale (occurrence 51), South Western Hwy and Waterloo Rd (occurrence 38, 52) and Fish Rd, Acton Park Rd and Yoongarillup Rd, Yoongarillup (occurrences 2, 76).

- Weed management and restoration plans have been developed for Bullsbrook Nature Reserve (occurrence 8), Ellen Brook Nature Reserve (occurrence 31) and Brixton St wetlands (occurrences 35, 50).

- A series of management plans have been developed for Jandakot Regional Park, Bandicoot Brook bushland – North Waroona Reserve, Brickwood Reserve and Briggs Park.

- Boardwalks and information shelters have been installed at Forrest Rd, Forrestdale (occurrences 33, 34, 46, 80, 86) and signage installed for public education on access and dieback hygiene at Brixton St and Albany Hwy, Kenwick (occurrence 35, 50) and Forrest Rd, Forrestdale (occurrences 33, 34, 46, 80, 86).

- Rubbish removal has been completed at Forrest Rd, Forrestdale (occurrence 33, 34, 46, 80, 86) and Brixton St and Albany Hwy, Kenwick (occurrence 35, 50).

- Track closures, construction of a parking area, and the installation of access gates, bollards, hygiene station and signage have been completed at occurrences 109, 110, (Birdwood Nature Reserve).

- The Julimar area (occurrence 101, 108) was fenced to prevent damage by bikes; Drummonds Nature Reserve (occurrences 99, 100) was fenced to prevent four wheel drive damage. Damage was observed previously at both sites.

- Disease mapping has been completed at Bullsbrook (occurrence 8) and a dieback management plan prepared.

- All original quadrats established in the clay pan communities for Gibson *et al*. (1994) were reestablished and rescored in 2013.

6.2 Recommended recovery actions

1. Liaise with stakeholders to implement recovery

Many of the occurrences of the clay pan communities are managed by authorities other than Parks and Wildlife, or are privately owned. Liaison with all land managers will be required in seeking conservation management and avoiding further loss or damage to the communities. Indigenous groups will also be consulted about relevant on-ground actions in this plan.

Road widening, maintenance activities, fencing or other infrastructure or development activities involving soil or vegetation disturbance in areas where the clay pan communities occur should be planned such that they do not adversely impact on known occurrences.

The locations of clay pan communities in the Perth-Peel area are to be specified in the Strategic Assessment planning document that covers that region and is to form an agreement between the State and the Australian Governments. The document will seek to ensure the conservation of Matters of National Environmental Significance including the clay pan communities, in future development plans for the region. Another document that seeks to ensure protection of specific areas of the clay pans is Bush Forever, a planning document for the Perth Metropolitan Region (Government of Western Australia 2000).

To prevent accidental destruction of the communities, and gain public support for their conservation, information about the community will continue to be provided by local Parks and Wildlife staff to all stakeholders including landholders and managers of land containing the community. This will include information from the TEC database, maps indicating the location of the community, and this recovery plan.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, Species and Communities Branch (SCB))
Cost:	$5,000 per year for all liaison (not including vehicle costs)
Completion date:	Ongoing

2. Continue to monitor extent and boundaries of occurrences

To date many of the occurrences have been manually mapped or mapped using aerial photographs. Extent and boundary information will continue to be updated on Parks and Wildlife's corporate threatened ecological communities database.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, Species and Communities Branch)
Cost:	$3000 per year
Completion date:	Ongoing

3. Encompass monitoring in an adaptive management framework

It is likely that the most important factors that will influence the future health and persistence of the clay pan communities will be weed levels, hydrological parameters, climatic factors such as reduced rainfall, fire intervals and characteristics, and grazing levels. Monitoring that is linked to the vegetation's responses to these pressures will therefore be most useful in guiding future management.

General monitoring established in the community includes success of weed control in occurrences including Brixton St (occurrences 35, 53), and Meelon Nature Reserve (occurrence 36). This type of detailed monitoring is required to quantify the effects of on-ground management and to plan future management strategies.

Monitoring protocols will be based on those developed through the Resource Condition Monitoring project. For example, Brown and Clarke (2009) specified a monitoring protocol for weeds in a clay pan community. The monitoring will be linked to areas where active management or impacts are anticipated, so analysis of results can be incorporated to improve management of fire, hydrology, grazing by native or feral animals, weed invasion and other factors, as is recommended for an adaptive management framework.

All occurrences contain permanent quadrats (Gibson *et al.* 1994, 2005; DEP 1996; Parks and Wildlife unpublished data), and these are progressively being relocated and monitored. Data collected includes plant species diversity, vegetation structure and comprehensive species lists. All native and weed species were recorded in quadrats that were initially established. Quantitative data that would provide information about density or cover for each species were not included in standard quadrat monitoring but have been established in specific areas subject to targeted weed control programs. Occurrences will be monitored every five years to provide information on composition, and condition. This information will be added to the TEC database.

Remote sensing data such as 'Vegetation Trend' from Landsat TM provides a coarse measure of change in vegetation cover. The interpretation of these data requires ground truthing as factors such as recovery from fire may not otherwise be evident. This remote sensing method may be suitable for some aspects of monitoring in future.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, Species and Communities Branch, SCB)
Cost:	$5,000 per year for field survey, specimen identification, and database management
Completion date:	Ongoing

4. Develop and implement fire management strategy

Burrows (2008) recommended fire regimes should be determined based on vital attributes, a diversity of frequency, season and intensity, and provide for habitat diversity and a fine-grain mosaic of habitats. The outcomes of implementation of a particular regime on the composition and structure of the community should be quantitatively monitored and results and data analysis incorporated into an adaptive management

framework. Vital attribute data should be entered into the Threatened and Priority Flora Database (TPFL) fire response data base. These data are required in particular for perennial herbs and geophytes. Fire history maps also need to be developed for occurrences of the community, and updated annually.

It is likely that some of the clay pan types such as those comprised of shrublands in damplands may be adapted to occasional fire as they contain species that will easily carry fire when vegetation is dry, and some component shrubs would reproduce from seed following fire. The fire response of the major types of clay pan vegetation needs to be determined however. Some clay pan types such as those that are predominantly herbfields under a sparse shrub layer are unlikely to have burnt very often historically.

Burrows *et al.* (2008) recommended a minimum period between fires that are lethal to fire-sensitive plants (obligate seeders with long juvenile periods) of at least twice the juvenile period of the slowest maturing species. That is, the juvenile period of plant taxa that are killed by fire and only reproduce from seed can be used as a guide to determine minimum inter-fire intervals. In fire sensitive habitats, this may be increased to 3-4 times the juvenile period for fire sensitive species (Barrett *et al.* 2009).

Appendix 2 indicates the juvenile periods for some taxa in clay pan communities. Most of the clay pan types, except community type 10a that is generally a shrubland, are dominated by annual flora that are largely unaffected by fire as they are annually renewed. Many occurrences also include a shrub layer dominated by species including *M. lateritia, M viminea, Verticordia densiflora, Astartea scoparia, Hakea varia, Pericalymma ellipticum* or *Regelia ciliata*. Some occurrences also include a tree layer with species including *Corymbia calophylla*, *Eucalyptus wandoo* or *E. rudis*. These trees generally survive fire and will resprout. Fire response data in Appendix 2 indicates that the most fire sensitive species in most of the clay pan types are generally the Melaleucas, especially *M. viminea* and *M. lateritia*. These species have a maturation time of 60 months. Community type 10a contains a variety of shrubs, some of which are obligate seeders and require a sufficient inter-fire interval to reproduce.

Based on current data, an appropriate inter-fire interval for this community may be a minimum of 10 years, with this community often being dominated by fire sensitive Melaleucas and other shrubs. As the clay pans are wetlands that would have burnt very seldom historically, they are considered fire sensitive habitats, so minimum inter-fire intervals of 15-20 years are advised.

Drying climate also needs to be considered when designing appropriate fire regimes. It is likely that reduced rainfall will cause diminishing growth rates, and plant maturation times will also therefore increase. Longer inter-fire intervals will therefore be desirable.

Given the peri-urban location of most of the clay pans long-term fire exclusion is unlikely due to the frequency of bushfires in bushland with easy access close to human population centres.

Maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to cause spread or intensification of disease or otherwise degrade the community. Careful use of herbicides is the preferred method of maintenance of firebreaks to minimise soil movement and risk of disease spread or intensification in the community. No new firebreaks should be constructed in intact vegetation in occurrences. Local Parks and Wildlife staff will be involved in planning fire break construction and maintenance for the community.

Fire management or response plans have been developed for some occurrences (Brixton St wetlands occurrences 35, 53; Ambergate reserve occurrence 21). Fire fighting authorities need to recognise the importance

of not constructing new tracks during their operations, including during bushfires. The use of heavy machinery to create new fire breaks within the community should be avoided to avoid further degrading the community, and chemicals that may be toxic to the community should not be used.

A local Parks and Wildlife staff member will ideally be present during bushfires and controlled burns in remnants that contain occurrences of the community, to advise on protecting the conservation values of the community. Prescribed fire should only be considered for early autumn when plants are not actively growing and flowering as 50% of the flora of these wetland communities are geophytes, perennial herbs and annual herbs. Prescribed fire in winter or spring will probably cause mortality of actively growing geophytes and perennial herbs and prevent seed set in annuals. Much of the flora is dormant from early summer to early autumn.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts) in liaison with surrounding landholders
Cost:	$7,000 pa
Completion date:	Ongoing

5. Implement weed control

A weed management strategy is required that identifies control of highest priority weeds that pose the greatest threat to the community in the early stages of invasion and in vegetation in good-excellent condition, including *Watsonia meriana* var. *bulbillifera, Sparaxis bulbifera, Hyparrhenia hirta,* and *Tribolium uniolae*. Information on the biology of serious weeds of clay pans and some case studies on control can be found in Brown and Brooks (2002) and updated/revised control information at: https://florabase.dpaw.wa.gov.au/weeds/swanweeds/. Options may include hand weeding or localized application of herbicides that are highly specific to the target species. Much of the floristic diversity in these wetlands is in the herb layer and particular care should be taken to minimize off-target damage.

The window of opportunity for herbicide application in winter-inundated areas of seasonal wetlands can be quite narrow, often just as the wetlands dry but while weeds are still actively growing. In some cases for small localized populations of serious weeds in winter inundated areas hand weeding may be the most appropriate control option.

Summer bushfires or prescribed burns can facilitate invasion of some serious weeds of clay pans (Brown and Brooks 2005, Brown *et al*. 2009). South African perennial grasses resprout, flower and produce seed post fire. Germinating seedlings are able to establish easily in the post fire environment with reduced competition from native flora, and increases in light and nutrients. Immediately post-fire is also an ideal time to control resprouting clumps and seedlings with grass selective herbicides (Brown and Brooks 2003a) when they are accessible, small, and vulnerable to herbicide application. The use of grass selective herbicides ensures no off-target damage to regenerating native flora.

A number of bulbous and cormous species, particularly watsonia and cape tulip, also flower en masse and set prolific amounts of seed in the post-fire environment. Wherever possible these species should be controlled prior to fire.

Watsonia in particular creates a mat of dead leaves once it has been killed that, along with dense mats of corms, tends to inhibit regeneration of invaded bushland. Once the watsonia plants have been killed a fire will destroy the dead mat of leaves and facilitate regeneration of native flora. In addition while the recommended herbicide

for watsonia invading native plant communities, 2-2 DPA, is fairly specific to watsonia it can impact vulnerable new growth of resprouting native flora and germinating native seedlings in the post-fire environment.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts)
Cost:	$5,000 per year
Completion date:	Ongoing

6. Investigate, monitor and manage water quality and hydrology

The limited studies of groundwater and surface water in the clay pan communities indicate a lack of connection between the two systems. Baseline and ongoing hydrological information is required however, to understand and avoid adverse changes to natural hydrological regimes. Data should include water quality information (including, pH, salinity, nutrients, and temperature), and water levels from bores in key occurrences of each of the clay pan communities.

A key requirement is the determination of thresholds of fundamental water level and quality parameters that are required to sustain the clay pan communities. Determining if there are groundwater inputs to some of the clay pan occurrences will also be important for management decisions.

Water sensitive design should be applied to drains through clay pans. The practicality of filling in some drains such as adjacent to the southern portion of the Brixton St wetlands to retain integrity of wetland function as recommended by V & C Semeniuk Research Group (2001) should be investigated.

Changes to hydrology that may result in changes to the natural hydrological regime of the clay pans, groundwater levels and subsequent increase or decrease in run-off, salinity, or pollution should be avoided.

Appropriate buffers should be determined on a case-by-case basis on local scale hydrological data and applied to developments. This will assist in protecting surface water quality and levels and potentially groundwater sources if relevant.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$20,000 per year
Completion date:	Ongoing

7. Implement and monitor control of feral and grazing animals

Impacts from grazing in particular in occurrences at Fish Road (Occurrence 2, 76), Forrestdale Lake (Occurrences 33, 34, 46, 47, 80, 86), Nicholson Road (Occurrences 43, 44, 82), Karnup Road (Occurrence 45), Plantation Road (occurrence 87) and Keane Road (Occurrences 88 and 89) Brixton St (occurrences, 35, 53), Ellen Brook (occurrence 31), Bullsbrook (occurrence 8), Austin Bay (occurrences 9-12) by rabbits, horses and kangaroos will be monitored. Feral pig activity has been recorded in Moore River Nature reserve (occurrence 22), Drummond Nature Reserve (occurrences 99, 100), Goonaping Swamp (occurrence 111) and in other nearby wetlands that are likely to be identified as clay pan TECs including Little Darkin and Dobaderry Swamps. Control programs will be implemented for feral animals, and results of control and the ongoing impacts will be monitored as part of action 3.

Impact from kangaroo grazing is a major threat in particular to remnants adjacent to pastures on agricultural lands including Fish Rd (Occurrences 2, 76), Ruabon (occurrence 3), Ambergate (occurrence 21). In addition to control trials for feral animals, grazing exclusion should also be investigated where high kangaroo impact is observed.

Responsibility:	Department of Parks and Wildlife (Swan Coastal and Blackwood District)
Cost:	$3,000 per year
Completion date:	Ongoing

8. Protect clay pans from physical damage

Illegal off-road vehicle or motor bike activity has been recorded in Julimar State Forest (occurrences 101, 108), Bashford Nature Reserve (Occurrence 104), near Goonaping Swamp (occurrence 111) and within other nearby wetlands that are likely to be identified as clay pan TECs including Little Darkin and Dobaderry Swamps. Access control such as fencing, bollards and signage will be installed wherever practical to control damage by inappropriate off-road vehicle use, and results of controls and the ongoing impacts will be monitored as part of action 3.

Responsibility:	Department of Parks and Wildlife (Perth Hills, Swan Coastal and Blackwood District)
Cost:	$20,000 per year
Completion date:	Ongoing

9. Identify potential new occurrences

Potential additional occurrences are located in Kenwick and the Shires of Beverley, York, West Arthur and Boyup Brook. Plots will be established in these areas and floristic data analysed to determine affinities to the clay pan types. Areas that align with the floristics of the clay pan types will be added to Parks and Wildlife's corporate TEC database and appropriate conservation management sought.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$10,000 in the second year
Completion date:	Year 2

10. Map habitat critical to survival

Although habitat critical to survival is described in Section 1, the areas as described have not yet been mapped and that will be completed under this action. In particular this will include determining the area required to maintain hydrological processes in the communities. If any additional occurrences are located, then this habitat will also be determined and mapped for these locations. The application of appropriate buffer zones will also be implemented throughout areas of the clay pan communities to protect the communities from edge effects such as hydrological changes, weed invasion and increased wind velocities.

Responsibility:	Department of Parks and Wildlife (Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$20,000 in the first and second years
Completion date:	Year 1

11. Seek to minimise direct clearing and hydrological change

Some occurrences of the clay pan communities are planned for clearing through approved management plans. For example the clearing of all occurrences in Perth Airport has been endorsed (occurrences 17, 18, 25, Perth Airport Corporation 2014). Additional areas of the community may be at risk from hydrological impact from adjacent development, for example occurrence 19 (Capel), 22 (Moore River), 26-29 (Austin Cove).

Parks and Wildlife will seek to influence the management of bushland that contains occurrences and adjacent lands that are likely to occur in areas that influence the hydrology such that groundwater and surface water processes are maintained within likely limits of tolerance. The limits of tolerance to change in water levels and quality are not known and will only be determined through the application of an adaptive management framework. Hydrology will be managed within an adaptive management framework, with detailed quantitative monitoring of floristic composition and structure linked to areas where there is likely to be significant hydrological change in terms of groundwater or surface water levels or quality.

Parks and Wildlife will continue to negotiate to seek minimal future clearing of the communities.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$5,000 per annum
Completion date:	Ongoing

12. Implement disease hygiene procedures

The disease susceptibility of the clay pan communities is likely to vary greatly depending on local habitat and flora. Risk of introduction of disease will be minimized by ensuring good hygiene procedures. This will involve adequately washing down any equipment and footwear used near or in the clay pans, and restricting access by vehicles and machinery to dry soil conditions. No vehicle access should be allowed onto vegetated areas of the clay pans. Hygiene management plans should be prepared for all occurrences and disease mapping should also occur where relevant.

Responsibility:	All personnel accessing occurrences
Cost:	$1,000 per annum
Completion date:	Ongoing

13. Seek long term protection of the clay pan communities for conservation

If suitable areas that contain the communities become available, Parks and Wildlife will seek to have the remnants that contain the communities, and adequate buffer areas where required, protected through perpetual protection agreements or reserved as conservation reserves vested with the Conservation Commission of WA.

Many occurrences are currently or are proposed for long-term management for conservation. For example, reserve 27165 (occurrences 33, 46, 47, 80, 86, Forrestdale) is currently vested in the City of Armadale, for the purpose of recreation. The City proposes division of the reserve so that areas outside the golf course lease are managed for conservation in future by the Conservation Commission of WA. Under this proposal a large portion of about 100 hectares of the reserve is proposed for conservation.

A series of locations are Bush Forever sites that are proposed for future conservation management that contain clay pan communities (for example occurrences 4, 13, 41, 54, 55, 56, 79, 92, 93 Kenwick), and suitable management will be sought for these areas.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$2,000 per year
Completion date:	Ongoing

14. Ensure best practice land management in areas of competing interests

Ellen Brook Nature Reserve (occurrence 31) was created for the protection and recovery of the critically endangered *Pseudemydura umbrina* (western swamp tortoise). Moore River and Lake Wannamal Nature Reserves that contain clay pan occurrences 22, 102, 103, 106, 107 are also translocation sites for the tortoise. Impacts of recovery actions for the tortoise within the reserves such as soil disturbance, altered localised hydrology and some weed control methods have potential to negatively impact on the clay pan vegetation. Linked monitoring of hydrology, flora, and vegetation is required to identify best practice management options and maintain vegetation condition.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$20,000 per year
Completion date:	Ongoing

15. Develop management guidelines

Up to date management guidelines are required for each major bushland area that contains the community. The management guidelines will include a weed map, weed control strategy, and a detailed fire management strategy, as described in other actions.

If site-based management guidelines for areas that contain the clay pan communities are not already being prepared or implemented, Parks and Wildlife will seek involvement in the cooperative preparation of guidelines for occurrences that include management considerations as listed in this plan.

Responsibility:	Department of Parks and Wildlife (Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB) and land managers
Cost:	$10,000 in year 3
Completion date:	Year 3

16. Report on recovery plan implementation

Reporting will be part of annual reports prepared by the Recovery Team for the Department of Parks and Wildlife, and will include results of analysis of monitoring within an adaptive management framework. A final report will be presented as part of the next review and update of the recovery plan, if deemed necessary.

Responsibility:	Department of Parks and Wildlife (Swan, South West, Midwest and Wheatbelt Regions, Moora, Swan Coastal, Perth Hills, Wellington and Blackwood Districts, SCB)
Cost:	$2,000 per year, $10,000 in fifth year

Completion date:	Year 1

7. TERM OF PLAN

The plan will operate from 2015 to 2020 but will remain in force until withdrawn or replaced. It is intended that, if the ecological communities are still ranked vulnerable or endangered in Western Australia after five years, the need for further recovery actions and for an updated recovery plan will be evaluated.

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Summary of costs for recovery actions

Recovery Action	Year 1	Year 2	Year 3	Year 4	Year 5
Liaise with stakeholders to implement recovery	$5,000	$5,000	$5,000	$5,000	$5,000
Monitor extent and boundaries of occurrences	$3,000	3,000	$3,000	$3,000	$3,000
Encompass monitoring in an adaptive management framework	$5,000	$5,000	$5,000	$5,000	$5,000
Develop and implement fire management strategy	$7,000	$7,000	$7,000	$7,000	$7,000
Implement weed control	$5,000	$5,000	$5,000	$5,000	$5,000
Investigate, monitor and manage water quality and hydrology	$20,000	$20,000	$20,000	$20,000	$20,000
Implement and monitor control of grazing animals	$3,000	$3,000	$3,000	$3,000	$3,000
Protect clay pans from physical damage	$20,000	$20,000	$20,000	$20,000	$20,000
Identify potential new occurrences		$10,000			
Map habitat critical to survival	$20,000	$20,000			
Seek to minimise direct clearing and hydrological change	$5,000	$5,000	$5,000	$5,000	$5,000
Implement disease hygiene procedures	$1,000	$1,000	$1,000	$1,000	$1,000
Seek long term protection for conservation	$2,000	$2,000	$2,000	$2,000	$2,000
Ensure best practice land management in areas of competing interests	$20,000	$20,000	$20,000	$20,000	$20,000
Develop management guidelines			$10,000		
Report on recovery plan implementation	$2,000	$2,000	$2,000	$2,000	$10,000
Total	**$118,000**	**$128,000**	**$108,000**	**$98,000**	**$106,000**

Total costs over five years: $558,000

Appendix 1

Tenure, characteristics of occurrences

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
1	CR 1459 and 17656 on Yoongarillup Rd, Yoongarillup	YOON03	SCP07	City of Busselton	Watering places/ Recreation	Degraded in quadrat location (2013)	15.5	-	Abba complex – Fluviatile deposits	Clearing, weed invasion, rubbish dumping, too frequent fire	TEC notification 05/08/2004. Quadrat rescored 2013.
2	Fish Rd Nature Reserve (CR 23321), Yoongarillup	FISH01,02	SCP07	Conservation Commission of WA	Conservation	Good (2013)	7.1	-	Abba complex – Fluviatile deposits	Weed invasion, too frequent fire, grazing by native or introduced species, clearing, recreational impacts, rubbish dumping, disease, edge effects, hydrological changes	Quadrats rescored 2013
3	Ruabon reserve (CR33269) on Ludlow-Hithergreen Rd, Lot 56 on Tutunup Rd, Road reserve along Tutunup Rd, Ruabon	RUAB04	SCP07	Conservation Commission WA / Department of Regional Development (DRD)/ City of Busselton	Conservation/ unallocated Crown land/ Road reserve	Very good – 20% Excellent 80% (2012)	3.9	-	Abba complex - fluviatile deposits	Weed invasion, too frequent fire, grazing, track/firebreak maintenance	Bushfire 2012. Rehab on firebreaks 2012. Vegetation monitoring, groundwater bores est. by DoW for ecological water requirements (EWRs).

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
4	Private land Bickley Rd Boundary Rd Brook Rd, Kenwick	YULE05	SCP07	Private owner	Freehold	Excellent 100% (1995)	11.8	387	Guildford complex – Guildford clays	Clearing, too frequent fire, hydrological change	Fenced. TEC notification 06/05/2005
5	CR 22831 on Bambun Rd, Gingin	BAMBUN01, 03)	SCP07	Shire of Gingin	Recreation	Very good – 100% (2010) Portion Degraded (2012).	6.8	-	Yanga complex - Fluviatile deposits	Clearing, too frequent fire, weed invasion, grazing by native or introduced species	Mythological site. TEC notification 05/08/2004 (Shire). Firebreaks maintained.
6	CR 46414 on Cockram Rd, railway reserve Brand Hwy	GINGIN01,02 ,03	SCP07	Conservation Commission WA / Shire of Gingin/ Main Roads WA	Conservation/ road, Rail reserve	Good – 50% Degraded – 50% (2008)	5.8	-	Yanga complex - Fluviatile deposits	Clearing, too frequent fire, weed invasion	Mythological site. Lot 1 Cockram Road, Gingin reserve 46414, for Conservation of Flora and Fauna.
7	CR 25431/CR 20366 south side of Lake Muckenburra, Muckenburra	MUCK02	SCP07	DRD/ Shire of Gingin	Government requirements/ Recreation	Excellent (1994, 2012)	10.8	292	Bassendean complex north – Aeolian deposits	Clearing, too frequent fire, weed invasion,	Notification letter 05/08/2004.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
8	Bullsbrook Nature Reserve (CR 1654) Great Northern Highway/ Private land Morrissey Rd/ road reserve Bullsbrook	BULL06,08)	SCP07	Conservation Commission WA/ private owner/ Main Roads WA	Conservation/ freehold/ Road reserve	Excellent (1995)	18.8	-	Beermullah complex – Fluviatile deposits	Clearing, too frequent fire, weed invasion, grazing by native or introduced species. Changing hydrology indicated 2011; drought - major shrub and rush deaths	Mythological site. Control of *Hesperantha falcata*, cape tulip, fig, *Sparaxis bulbifera*, veldt grass completed. Dieback mapping, and weeds management and restoration plan completed.
9	Austin Bay Nature Reserve (CR 4990)	CARAB02, AustSth01, 02	SCP07	Conservation Commission WA	Conservation	Very Good (1995)	3.7 + 40	-	Vasse complex – Marine deposits	Too frequent fire, weed invasion, grazing by native or introduced species	Weed control and fencing at Austin Bay NR,
10	Austin Bay Nature Reserve (CR 4990), CR 38749	AUSTB07	SCP07	Conservation Commission WA	Conservation	Excellent (1995)	8.9	-	Vasse complex - Marine deposits	Too frequent fire, weed invasion, recreational activities	
11	Austin Bay Nature Reserve (CR4990)	AUSTB01,02	SCP07	Conservation Commission WA	Conservation	Excellent– 90% Very Good – 10% (1995) Austin Bay quadrat 1 Completely Degraded, quadrat 2 Good (2012)	6.4	-	Vasse complex - Marine deposits	Too frequent fire, weed invasion, recreational activities. Extensive soil disturbance, impacts of the Dawesville Cut evident (incursion of salt water); grazing impacts	

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
12	Austin Bay Nature Reserve (CR4990), CR47273, road reserve	AUSTB08	SCP07	Conservation Commission WA /Water Corporation/ Shire of Murray	Conservation/ drainage/ Road reserve	Excellent 80% Very Good – 20% (1995)	27.1	-	Vasse complex - Marine deposits	Too frequent fire, weed invasion, recreational activities	
13	Lot 504 and Lot 7 on Kenwick Rd, Kenwick	MYKENWK01	SCP07	Shire of Gosnells	Freehold, Library	Good – 50% Very Good – 50% (2013)	0.3	422	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, recreational activities, illegal rubbish dumping	Official TEC Notification Letter Sent 05/08/2004, Shire has fenced the wetland perimeter with pine poles and ring lock, and good gates.
14	Road reserve and railway reserve along Hall Rd, Serpentine	PAUL04	SCP07	Shire of Serpentine-Jarrahdale	Road reserve/ Railway reserve	Very good – 100% (2002)	0.1	-	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, clearing	Official TEC Notification Letter Sent 26/05/2005, Draft management plan
15	Lot 506 on Rapids Rd; Lot 61 on Punrak Rd, Serpentine	PUNR01	SCP07	Western Australian Planning Commission (WAPC)/ DRD	Freehold/ unallocated Crown land	Very good -100% (2010)	5.9	74	Southern River complex - Aeolian deposits	Inappropriate fire regime (too frequent), Weed invasion, clearing, impacts of feral animals, illegal rubbish dumping, track creation, disturbance due to recreational activities	Official TEC notification letter sent 18/05/05, Fenced by WAPC, Extended mapping of SCP07 boundary

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
16	Roadside remnant and adjacent land, Lot 506 and 505 on Rapids Rd; Lot 61 on Punrak Rd, Serpentine	PUNR04	SCP07	WAPC/ DRD	Freehold/ unallocated Crown land	Good – 10% Pristine – 70% Very good 20% (2002)	0.9	74	Southern River complex - Aeolian deposits	Inappropriate fire regime (too frequent), Weed invasion, Clearing, Impacts of feral animals, Illegal rubbish dumping	Official TEC Notification Letter Sent 05/08/2004 (Shire), Official TEC Notification Letter Sent 18/05/05
17	Lot 6246 on Kalamunda Rd, Perth Airport	(myperth01; perth05	SCP07	Commonwealth of Australia	Airport	Pristine – 95% Excellent – 5% (2002)	4.4	386	Southern River complex – Aeolian deposits	Clearing, Weed invasion	Artefacts, scatter, ceremonial, mythological site. Official TEC Notification Letter Sent 04/04/2005. Planned for clearing in endorsed management plan for Perth Airport.
18	Lot 100 on Boud Ave, Perth Airport	myperth02, myperth04	SCP07	Commonwealth of Australia	Airport	Pristine – 95% Excellent – 5% (2002)	0.3 + 1.2	386	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, clearing	Registered Aboriginal site. Official TEC Notification Letter Sent 04/04/2005. Planned for clearing in endorsed management plan for Perth Airport.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
19	Private land Cloverdale Rd, Road reserve, North Capel	davies02	SCP07	Private owner/ Private owner/ Shire of Capel	Private land/ road reserve (unmade).	Very good – 100% (1995)	2.3	-	Abba complex - Fluviatile deposits	NS	Iluka Resources preparing site to transfer to Parks and Wildlife as development offset. Site requires full survey. Official TEC Notification Letter Sent 27/01/2005
20	Manea Park (CR 16044), Bunbury	mySwamp01 , Swamp02	SCP07	DRD	Rifle range	Pristine – 90% Very good – 10% (2002)	0.5	-	Karrakatta complex (central and south) - Aeolian deposits	Clearing, Inappropriate fire regime (too frequent), weed invasion, illegal rubbish dumping, grazing by native or introduced species	Official TEC Notification Letter Sent 05/08/2004
21	CR22614 on Doyle Rd, Busselton	myAMBR05	SCP07	City of Busselton /Busselton Naturalists Club	Landscape Protection	Good – 10% Pristine – 90% (2002)	0.2	-	Abba complex – Fluviatile deposits	Clearing, Inappropriate fire regime (too frequent), weed invasion, grazing by native or introduced species, Phytophthora invasion and spread	

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
23	Private land Kenwick Road, Kenwick	REHOBOTH02	SCP07	Private owner	School	Good – 10% Excellent – 90% (2004)	0.34	-	Guildford complex - Fluviatile deposits	Clearing, Weed invasion, Hydrological changes (water quality and/or quantity) changes	Official TEC Notification Letter Sent 23/03/2005
24	Private land Kenwick Road, Kenwick	REHOBOTH03	SCP07	Private owner.	School	Excellent – 100% (2004)	0.02	-	Guildford complex - Fluviatile deposits	Clearing, Weed invasion, Hydrological changes (water quality and/or quantity) changes	Official TEC Notification Letter Sent 04/04/2005
25	Lot 6246 on Kalamunda Rd, Perth Airport	myperth04	SCP07	Commonwealth of Australia	Airport	NS	1.2	386	Southern River complex - Aeolian deposits	NS	Official TEC Notification Letter Sent 04/04/2005. Planned for clearing in endorsed management plan for Perth Airport.
26 to 29	Private land South Yunderup Rd; CR 50025; CR 49777; Road reserve on Countess Cct, South Yunderup	AC03, 04, 05, 17, AC13, AustinCove, AC11, AC06	SCP07	Private owner / DRD/ Shire of Murray	School and offices/ Conservation and Recreation/ Conservation and Recreation/ Road reserve	NS	9.7 + 6.8 + 13.2 + 2.2	-	Vasse complex - Marine deposits	NS	Official TEC Notification Letter Sent, Satterley, RPS developed management plan noting exclusion of TECs from development.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
30	Lot 201 on Boyanup West Rd; Road reserves along Boyanup West Rd and Roselands Rd	ROSE03	SCP08	Conservation Commission WA / Shire of Capel	Not specified/ Road reserve	Very good – 90% Degraded – 10% (2006)	3.3	-	Guildford complex - Fluviatile deposits	Weed invasion, groundwater drawdown, clearing (power line maintenance, grazing by native or introduced species, unauthorised access (area unfenced), track creation	TEC hockey stick markers installed at 3 corners
31	Ellen Brook Reserve (CR 27620) on Great Northern Hwy	ELLEN01,02,03,04,05	SCP08	Conservation Commission WA	Conservation	Excellent – 100% (2008) ELLEN 04 quadrat area degraded 2012.	30.2	301	Guildford complex - Fluviatile deposits	Weed invasion, inappropriate fire regime (too frequent), grazing by native or introduced species, hydrological changes (water quality and/or quantity) changes	Mythological site. Adjoining land to west being rehabilitated; new fence, weed control & mapping done in Ellenbrook NR, infill planting post-weed control, dieback mapping.
32, 40	CR 23793 on Kargotich Rd; Road reserve + Mundijong Rd, Mundijong	MUD02,03,06,07, 09	SCP08	Public Transport Authority of WA/ Shire of Serpentine-Jarrahdale	Government requirements/ Road reserve	Pristine – 70% Very good – 30% (1994)	2.6 +5	360	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), clearing, weed invasion, grazing by native or introduced species, disturbance due to recreational activities	Drain historically emptied into TEC. Soil removal and rehabilitation works completed. Official TEC Notification Letter Sent 05/08/2004

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
33, 46, 47	CR 27165 on Forrest Rd, Forrestdale	Forrestdale01, FL03, myFL01, 02, 03, PM06, 07, myFL04, myFL05, myFL07	SCP08	City of Armadale	Recreation	Excellent – 90% Degraded – 10% (2011)	33.3 + 16+1 + 0.3	345	Southern River complex - Aeolian deposits	Inappropriate fire regime (too frequent), weed invasion, disturbance due to recreational activities, hydrological changes – water quality and/or quantity	Official TEC Notification Letter Sent 05/08/2004, Fenced for access control, rubbish removed, Forrestdale Lakes NR boardwalk and information shelter completed
35, 53	CR 49200 on Brixton St; Lot 807 on Brixton St; Lot 1 on Brixton St; Lot 9, 36 and 123 on Albany Hwy; Lot 34 on Albany Hwy, Kenwick	BRIX01,03, 04	SCP08	Conservation Commission WA, WAPC/ CMS Gas Transmission of Australia/ Public Transport Authority WA	Conservation/ Residential/ Gas maintenance/ Residential/ Car park, Vacant land (residential)	Good – 5% Excellent 95% (2013)	19.9 +3	387	Guildford complex - Fluviatile deposits	Clearing, too frequent, too hot fires, weed invasion, disturbance due to recreational activities	Site fenced. Wildflower Society and Friends Group developed management plan and Parks and Wildlife and Friends Group undertake weed control. Friends do rubbish removal, fence repairs planting, signage installed re TEC and threats.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
36	Meelon Nature Reserve (CR 24430); Lot 1464; CR 5829 on Pinjarra Williams Rd; Road reserve and railway reserve near junction of Pinjarra Williams Rd and Vezey Rd, Meelon	MEELON01,02; Meelontransect01	SCP08	Conservation Commission WA / Shire of Waroona	Conservation/ Conservation/ Resting place/ Road reserve/ Railway reserve	Good – 100% (1995) Parts of area currently Very Good.	4.4	-	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), Weed invasion	Mythological site. Official TEC Notification Letter Sent 27/01/2005, Ongoing management trials for Watsonia, Reserve fenced.
37	CR 31437 on McNeill Rd; Railway reserve along McNeill Rd, Waroona	WARO03,04; PM14	SCP08	Shire of Waroona	Conservation and parklands	Very good – 20% Excellent – 80% (2012)	4.5	-	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, clearing	Official TEC Notification Letter Sent 05/08/2004
38, 52	CR 46108 on South Western Hwy; CR11078 on Railway Rd; Road reserve Waterloo Rd & SW Hwy; Railway reserve along Railway Rd, Waterloo, CR 2806; Private land SW Hwy; CR 39954; Waterloo	PM28; WATER04, 05_Webb	SCP08	Conservation Commission WA, Shire of Dardanup, Main Roads WA, DRD, Private owner, Water Corporation	Conservation, recreation, road reserve, rail reserve, Government requirements, not specified, drainage	Good to Excellent (2011), quadrat location Degraded (2013)	10.3 +2.3	-	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent and high intensity; burnt 2008), weed invasion, clearing, recreational impacts, hydrological change, rubbish dumping	Official TEC Notification letter 18/03/2005, Weeds mapped post 2008 fire, weed plots for weed management, weed control ongoing. Quadrat rescored 2013.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
39	CR 23172, Waroona	C5803	SCP08	Shire of Waroona	Camping	Good to excellent (2005)	7.2	-	Serpentine River complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, clearing	Official TEC notification letter sent 05/08/2004. Weed management and restoration plan completed.
41	Lot 504 and lot 7 on Kenwick Rd, Kenwick	MYKENW02	SCP08	City of Gosnells	Not specified/ Library	Good – 50% Very good – 50% (2013)	0.4	422	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), Weed invasion, Disturbance due to recreational activities, illegal rubbish dumping	Official TEC Notification Letter Sent 05/08/2004, Shire has fenced the wetland perimeter with pine poles and ring lock, and good gates.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
42	Lot 9000 on Hopkinson Rd; CR 44662, Oakford	ABERNETHY RD PLOT1, MYABERN04	SCP08	WAPC/ Water Corporation	Not specified/ Drainage	Very good – 20% Excellent – 80% (2007)	5.7	65	Beermullah complex and Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, Clearing, Grazing by native or introduced species, Disturbance due to recreational activities, Illegal rubbish dumping	Subdivision of site approved. Part of area under conservation covenant (Andrew Del Marco pers. comm. 13/07/2000), TEC notification letter sent 18/05/05, Abernethy Rd widened, may increase runoff onto community, Weed mapping done by District
43	Lot 307 on Nicholson Rd and Lot 2 on Woodmore Rd; CR 33434 on Woodmore Rd	NICHOLSON 02	SCP08	WAPC, City of Gosnells	Not specified, Recreation	Completely degraded to excellent (2001)	2.5	456	Southern River complex - Aeolian deposits	Inappropriate fire regime (too frequent), weed invasion, clearing, grazing by native or introduced species, recreational impacts, illegal rubbish dumping	Fenced

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
44	Lot 307 on Nicholson Rd; Lot4890	GOSN10; NICHOLSON 03; PM08	SCP08	WAPC/ Main Roads WA	Not specified	Very good to excellent (2008)	1.5	456	Southern River complex - aeolian deposits	Inappropriate fire regime (too frequent), weed invasion, clearing, grazing by native or introduced species, disturbance due to recreational activities, illegal rubbish dumping	Site fenced, Translocation of declared rare flora into area adjacent to TEC
45	Railway reserve and unallocated Crown land, SE of rail crossing at Karnup Road	PAUL05	SCP08	Not specified	Not specified	Good - excellent (2002)	0.2	375	Guildford complex - Fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, clearing	Ceremonial, mythological site. Official TEC notification letter 26/05/2005, draft management plan
48	Hay Park (CR 30601) on Parade Rd; Road reserve along Bussell Hwy, Bunbury	HAY01; myHAY01,02; PM22,24	SCP08	City of Bunbury/ Main Roads WA	Recreation/ Road reserve	Very good - excellent (2008)	8.6	-	Yoongarillup complex - Marine deposits	Inappropriate fire regime (too frequent), weed invasion, clearing, grazing by native or introduced species, recreational impacts, rubbish dumping	Discussed management options for reserve with City of Bunbury. Official TEC notification sent 05/08/2004
49	Lot 136 on Turner Rd, Bullsbrook	mypearce07; xPearce02	SCP08	Commonwealth of Australia	Pearce Air Force Base	Excellent - very good (2002)	0.1	294	Beermullah complex - Fluviatile deposits	Clearing, weed invasion, illegal rubbish dumping	Mythological site. Official TEC notification 06/05/2005, dieback assessed

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
50	CR 30345 on Kenwick Rd; CR 46593; Private land Kenwick Rd and Brixton St, Kenwick	REHOBOOTH01	SCP08	Private landowners, City of Gosnells	School, Parklands, Not specified	Good – very good (2013)	3.5	-	Guildford complex - Fluviatile deposits	Clearing, weed invasion, hydrological changes (water quality and/or quantity), grazing by native or introduced species, illegal rubbish dumping	Official TEC notification 23/03/2005
51	Private land Hensbrook Loop and Armadale Rd; Road reserve along Hensbrook Loop, Forrestdale	FORRESTDALE01	SCP08	Conservation Commission WA, private owners, DRD, City of Armadale	Private land, unallocated Crown land, road reserve	Completely degraded - excellent (2008)	16.0	-	Southern River complex - aeolian deposits	Clearing, weed invasion, hydrological changes (water quality and/or quantity), grazing by native or introduced species	Main roads portion fenced, weed control done in Ellenbrook NR, Forrestdale Industrial Park and Greater Brixton St. wetlands, fencing at Forrestdale Lake Reserve.
54, 55, 56	Lot 106 on Wanaping Rd, Kenwick	WANAPING01	SCP08	WAPC	Vacant land (residential)	Good-Excellent (2013)	0.4+0.6 +0.2	387	Guildford complex - Fluviatile deposits	Weed invasion, hydrological changes – water quality and/or quantity, illegal rubbish dumping, recreational impacts, fire regime – too frequent	Official TEC notification letter to WAPC
57	Private land Brentwood Rd, Kenwick	BRENTWD08	SCP08	Private owner	Private land	Very good (2008)	0.7	-	Guildford complex - fluviatile deposits	NS	Agricultural use

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
58	Private land Brentwood Rd, Kenwick	BRENTWD11	SCP08	Private owner	Vacant land (residential)	Very good (2008)	1.5	-	Guildford complex - fluviatile deposits	NS	Contains declared rare flora
59	Private land Brentwood Rd, Kenwick	BRENTWD14	SCP08	Private owner	Vacant land (residential)	Good (2014)	0.6	-	Guildford complex - fluviatile deposits	Track/firebreak maintenance, weed invasion	
60	Private land Bickley Rd; Road reserve Bickley Rd, Kenwick	BICKLEYRD06	SCP08	Private owners, City of Gosnells	Vacant land (residential)/ Residential/ Road reserve	Very good (2007)	1.8	-	Guildford complex - Fluviatile deposits	Weed invasion, grazing by native or introduced species, nutrient enrichment	
61	Private land Brentwood Rd, Kenwick	Kenwick03	SCP08	Private owner	Private land	Excellent (2011)	0.2	-	Guildford complex - fluviatile deposits	Grazing by native or introduced species, recreational impacts, fire regime – too frequent	Artefact/scatter site. TEC notification letter 05/08/2004
62	Private land Bickley Rd, Kenwick	Kenwick05	SCP08	Private owner	Vacant land (residential)	NS	0.1	-	Guildford complex - fluviatile deposits	NS	
63	Private land Bickley Rd, Kenwick	Kenwick06	SCP08	Private owner	Private land	NS	0.1	-	Guildford complex - fluviatile deposits	NS	
64	Private land Victoria Rd, Kenwick	Kenwick07	SCP08	Private owner	Private land	NS	0.1	-	Guildford complex - fluviatile deposits	NS	

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
65	Private land Seaforth Ave, Gosnells	Tonkin01	SCP08	Private owner	Private land	NS	4.4	255	Southern River complex - aeolian deposits	NS	Mythological site
90	Crown Reserve C670	Manea04	SCP08	City of Bunbury	Endowment	Excellent (2011)	3.4	-	Southern River complex - aeolian deposits	Kangaroo impacts, motor bike impacts	Quadrat established and analysed 2011(Webb *et.al* 2013).
113	State Forest 2/Timber Reserve	Eastw01	SCP08	Conservation Commission WA	Timber	Excellent (2011)	62.6	-	-	Land clearing associated with adjacent rail line	Quadrat established and analysed 2011(Webb *et.al.* 2013). Ludlow River aboriginal site adjacent
114	CR40251 Tuart Forest National Park	Eastw02	SCP08	Conservation Commission WA	National Park	Excellent (2011)	39.8	-	Southern River complex - aeolian deposits	Heavy grazing by kangaroos	Quadrat established and analysed 2011(Webb *et.al.* 2013).
22	Moore River Nature Reserve (CR 41830)	MYMRNP01	SCP09	Conservation Commission WA	Conservation	Pristine – 100% (2004)	136.4	-	Mungala complex - Fluviatile deposits	Inappropriate fire regime (too frequent), Weed invasion, Hydrological changes (water quality and/or quantity) changes	Site fenced to control access. Bunds created to increase water depth for western swamp tortoise habitat.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
66	CR 23793 Mundijong Rd, Peel Estate	DUCK03	SCP09	Public Transport Authority WA	Government requirements	Excellent – 100% (2010)	0.3	360	Guildford complex - fluviatile deposits	Clearing, Inappropriate fire regime (too frequent), weed invasion, rubbish dumping, recreational impacts, fragmentation, grazing by native or introduced species, feral animals	Discussions with shire re management. TEC notification letter 05/08/2004, Ongoing weed management and rehabilitation in main portion of TEC. Fenced
67	CR 17490 on Turner Rd; Road reserve along Turner Rd, Byford	BRICK04	SCP09	Shire of Serpentine-Jarrahdale	Recreation, road reserve	Excellent (2012)	3.1	321	Forrestfield unit - Ridge Hill Shelf	Clearing, Inappropriate fire regime (too frequent), weed invasion, hydrological changes – water quality and/or quantity	TEC signage installed. Dieback assessed and mapped, TEC notification letter 05/08/2004, Draft Management Plan by City of Armadale. Fenced
68	CR 22215 on South Western Hwy; Road reserve along South Western Hwy	YARL02	SCP09	Shire of Waroona/ Main Roads WA	Camping and drainage/ Road reserves	Excellent (1995)	0.7	-	Guildford complex - fluviatile deposits	Clearing, inappropriate fire regime (too frequent), weed invasion, grazing by native or introduced species	TEC notification letter 05/08/2004

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
69	Wellard Nature Reserve (CR 2547) on Crampton Rd, Myalup	WELR01,02	SCP09	Conservation Commission WA	Conservation	Excellent (2013)	4.3	-	Serpentine River complex - fluviatile deposits	Clearing, inappropriate fire regime (too frequent), weed invasion	Quadrat rescored 2013
70	Byrd Swamp Nature Reserve (CR 2517) on Leitch Rd; CR 26999 on Leitch Rd; Private land Forrest Rd, Myalup	BYRD01	SCP09	Conservation Commission WA, Water Corporation, private owner	Conservation, Drainage, private land	Excellent (2013)	46.3	-	Serpentine River complex - fluviatile deposits	Weed invasion, inappropriate fire regime (too frequent)	Weed control by District. Quadrat rescored 2013.
71	CR 32963 on Robertson Dr; Road reserve along Robertson Dr, Bunbury	MANEA01	SCP09	City of Bunbury	Recreation, road reserve	Excellent (2013)	3.2	-	Karrakatta complex (Central and South) and Southern River complex - aeolian deposits	Clearing, inappropriate fire regime (too frequent), recreational impacts	TEC notification letter 05/08/2004. Quadrat rescored 2013.
72, 73	CR 34033 on Moores Rd, Pinjarra	pind02,03, 04, Pinj03, 04	SCP09	Shire of Murray	Recreation	Good - excellent (2002)	7.5+0.9	-	Bassendean complex (Central and South) - aeolian deposits	Clearing, inappropriate fire regime (too frequent), weed invasion, rubbish dumping	Notification letter 05/08/2004 (Shire)
74	CR 36717 on Vasse-Yallingup Siding Rd, Quindalup	YALLIN02	SCP09	DRD	Parklands	Very good – excellent – (2011)	14.5	-	Abba complex – fluviatile deposits	Weed invasion, clearing (understorey)	TEC notification letter 05/08/2004 (shire)

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
75	CR 25229 and CR 36468, CR 40445 CR 34732 Lot 115 on Naturaliste Tce and Gifford Ave, Dunsborough	TOBY01, 02	SCP09	City of Busselton, DoW, Dept Regional Development, Country Women's Association of WA Inc.	Recreation, Depot, Drainage, Bush Fire Brigade, Rest Room, road reserve	Excellent (2011)	1.3	-	Abba complex – Fluviatile deposits	NS	Two quadrats established and analysed 2011 (Webb *et.al.* 2013).
34	Northern portion of recreation reserve adjacent and to the east of Forrestdale Lake	myFL06	SCP10a	City of Armadale	Recreation	Very good – 80% Excellent – 20% (2010)	2.4	345	Southern River complex - Aeolian deposits	Inappropriate fire regime (too frequent), Weed invasion, Disturbance due to recreational activities, salinization, illegal rubbish dumping	Official TEC Notification Letter sent 05/08/2004, fencing for humans and rabbits, rubbish removal, upgraded facilities for public use and education- Forrestdale Lakes NR boardwalk and information shelter

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
76	CR 23321 on Fish Rd; Road reserve along Fish Rd, Acton Park Rd and Yoongarillup Rd, Yoongarillup	FISH03,04	SCP10a	Conservation Commission WA / City of Busselton	Conservation/ Road reserve	Good – Degraded (2013)	15.2	-	Abba complex – Fluviatile deposits	Clearing, inappropriate fire regime (too frequent), weed invasion, grazing by native or introduced species, recreational impacts, rubbish dumping, *Phytophthora* spp., hydrological changes	Ongoing weed management, lovegrass (*Eragrostis curvula)* and annual grass spraying, spot spraying of arum lilies (*Zantedeschia aethiopica)* Rare flora markers installed. Quadrats rescored 2013.
77	CR 31437; Road reserve along South Western Hwy; Railway reserve, Waroona	WARO05	SCP10a	Shire of Waroona/ Main Roads WA	Conservation and Parklands	Very good - excellent (2012)	6.6	-	Guildford complex - fluviatile deposits	Clearing, inappropriate fire regime (too frequent), weed invasion	Gate installed to restrict access along track. TEC notification letter 05/08/2004
78	Kooljerrenup Nature Reserve (CR 23756) Herron Point Rd; CR 15028, West Coolup	KOOLJ06,07	SCP10a	Conservation Commission WA, Water Corporation	Conservation, Drainage	Excellent (2010)	6.9	-	Cannington complex - fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, grazing by native or introduced species, recreational impacts, hydrological changes – water quality and/or quality	Fencing at Kooljerrenup NR

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
79	Private land Bickley Rd and Brook Rd, Kenwick	YULE04	SCP10a	Private owner	Vacant land (residential)	Pristine – 100% (1995)	4.1	387	Guildford complex - Fluviatile deposits	Clearing, Inappropriate fire regime (too frequent), Hydrological changes (water quality and/or quantity)	Artefact, scatter site. Site fenced. Official TEC Notification Sent 06/05/2005
80	CR 27165 on Forrest Rd, Forrestdale	FL02; myFL06	SCP10a	City of Armadale	Recreation	Very good – 80% Excellent – 20% (2010)	2.4	345	Southern River complex - Aeolian deposits	Inappropriate fire regime (too frequent), Weed invasion, Disturbance due to recreational activities, salinization, illegal rubbish dumping	Official TEC Notification Letter Sent 05/08/2004, Fenced for access control, rubbish removed, Forrestdale Lakes NR boardwalk and information shelter completed
81	CR 23172; Road reserve, Waroona	C5804	SCP10a	Shire of Waroona	Camping, Road reserve (un-made)	Good –	17.6	-	Serpentine River complex and Cannington complex - Fluviatile deposits	Clearing, inappropriate fire regime (too frequent), weed invasion, grazing by native or introduced species	Official TEC Notification Letter Sent 05/08/2004

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
82	Lot 307 on Nicholson Rd; Lots 2, 10 and 102 adjacent Woodmore St, Langford	NICHOLSON 01; gosn11	SCP10a	WAPC	Not specified	Excellent-very good (2001)	2.6	456	Southern River complex - aeolian deposits	Clearing, Inappropriate fire regime (too frequent), Weed invasion, Disturbance due to recreational activities, Illegal rubbish dumping, Grazing by native or introduced species, groundwater decline	Fence around perimeter of site. Rare flora translocation adjacent. Weed control and slashing of grassy weeds by Dept of Planning
83, 84	Bradbury Nature Reserve (CR 46587); Road reserve along Hall Rd, Serpentine	HALL02, 04, Byfrail09	SCP10a	Conservation Commission WA, Shire of Serpentine-Jarrahdale	Conservation, road, rail reserve	Excellent – degraded (2010)	1.4+1.1 + 0.2	365	Guildford complex - fluviatile deposits	Inappropriate fire regime (too frequent), weed invasion, Disturbance due to recreational activities, grazing by native or introduced species, altered surface drainage, rubbish dumping, edge effects	Ceremonial, mythological site. TEC signage. Fenced

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
85	Lot 506 on Rapids Rd; Lot 61 on Punrak Rd, Serpentine	PUNR03	SCP10a	WAPC/ DRD	Not specified/ unallocated Crown land	Excellent – (2010)	1.8	74	Southern River complex - Aeolian deposits	Clearing, Inappropriate fire regime (too frequent), Weed invasion, Illegal rubbish dumping, Impacts of feral animals, fragmentation – edge effect, altered surface drainage	Actions and Official TEC Notification Letter Sent 05/08/2004 (Shire), Official TEC Notification Letter Sent 18/05/05, Bush Forever signs
86	CR 27165 on Forrest Rd, Forrestdale	myFL07	SCP10a	City of Armadale	Recreation	Good – excellent (2002)	0.7	345	Southern River complex - aeolian deposits	Too frequent fire, weed invasion, recreational impacts, grazing by native or introduced species	TEC notification letter 05/08/2004. Fenced Rubbish removal. Forrestdale Lakes NR boardwalk and information shelter completed
87	Private land Plantation Rd, Capel	plant01; plantation02	SCP10a	Private owner	Not specified	Excellent – 90% Very good – 10% (2010)	0.4	-	Southern River complex - aeolian deposits	Clearing, weed invasion, grazing by native or introduced species	TEC notification letter 27/01/2005

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
88, 89	Lot 66, Forrestdale	Anstey Plot02; anstey01,02, 03, 04,05,06 Anstey Plot01, 02	SCP10a	WAPC	Not specified	Excellent – degraded – (2011)	3.2+17.4	342	Southern River complex - aeolian deposits	Inappropriate fire regime (too frequent, too intense), weed invasion, recreational impacts, grazing by native or introduced species, rubbish dumping, hydrological changes – water quality and/or quantity, disease, clearing	TEC notification 06/05/2005
91	CR 13136 on Ruabon Rd, Ruabon	TUT01; myRUAB04	SCP10a	Public Transport Authority WA	Railway	Very Good (2013)	2.3	-	Abba complex - fluviatile deposits	Fire regime – too frequent, weed invasion	Two quadrats installed and analysed 2011(Webb *et al.* 2013).
92	Lot 106 on Wanaping Rd, Kenwick	WANAPING02	SCP10a	WAPC	Freehold	Excellent (2010)	0.1	387	Guildford complex - fluviatile deposits	Weed invasion, illegal rubbish dumping, fire regime – too frequent	TEC notification to WAPC

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
93	Private land Brook Rd, Wattle Grove	BROOK01	SCP10a	Private landowner	Freehold	Very good (2010)	0.4	387	Guildford complex - fluviatile deposits	Weed invasion, hydrological changes – water quality and/or quantity, fire regime – too frequent, grazing by native or introduced species	Comments provided re planning
94, 95	Railway reserve along Railway Rd, Capel, Elgin	RAIL03a; RAIL09, LOWRIE01	SCP10a	Shire of Capel	Railway reserve, Road reserve	Good - Very Good (2007, 2012)	3.9 +1.9 = 5.8	-	Southern River complex - aeolian deposits	Hydrological changes – water quality and/or quality, grazing by native or introduced species, clearing along gas pipeline, weed invasion	
96	Private land, Oakley	ALCOA01	SCP10a	Private landowner	Freehold	Excellent (2011)	1.8	-	Guildford complex - fluviatile deposits	Clearing, weed invasion, hydrological changes – water quality and/or quantity	TEC notification sent
97	Private land Bickley Rd, Kenwick	Kenwick04	SCP10a	Private owner	Freehold	NS	0.1	-	Guildford complex - fluviatile deposits	NS	
98	Private land Clifford St, Maddington	Kenwick09	SCP10a	Private landowner	Freehold	-	Too degraded	-	Guildford complex - Fluviatile deposits	NS	

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
99, 100	Drummond Nature Reserve (CR 42808),	8AQ1A; JB26, 8BQ1A; JB18	Clay pans with shrubs over herbs	Conservation Commission WA	Conservation	Excellent (2012)	3.7+3.5	-	Bindoon complex – major valley floors and scarps	Hydrological changes – water quality and/or quantity (inc. salinisation), weed invasion, disease – invasion and spread	Hydrological and grazing monitoring. Kangaroo exclusion plots. Gates and fencing. Reserve also contains PEC 'Wandoo woodland over dense low sedges of *Mesomelaena preissii*'
105	Private land Wattening. Nelson (Wilga)	Wilga01, 02	Clay pans with shrubs over herbs	Private landowner	Freehold	Excellent (2012)	8.4	-	Wilga complex – in low to medium rainfall	Hydrological changes – water quality and/or quantity (inc. salinisation), weed invasion, disease – invasion and spread	
101, 108	State forest 61, Julimar	JB20; JNR01	Clay pans with shrubs over herbs	Conservation Commission WA	Conservation	Good – 70% Very good - 30% (2001)	1.8	-	Dwellingup complex and Yallanbee complex - Lateritic uplands	Disturbance due to recreational activities, grazing by native or introduced species, feral animals	Occurrence JB20 fenced to exclude off-road vehicles.

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
102, 103, 106, 107	Lake Wannamal Nature Reserve (CR 9838), Mindarra	PURS02, 05	Clay pans with shrubs over herbs	Conservation Commission WA	Conservation	Excellent (2011)	3.2+8.2 +6.1+0.8	-	Wannamal complex - Lateritic uplands	Hydrological changes – water quality and/or quantity, fire regime – too high intensity, weed invasion, grazing by native or introduced species, disease	Water pumped into small areas for western swamp tortoise habitat 2009
104	Bashford Nature Reserve (R 39221)	BNR01	Clay pans with shrubs over herbs	Conservation Commission WA	Conservation	Good – Excellent (2013)	1.2	-	Coastal limestone covered by residual quartz sand (Cottesloe complex (North) – Aeolian deposits?)	Weed invasion, grazing by native or introduced species, recreational activities (4x4), hydrological changes - water quality and/ or quantity	Four floristic quadrats established.
109, 110	CR 9090, Cherry Tree Pool	DA21; DA21B, Birdwood02	Clay pans with shrubs over herbs	Shire of Kojonup	Waterway	Excellent-very good (2009)	0.4+0.4 + 0.4	-	Beaufort complex and Carrolup complex – Fluviatile deposits	Clearing, fire regime – too high intensity, weed invasion, grazing by native or introduced species, hydrological changes – water quality and/or quantity	TEC notification letter 31/07/2007, Quadrat installed

Occ. #	Location	Site ID	Comm-unity Type	Land owner/ manager	Purpose	Condition	Estimated area (ha)	Bush Forever site (Site no.)	Soil and Landform From Churchward and McArthur (1978) and Heddle *et al.* (1980)	Major threats #	Comments, Aboriginal sites
111	R47883 Wandoo National Park	Goonaping01, SPM013a-d	Clay pans with shrubs over herbs	Shire of Beverley	Conservation	Excellent (2014)	42ha	-	Goonaping Complex: shallow depressions at the heads of drainage lines; sandy landscapes	Weed invasion, recreational impacts	Four monitoring quadrats established
112	Jingalup Nature Reserve A17759	DA20	Clay pans with shrubs over herbs	Conservation Commission WA	Conservation	Excellent (2012)	0.4ha	-	-	Hydrological changes, weed invasion	One quadrat installed

#The potential impacts of drying climate would be applicable to all occurrences of the community so is not listed as a specific threat to individual occurrences

Appendix 2

Characteristics of flora taxa that commonly occur in the clay pan communities

Taxon	**Fire response** (Source-NatureMap)	**Months to first flowering** (Source-NatureMap)	**Longevity** (Source-NatureMap & Florabase)	**Dieback response** (Source-NatureMap)
SCP07				
Centrolepis aristata^	ND	ND	Annual	ND
Philydrella pygmaea ^	ND	ND	Perennial	ND
Briza minor *^	Killed by 100% scorch	6	Annual	ND
*Hypochaeris glabra**^	ND	24	Biennial	ND
Goodenia micrantha ^	ND	ND	Annual	ND
Pogonolepis stricta	ND	ND	Annual	ND
*Cicendia filiformis**^	ND	ND	Annual	ND
*Briza maxima**^	Killed by 100% scorch	6	Annual	Inferred evidence of resistance
Centrolepis polygyna	ND	ND	Annual	ND
Siloxerus humifusus ^	ND	ND	Annual	ND
Schoenus plumosus	ND	ND	Annual	ND
Utricularia multifida	100% scorch kills, in soil seed storage	6	Annual	Good evidence of resistance
Melaleuca viminea ^	100% scorch kills, on plant seed storage	60	Perennial	Inferred evidence of resistance
SCP08				
Centrolepsis aristata ^	ND	ND	Annual	ND
*Briza maxima**^	Killed by 100% scorch	6	Annual	Inferred evidence of resistance
Cyperus tenellus *^	ND	ND	Annual	ND
*Cicendia filiformis**^	ND	ND	Annual	ND
Drosera menziesii ^	Geophyte (Survives 100% scorch)	8	Perennial	ND
Haemodorum simplex	Geophyte (Survives 100% scorch)	8	Perennial	ND
*Monopsis debilis**	ND	ND	Annual	ND
*Parentucellia viscosa**	100% scorch kills, in soil seed storage	13	Annual	ND
Viminaria juncea	100% scorch kills, in soil seed storage	ND	Perennial	ND
*Hypochaeris glabra**^	ND	24	Biennial	ND
Chorizandra enodis	ND	ND	Perennial	ND
Schoenus odontocarpus	ND	ND	Annual	ND
Goodenia micrantha ^	ND	ND	Annual	ND
*Aira caryophyllea**	100% scorch kills, in soil seed storage	12	Annual	Inferred evidence of resistance
*Juncus capitatus**	ND	ND	Annual	ND
SCP09				
Cassytha racemosa	100% scorch kills, in soil seed storage	24	Perennial	ND
Melaleuca viminea ^	100% scorch kills, on plant seed storage	60	Perennial	Inferred evidence of resistance
*Hypochaeris glabra**^	ND	24	Biennial	ND

Burchardia multiflora	Geophyte (Survives 100% scorch)	12	Perennial	Good evidence of resistance
Cyathochaeta avenacea	Survives 100% scorch, basal sprouts	6	Perennial	Good evidence of resistance
Lepidosperma longitudinale	Survives 100% scorch, soil suckers	24	Perennial	ND
Schoenus tenellus	ND	ND	Annual	ND
Dampiera linearis	Survives 100% scorch, soil suckers	24	Perennial	Good evidence of resistance
Astartea scoparia	Survives 100% scorch, basal sprouts	24	Perennial	Inferred evidence of resistance
Eutaxia virgata	100% scorch kills, in soil seed storage	24	Perennial	ND
Hakea varia ^	100% scorch kills, on plant seed storage	24	Perennial	Some evidence of moderate susceptibility
Meeboldina coangustata	ND	ND	Perennial	ND
SCP10a				
Centrolepis aristata^	ND	ND	Annual	ND
Aphelia cyperoides	Killed by 100% scorch	6	Annual	ND
Drosera gigantea	Ferns and allies (spores)	10	Perennial	ND
*Cyperus tenellus**^	ND	ND	Annual	ND
Siloxerus humifusus ^	ND	ND	Annual	ND
Drosera menziesii ^	Geophyte (Survives 100% scorch)	8	Perennial	ND
Pericalymma ellipticum	Survives 100% scorch, basal sprouts	22	Perennial	ND
*Briza minor**^	Killed by 100% scorch	6	Annual	ND
Hakea sulcata	100% scorch kills, on plant seed storage	ND	Perennial	ND
Schoenus rigens	ND	ND	Perennial	ND
Philydrella pygmaea ^	ND	ND	Perennial	ND
Hakea varia ^	100% scorch kills, on plant seed storage	24	Perennial	Some evidence of moderate susceptibility
Schoenolaena juncea	ND	ND	Perennial	ND
*Cicendia filiformis**^	ND	ND	Annual	ND
Goodenia pulchella	ND	ND	Annual/ Perennial	ND
Tribonanthes australis	ND	ND	Perennial	ND
Regelia ciliata	Survives 100% scorch, basal sprouts	60	Perennial	ND
Verticordia densiflora	100% scorch kills, in soil seed storage	30	Perennial	ND
Stylidium calcaratum	100% scorch kills, in soil seed storage	7	Ephemeral	ND
Stylidium guttatum	ND	ND	Perennial	ND
Clay pans with shrubs over herbs				
Aira caryophyllea (silvery hairgrass)*	100% scorch kills, in soil seed storage	12	Annual	Inferred evidence of resistance
Aphelia drummondii	ND	ND	Annual	ND
Aponogeton hexatepalus^	ND	ND	Perennial	ND
Bulbine semibarbata (leek lily)	ND	ND	Annual	ND
Caesia sp. Wongan (formerly *C. alfordii*)	ND	ND	Biennial	ND
Caesia micrantha (pale grass-lily)	ND	ND	Perennial	ND
Calandrinia sp. Kenwick (G.J. Keighery 10905)	ND	ND	Annual	ND
Centrolepis alepyroides	ND	ND	Annual	ND

Centrolepis aristata (pointed Centrolepis)	ND	ND	Annual	ND
Centrolepis glabra (smooth Centrolepis)	ND	ND	Annual	ND
Centrolepis polygyna (wiry Centrolepis)	ND	ND	Annual	ND
Chamaescilla corymbosa (blue squill)	Geophyte (Survives 100% scorch)	7	Perennial	ND
Chorizandra enodis (black bristlerush)	ND	ND	Perennial	ND
Cicendia filiformis (slender Cicendia)*	ND	ND	Annual	ND
*Cicendia quadrangularis**	ND	ND	Annual	ND
Conospermum glumaceum (Hooded Smokebush)	ND	ND	Perennial	ND
Corymbia calophylla (Marri)	Survives 100% scorch, epicormics	48	Perennial	Good evidence of resistance
Cotula bipinnata (Ferny Cotula)*	ND	ND	Annual	ND
*Crassula natans**	ND	ND	Annual	ND
Cycnogeton lineare (formerly *Triglochin linearis*)	ND	ND		ND
Cyperus tenellus (tiny flat sedge)*	ND	ND	Annual	ND
Diuris laxiflora (bee orchid)	ND	ND	Perennial	ND
Drosera gigantea (giant sundew)	Geophyte (Survives 100% scorch)	10	Perennial	ND
Drosera glanduligera (pimpernel sundew)	Geophyte (Survives 100% scorch)	12	Annual	ND
Drosera menziesii (pink rainbow)	Geophyte (Survives 100% scorch)	8	Perennial	ND
Drosera stolonifera (leafy sundew)	ND	ND	Perennial	ND
Eleocharis acuta (common spikerush)	ND	ND	Perennial	ND
Eleocharis keigheryi^	ND	ND	Perennial	ND
Eryngium pinnatifidum subsp. *Palustre*^	ND	ND	Perennial	ND
Eucalyptus rudis (flooded gum)	Survives 100% scorch, epicormics	48	Perennial	Inferred evidence of resistance
Eucalyptus wandoo (Wandoo)	Survives 100% scorch, epicormics	48	Perennial	Good evidence of resistance
Glossostigma diandrum	ND	ND	Annual	ND
Gnephosis tenuissima	ND	ND	Annual	ND
Gonocarpus nodulosus	ND	ND	Annual	ND
Goodenia micrantha	ND	ND	Annual	ND
Goodenia pulchella	ND	ND	Annual/Perennial	ND
Gratiola pubescens	ND	ND	Perennial	ND
Grevillea bipinnatifida (fuchsia Grevillea)	Survives 100% scorch, basal sprouts	24	Perennial	Inferred moderate susceptibility
Hakea varia (variable-leaved Hakea)	100% scorch kills, on plant seed storage	24	Perennial	Some evidence of moderate susceptibility
Homalosciadium homalocarpum	ND	ND	Annual	ND
Hyalosperma cotula	100% scorch kills, in soil seed storage	12	Annual	ND
Hydrocotyle alata	ND	ND	Annual	ND
Hydrocotyle callicarpa (small pennywort)	ND	ND	Annual	ND
Hydrocotyle lemnoides (aquatic pennywort)^	ND	ND	Annual	ND
Hypochaeris glabra (smooth catsear)*	ND	24	Biennial	ND
Isoetes drummondii (quillwort)	ND	ND	Perennial	ND

Isolepis cernua (nodding club-rush)	ND	ND	Perennial	ND
Isolepis congrua	ND	ND	Annual	ND
Isolepis marginata (coarse club-rush) *	ND	ND	Annual	ND
Isolepis stellata (star club-rush)	ND	ND	Annual	ND
Isotoma hypocrateriformis (Woodbridge poison)	100% scorch kills, in soil seed storage	12	Annual	ND
Isotoma pusilla (small isotome)	ND	ND	Annual	ND
Juncus bufonius (toad rush)*	ND	ND	Annual	ND
Juncus capitatus (capitate rush)*	ND	ND	Annual	ND
Lachnagrostis filiformis	ND	ND	Annual	ND
Lachnagrostis plebeia	ND	ND	Annual	ND
Liparophyllum capitatum (Formerly *Villarsia capitata*)	ND	ND		ND
Lolium rigidum (wimmera ryegrass)*	ND	ND	Annual	ND
Lotus angustissimus (narrowleaf trefoil)*	ND	ND	Annual/Perennial	ND
Lythrum hyssopifolia (lesser loosestrife)*	ND	ND	Annual	ND
Marsilea drummondii (common nardoo)	ND	ND	Perennial	ND
Meeboldina cana	ND	ND	Perennial	ND
Meeboldina coangustata	ND	ND	Perennial	ND
Melaleuca lateritia (robin redbreast bush)	Survives 100% scorch, basal sprouts	60	Perennial	ND
Melaleuca teretifolia (Banbar)	Survives 100% scorch, basal sprouts	ND	Perennial	ND
Melaleuca viminea (mohan)	100% scorch kills, on plant seed storage	60	Perennial	Inferred evidence of resistance
Mesomelaena preissii	ND	ND	Perennial	ND
Microtis media (tall mignonette orchid)	ND	ND	Perennial	ND
Microtis orbicularis (dark mignonette orchid)	ND	ND	Perennial	ND
*Monopsis debilis**	ND	ND	Annual	ND
Myriocephalus appendiculatus	ND	ND	Annual	ND
Myriocephalus occidentalis	ND	ND	Annual	ND
Myriophyllum drummondii	ND	ND	Annual	ND
Myriophyllum echinatum^	ND	ND	Annual	ND
Myriophyllum limnophilum	ND	ND	Annual	ND
Neurachne alopecuroidea (foxtail mulga grass)	Survives 100% scorch, soil suckers	13	Perennial	Inferred evidence of resistance
Ophioglossum lusitanicum (adders tongue)	ND	ND	Perennial	ND
Ornduffia submersa (formerly *Villarsia submersa*)^P4	ND	ND	ND	ND
Pauridia glabella (tiny star)	ND	ND	Perennial	ND
Pauridia occidentalis	ND	ND	Perennial	ND
Philydrella drummondii	ND	ND	Perennial	ND
Philydrella pygmaea (butterfly flowers)	ND	ND	Perennial	ND
Podolepis gracilis (slender podolepis)	Killed by 100% scorch	12	Annual	ND
Prasophyllum gracile	ND	ND	Perennial	ND
Prasophyllum macrostachyum (laughing leek orchid)	ND	ND	Perennial	ND
Ranunculus sessiliflorus	ND	ND	Annual	ND

Rhodanthe pyrethrum	ND	ND	Annual	ND
Romulea rosea (Guildford grass)*	ND	ND	Perennial	ND
Schoenus capillifolius^P3	ND	ND	Annual	ND
Schoenus elegans	ND	ND	Annual	ND
Schoenus natans (Floating Bog-rush)^ P4	ND	ND	Annual	ND
Schoenus odontocarpus	ND	ND	Annual	ND
Schoenus sculptus (gimlet bog-rush)	ND	ND	Annual	ND
Schoenus tenellus	ND	ND	Annual	ND
Sebaea ovata (Yellow Sebaea)	ND	ND	Annual	ND
Siloxerus humifusus (procumbent siloxerus)	ND	ND	Annual	ND
Siloxerus multiflorus	ND	ND	Annual	ND
Sonchus oleraceus (common sowthistle)*	100% scorch kills, no seed storage	ND	Annual	ND
*Stylidium ecorne (*foot triggerplant)	ND	ND	Annual	ND
Stylidium inundatum (hundreds and thousands)	ND	ND	Ephemeral	ND
Stylidium longitubum (jumping jacks)^ P3	ND	ND	Ephemeral	ND
Stylidium calcaratum (formerly *mimeticum*)	100% scorch kills, in soil seed storage	7	Ephemeral	ND
Stylidium obtusatum (pinafore triggerplant)	ND	ND	Perennial	ND
Stylidium roseoalatum (pink-wing triggerplant)	ND	ND	Annual	ND
Stylidium roseonanum^ P3	ND	ND	Annual	ND
Thelymitra antennifera (vanilla orchid)	Geophyte (Survives 100% scorch)	12	Perennial	Inferred evidence of resistance
Thelymitra vulgaris	ND	ND	Perennial	ND
Thysanotus patersonii	Survives 100% scorch, soil suckers	22	Perennial	ND
Thysanotus thyrsoideus	100% scorch kills, in soil seed storage	ND	Perennial	ND
Tribonanthes longipetala	ND	ND	Perennial	ND
Tribonanthes violacea	ND	ND	Perennial	ND
Tribulus minutus^	ND	ND	Annual	ND
Trifolium campestre (hop clover)*	ND	ND	Annual	ND
Trifolium dubium (suckling clover)*	ND	ND	Annual	ND
Triglochin centrocarpa	ND	ND	ND	ND
Triglochin minutissima	ND	ND	Annual	ND
Triglochin stowardii	ND	ND	Annual	ND
Trithuria bibracteata	ND	ND	Annual	ND
Trithuria submersa	ND	ND	Annual	ND
Ursinia anthemoides (Ursinia)*	100% scorch kills, in soil seed storage	12	Annual	ND
Utricularia inaequalis	ND	ND	Annual	ND
Utricularia multifida	ND	ND	Annual	ND
Utricularia violacea (violet bladderwort)	ND	ND	Annual	ND
Vellereophyton dealbatum (white cudweed)*	100% scorch kills, no seed storage	10	Annual	ND
Wurmbea dioica (early nancy)	ND	ND	Perennial	ND
Wurmbea monantha	ND	ND	Perennial	ND
Xanthorrhoea preissii (grass tree)	Survives 100% scorch, large apical bud	9	Perennial	Good evidence of high susceptibility

Source: NatureMap and Florabase (accessed January 2014)
ND = no data available in NatureMap or Florabase
* = introduced species
^= threatened and priority flora that occur in the TEC

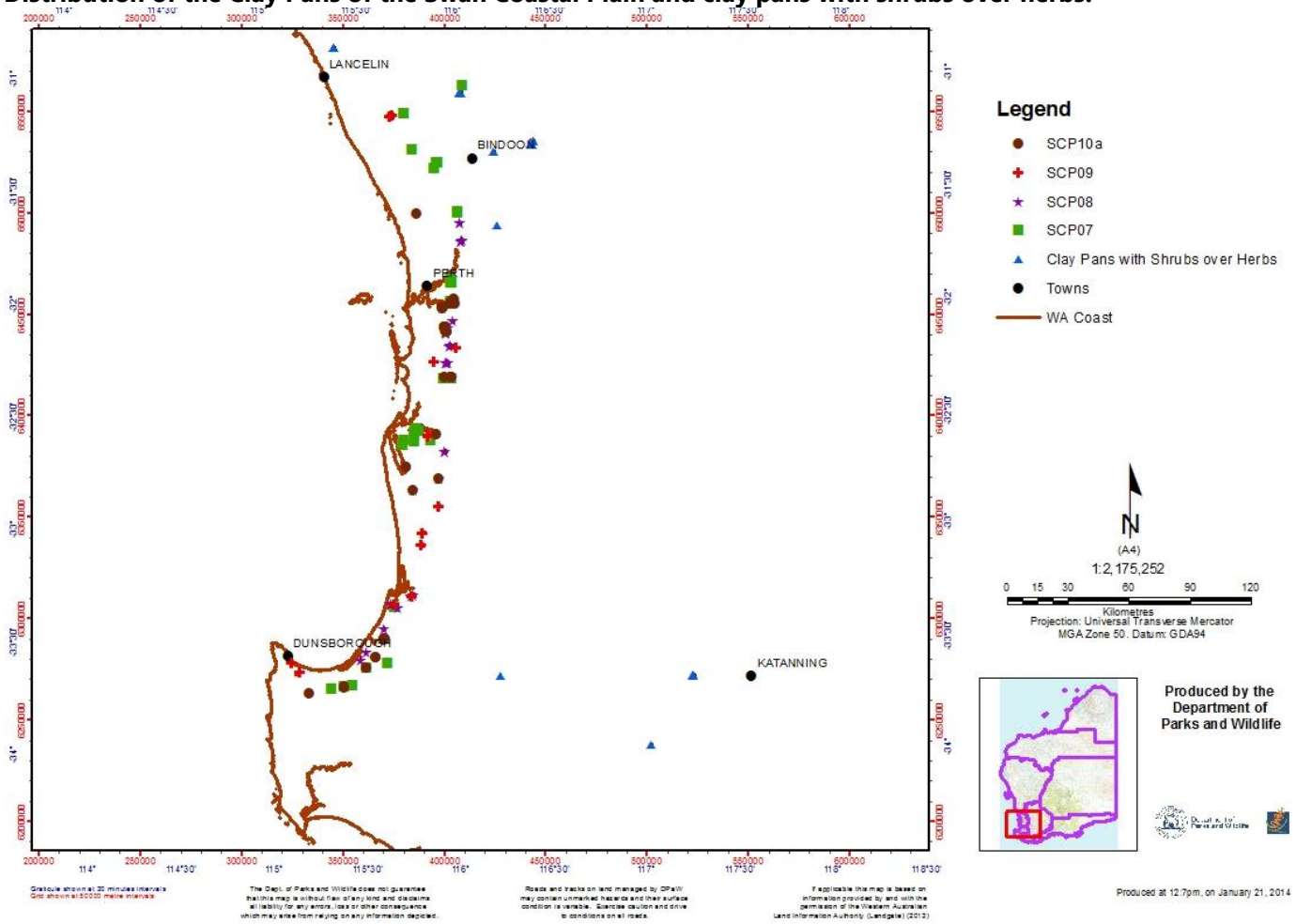
Appendix 3

Common weed taxa recorded in clay pan community types 7, 8, 9, and 10a (Gibson *et al.* 1994) and weed taxa recorded in Gibson *et al*. (2000)

Taxon
Aira caryophyllea
Anthoxanthum odoratum
Arctotheca calendula
Avellinia michelii
Briza maxima
Briza minor
Bromus rubens
Cicendia filiformis
Cotula bipinnata
Crassula decumbens
Crassula natans
Cyperus tenellus
Eragrostis curvula
Erodium cicutarium
Hyparrhenia hirta
Hypochaeris glabra
Isolepis marginata
Juncus bufonius
Juncus capitatus
Lolium perenne
Lotus subbiflorus
Lysimachia arvensis
Monopsis debilis
Ornithopus compressus
Parentucellia latifolia
Parentucellia viscosa
Polypogon monspeliensis
Romulea rosea
Trifolium arvense var. arvense
Trifolium dubium
Trifolium tomentosum
Vellereophyton dealbatum
Vulpia bromoides
Zantedeschia aethiopica

Appendix 3

Distribution of the Clay Pans of the Swan Coastal Plain and clay pans with shrubs over herbs.



Appendix 4

Site Id	Occurrence	AWRC_Name	Water level	Date	Owner
23016851	SCP07 (CARAB02: occ 9)	BORE 3	Static water level.800 m from Ground level	24-02-2004	Department of Water (DOW)
23023199	SCP07 (YOON03: occ 1)	EW7	Static water level 1.900 m from Top of casing	06-11-2008	DOW
20018683	SCP08 (NICHOLSON01; 03, PM08, GOSN10; occ 82)	BORE	Static water level 4.850 m from Ground level	18-07-1977	Middleton
23023904	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	FRD_SEB	Static water level 2.450 m from Top of casing	05-05-2008	DOW
23023190	SCP08 (PM22, 44, HAY01, myHAY01, 02; occ 48)	EW2	Static water level 1.140 m from Top of casing	07-11-2008	DOW
23023903	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	FRD_SEC	Static water level 2.280 m from Top of casing	21-05-2008	DOW
23023191	SCP08 (PM22, 44, HAY01, myHAY01, 02; occ 48)	EW2 ASS	Static water level 1.080 m from Top of casing	07-11-2008	DOW
23023905	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	FRD_SEA	Static water level 2.390 m from Top of casing	05-05-2008	DOW
20018452	SCP08 (BRENTWD08, 11; occ 57)	317 NO. 1	Static water level 0.000 m from Ground level	?	Tapper
20018451	SCP08 (BRENTWD08, 11, 14; occ 57)	316 NO. 2	Static water level 1.220 m from Ground level	?	Tapper
23034876	SCP09 (pind04, PINJ03, 04; occ 72)	HS080-2A	Static water level 1.970 m from Top of inner casing	17-07-2009	DOW
23034236	SCP09 (pind04, PINJ03, 04; occ 72)	HS080-2C	Static water level 0.770 m from Top of inner casing	17-07-2009	DOW
23034235	SCP09 (pind04, PINJ03, 04; occ 72)	HS080-2B	Static water level 2.200 m from Top of inner casing	17-07-2009	DOW
1593	SCP10a (LOWRIE01, RAIL03a, 08, 09; occ 95)	BY25B	Static water level 2.010 m from Top of casing	27-05-2009	DOW
1592	SCP10a (LOWRIE01, RAIL03a, 08, 09; occ 95)	BY25A	Static water level 9.350 m from Top of casing	27-05-2009	DOW
20011182	SCP10a (plant01, plantation02; occ 87)	BORE	Static water level 1.220 m from Ground level	?	Reynolds
20041317	Clay Pans with Shrubs over Herbs (8BQ1A, 8BQ2A, 8BQ1B, 8BQ2B, 8BQ3B, Drummond 8b, JB18; occ 99)	SWAMP 117	Static water level 0.000 m from Ground level	?	Camerer & Co

Appendix 5

Bores within 200m of occurrences

Site ID	Occurrence	AWRC_NAME	AWRC_CTXT	Latitude	Longitude	Water Level	Bore Proximity to Occurrences
20023245	SCP07/SCP10a (PUNR01/ 03; occ 15)	BORE	MURRAY RIVER CATCHMENT 614	-32.360163	115.942941	Static water level 1.520 m from Ground level on 01-01-1000	90m – SCP07 135m – SCP10a
23023195	SCP07 (Swamp02, mySwamp01; occ 20)	EW4 ASS	SWAN COASTAL PLAIN	-33.3802	115.6618	Static water level 1.780 m from Top of casing on 06-11-2008	100m
23035342	SCP07 (YOON03; occ 1)	EW07A	SWAN COASTAL PLAIN	-33.723662	115.433917		Within
12574202	SCP07 (PUNR01, 03; occ 85)	SED12	SOUTH EAST CORRIDOR	-32.361161	115.944673	Static water level .550 m from Top of casing on 29-09-1998	33m
23016851	SCP07 (CARAB02; occ 9)	BORE 3	CALM RESERVE AUSTIN BAY	-32.637477	115.721014	Static water level .800 m from Ground level on 24-02-2004	Within
5819	SCP07/SCP08 (MYKENW01/ MYKENW02, REHOBOTH01; occ 23)	AM44	ARTESIAN MONITORING	-32.0335	115.9787	Static water level - 4.330 m from Top of casing on 01-05-2009	103m – SCP07 90m – SCP08
20023455	SCP07/SCP08 (PAUL05/ PAUL04; occ 14)	212	MURRAY RIVER CATCHMENT 614	-32.363621	115.977178	Static water level 2.740 m from Ground level on 01-01-1000	157m – SCP07 70m – SCP08
23023199	SCP07 (YOON03; occ 1)	EW7	SWAN COASTAL PLAIN	-33.7237	115.4339	Static water level 1.900 m from Top of casing on 06-11-2008	Within
23023194	SCP07 (Swamp02, mySwamp01; occ 20)	EW4	SWAN COASTAL PLAIN	-33.380154	115.661808	Static water level 1.860 m from Top of casing on 07-11-2008	100m
20023452	SCP07/SCP08 (PAUL05/ PAUL04;	205	MURRAY RIVER CATCHMENT 614	-32.365642	115.977261	Static water level .910 m from Ground	160m – SCP07 134m – SCP08

	occ 45)					level on 30-06-1968	
20023242	SCP07/SCP10a (PUNR04/ 03; occ 16)	BORE	MURRAY RIVER CATCHMENT 614	-32.35981	115.937397	Static water level 1.520 m from Ground level on 01-01-1000	145m – SCP07 125m – SCP10a
20014087	SCP08 (ROSE03; occ 30)	NO. 5	610 - BUSSELTON COAST BASIN	-33.476663	115.600668	Static water level 3.600 m from Ground level on 15-11-1976	149m
20023188	SCP08 (MUD02, 03, 06, 07, 09; occ 32)	MUNDIJONG NO. 1	MURRAY RIVER CATCHMENT 614	-32.295565	115.95256		41m
20018609	SCP08 (Kenwick06; occ 63)	PRIVATE	SWAN COASTAL CATCHMENT 616	-32.030237	115.990008		156m
20018683	SCP08/SCP10a (NICHOLSON01, 03, PM08, GOSN10/ NICHOLSON01, gosn11; occ 82)	BORE	SWAN COASTAL CATCHMENT 616	-32.049449	115.932367	Static water level 4.850 m from Ground level on 18-07-1977	Within – SCP08 22m – SCP10a
20023260	SCP08 (MUD02, 03, 06, 07, 09; occ 32)	NO 51 (PREV NO. 32)	MURRAY RIVER CATCHMENT 614	-32.295658	115.95189		22m
3110	SCP08 (MUD02, 03, 06, 07; occ 32)	T320	LAKE THOMSON	-32.295144	115.945438	Static water level 9.220 m from Top of casing on 05-05-2009	65m
20018259	SCP08/SCP10a (BICKLEYRD06/ Kenwick04; occ 60)	NO. 3	SWAN COASTAL CATCHMENT 616	-32.028071	115.989916	Static water level 4.570 m from Ground level on 01-01-1000	100m – SCP08 115m – SCP10a287
20018781	SCP08 (Kenwick05, BICKLEYRD06; occ 62)	BORE	SWAN COASTAL CATCHMENT 616	-32.028048	115.985924		97m
20018450	SCP08 (BRENTWD08, 11, 14; occ 57)	315 NO 3	SWAN COASTAL CATCHMENT 616	-32.018641	115.991862	Static water level 1.220 m from Ground level on 01-01-1000	81m
20018452	SCP08 (BRENTWD08, 11; occ 57)	317 NO. 1	SWAN COASTAL CATCHMENT 616	-32.017757	115.990707	Static water level .000 m from Ground level on 01-01-1000	2m
20018454	SCP08 (BRENTWD14; occ 59)	319 NO. 2	SWAN COASTAL CATCHMENT 616	-32.02175	115.993638		105m
20023278	SCP08 (MUD02, 03, 06, 07, 09; occ 32)	BORE	MURRAY RIVER CATCHMENT 614	-32.29565	115.953069		30m

23023904	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	FRD_SEB	LAKE FORRESTDALE	-32.164825	115.949445	Static water level 2.450 m from Top of casing on 05-05-2008	Within
20012024	SCP08 (PM28, WATER04; occ 38)	BORE	612 - COLLIE RIVER BASIN	-33.329315	115.760169		Within
20018431	SCP08/SCP10a (BICKLEYRD06/ Kenwick04; occ 60)	287 NO. 2	SWAN COASTAL CATCHMENT 616	-32.029263	115.988897	Static water level 1.220 m from Ground level on 01-01-1000	87m – SCP08 171m – SCP10a
20021105	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	BORE	SWAN COASTAL CATCHMENT 616	-32.164572	115.950265		Within
20021670	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	BORE	MURRAY RIVER CATCHMENT 614	-32.218432	115.971814	Static water level 1.200 m from Ground level on 12-04-1993	103m
20021114	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	20	MURRAY RIVER CATCHMENT 614	-32.219393	115.97245	Static water level .300 m from Ground level on 01-01-1000	43m
20018451	SCP08 (BRENTWD08, 11, 14; occ 58)	316 NO. 2	SWAN COASTAL CATCHMENT 616	-32.017986	115.991096	Static water level 1.220 m from Ground level on 01-01-1000	5m
20018511	SCP08 (BRIX01, 03, 04; occ 35)	375	SWAN COASTAL CATCHMENT 616	-32.031701	115.972423		11m
20012579	SCP08 (PM22, 44, HAY01, myHAY01, 02; occ 48)	BUNBURY 3 E2-1	611 - PRESTON RIVER BASIN	-33.36588	115.644718		105m
12574105	SCP08 (MUD02, 03, 06, 07, 09; occ 32)	SED7	SOUTH EAST CORRIDOR	-32.295655	115.952538		30m
20018436	SCP08 (Kenwick07; occ 64)	291	SWAN COASTAL CATCHMENT 616	-32.026636	115.994326	Static water level 1.830 m from Ground level on 01-01-1000	155m
20084101	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	BORE	MURRAY RIVER CATCHMENT 614	-32.223413	115.968712		110m
23023190	SCP08 (PM22, 44, HAY01, myHAY01, 02; occ 48)	EW2	SWAN COASTAL PLAIN	-33.3682	115.6445	Static water level 1.140 m from Top of casing on 07-11-2008	Within

23023903	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	FRD_SEC	LAKE FORRESTDALE	-32.164861	115.949413	Static water level 2.280 m from Top of casing on 21-05-2008	Within
20021791	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	BORE	MURRAY RIVER CATCHMENT 614	-32.220634	115.970823		Within
23023191	SCP08 (PM22, 44, HAY01, myHAY01, 02; occ 48)	EW2 ASS	SWAN COASTAL PLAIN	-33.3682	115.6445	Static water level 1.080 m from Top of casing on 07-11-2008	Within
20023220	SCP08 (MUD02, 03, 06, 07; occ 32)	BORE	MURRAY RIVER CATCHMENT 614	-32.294115	115.946353	Static water level .910 m from Ground level on 01-01-1000	127m
23023905	SCP08 (myFL01, 02, 03, PM06, 07, FL03; occ 33)	FRD_SEA	LAKE FORRESTDALE	-32.164843	115.949435	Static water level 2.390 m from Top of casing on 05-05-2008	Within
20021932	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	BORE	MURRAY RIVER CATCHMENT 614	-32.219246	115.972102	Static water level 4.000 m from Ground level on 19-01-1999	26m
20018937	SCP08 (BRIX01, 03, 04; occ 35)	BORE	SWAN COASTAL CATCHMENT 616	-32.032577	115.972519	Static water level 3.660 m from Ground level on 30-04-1980	85m
20018453	SCP08 (BRENTDWD08, 14; occ 58)	318 NO. 1	SWAN COASTAL CATCHMENT 616	-32.020441	115.99127	Static water level 1.520 m from Ground level on 01-01-1000	92m
20021813	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	BORE	MURRAY RIVER CATCHMENT 614	-32.223262	115.966751	Static water level 2.000 m from Ground level on 03-03-1996	128m
20021115	SCP08 (ABERNETHY RD PLOT1, MYABERN04; occ 42)	21	MURRAY RIVER CATCHMENT 614	-32.220656	115.972351		65m
20018780	SCP08 (Kenwick05, BICKLEYRD06; occ 62)	D.F. PORT	SWAN COASTAL CATCHMENT 616	-32.028048	115.985924		98m
20018958	SCP08/SCP10a (BRIX01, 03, 04,	BORE	SWAN COASTAL CATCHMENT 616	-32.030186	115.974664	Static water level 1.520 m from Ground	27m – SCP08 144m – SCP10a

	WANAPING 01, 03, REHOBOTH01/ WANAPING02; occ 35)					level on 09-10-1976	
20018516	SCP08 (Kenwick05, BICKLEYRD06; occ 62)	380	SWAN COASTAL CATCHMENT 616	-32.030172	115.986398	Static water level 2.130 m from Ground level on 01-01-1000	99m
20011720	SCP09 (WELR01, 02; occ 69)	BORE	612 - COLLIE RIVER BASIN	-33.054133	115.814648	Static water level 1.600 m from Ground level on 11-09-1979	98m
20012219	SCP09 (WATER07; occ 38)	BY16C	BUNBURY SHALLOW	-33.332602	115.754299		113m
23034876	SCP09(pind04, PINJ03, 04; occ 72)	HS080-2A	MURRAY SUPERFICIAL	-32.618821	115.851536	Static water level 1.970 m from Top of inner casing on 17-07-2009	0.5m
23034236	SCP09(pind04, PINJ03, 04; occ 72)	HS080-2C	MURRAY SUPERFICIAL	-32.618786	115.851536	Static water level .770 m from Top of inner casing on 17-07-2009	1m
20006569	SCP09 (TOBY01; occ 75)	NO. 23 TULLOCH	610 - BUSSELTON COAST BASIN	-33.62266	115.113579	Static water level .700 m from Ground level on 14-06-1977	131m
1571	SCP09 (WATER07; occ 38)	BY16B	BUNBURY SHALLOW	-33.332778	115.754167	Static water level 2.430 m from Top of casing on 26-05-2009	131m
1570	SCP09 (WATER07; occ 38)	BY16A	BUNBURY SHALLOW	-33.332778	115.754167	Static water level 3.720 m from Top of casing on 26-05-2009	131m
23034235	SCP09(pind04, PINJ03, 04; occ 72)	HS080-2B	MURRAY SUPERFICIAL	-32.618804	115.851536	Static water level 2.200 m from Top of inner casing on 17-07-2009	0.8m
1593	SCP10a (LOWRIE01, RAIL03a, 08, 09; occ 95)	BY25B	BUNBURY SHALLOW	-33.521111	115.604722	Static water level 2.010 m from Top of casing on 27-05-2009	2m
20018673	SCP08/SCP10a (NICHOLSON02/ gosn08; occ 43)	BORE	SWAN COASTAL CATCHMENT 616	-32.047028	115.934175	Static water level 1.830 m from Ground level on 13-04-1978	92m – SCP08 178m – SCP10a

1592	SCP10a (LOWRIE01, RAIL03a, 08, 09; occ 95)	BY25A	BUNBURY SHALLOW	-33.521111	115.604722	Static water level 9.350 m from Top of casing on 27-05-2009	2m
20011182	SCP10a (plant01, plantation02; occ 87)	BORE	610 - BUSSELTON COAST BASIN	-33.599456	115.562552	Static water level 1.220 m from Ground level on 01-01-1000	20m
20023235	SCP10a (HALL02, 04; occ 83)	BORE	MURRAY RIVER CATCHMENT 614	-32.358138	115.972925	Static water level 3.590 m from Ground level on 12-01-1987	81m
20023557	SCP10a (HALL02, 04, BYFrail09; occ 83)	BORE	MURRAY RIVER CATCHMENT 614	-32.360747	115.976477	Static water level 1.500 m from Ground level on 30-06-1981	97m
20023556	SCP10a (HALL02, 04, BYFrail09; occ 83)	BORE	MURRAY RIVER CATCHMENT 614	-32.360511	115.976394	Static water level 1.000 m from Ground level on 15-06-1986	80m
20023207	SCP10a (HALL02, 04, BYFrail09; occ 83)	BORE	MURRAY RIVER CATCHMENT 614	-32.360567	115.976638	Static water level 4.500 m from Ground level on 11-01-1987	105m
1594	SCP10a (LOWRIE01; occ 95)	BY25C	BUNBURY SHALLOW	-33.522236	115.608074	Static water level 5.790 m from Top of casing on 01-06-1978	28m
20018432	SCP08/ SCP10a (BICKLEYRD06, kenwick04; occ 60)	BY25C	SWAN COASTAL CATCHMENT 616	-32.029134	115.989766		171m –SCP08 185m – SCP10a
20041317	Clay Pans with Shrubs over Herbs (8BQ1A, 8BQ2A, 8BQ1B, 8BQ2B, 8BQ3B, Drummond 8b, JB18; occ 99)	SWAMP 117	615 - AVON RIVER BASIN	-31.325143	116.402987	Static water level .000 m from Ground level on 01-01-1000	Within
20041679	Clay Pans with Shrubs over Herbs (PURS01, 03, 04, 06; occ 102)	BORE	SWAN COASTAL CATCHMENT 616	-31.094326	116.035631		28m

Appendix 6: Bush Forever vegetation condition scales (Government of Western Australia 2000).

Pristine (1)
Pristine or nearly so, no obvious signs of disturbance.

Excellent (2)
Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.

Very Good (3)
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, then presence of some more aggressive weeds, dieback, logging and grazing.

Good (4)
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (5)
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (6)
The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.