INTERIM RECOVERY PLAN 196

Assemblages of Organic Mound Springs of the Three Springs Area

Interim Recovery Plan

2005-2010

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Photograph: Sheila Hamilton-Brown

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Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
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FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) 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.

CALM is committed to ensuring that Critically Endangered, and where appropriate and feasible, other 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 Minister.

This Interim Recovery Plan will operate from August 2005 to July 2010 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Endangered, this IRP will be reviewed after five years and the need for a full Recovery Plan assessed.

This IRP was given regional approval on, 5 September, 2005 and was approved by the Director of Nature Conservation on 2 October, 2005. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate at August 2005.

ACKNOWLEDGMENTS

The following people provided valuable advice and assistance in the preparation of this IRP:

John Blyth	Nature Conservation Fellow, Species and Communities Branch, CALM
Rebecca Carter	Nature Conservation Coordinator, CALM's Moora District
Jenny Borger	Botanical Consultant, Shire of Three Springs
John Hutchison	Property owner, Shire of Three Springs
Nan & Tony McAleer	Property owners, Shire of Three Springs
Russel Speed	Senior Hydrogeologist, Agriculture WA, Geraldton
Allan Tinker	Western Flora Caravan Park, Eneabba

SUMMARY

Name: Assemblages of organic mound springs of the Three Springs area.

Description: The habitat of this community is characterised by continuous discharge of groundwater in raised areas of peat. The peat and surrounds provide a stable, permanently moist series of micro-habitats. There is a high level of heterogeneity of invertebrate fauna assemblages between occurrences, and all are associated with a rich and healthy fauna. Results of a survey of a subset of the springs are documented by Pinder and Pennifold (2001) who concluded that "although it is unlikely that any element of this subset is restricted to these particular springs, taken together they form an assemblage that may not occur in other aquatic habitats". Invertebrate groups commonly represented include beetles, oligochaetes, non-biting midge and bugs.

The vegetation component of the community contains many moisture loving species including an overstorey of *Melaleuca preissiana* trees. *Eucalyptus camaldulensis* and *E. rudis* are also found in a number of the mound springs. The shrub layer often includes *Hypocalymma angustifolium* and *Acacia saligna* over *Baumea vaginalis* and other sedges. The herbaceous *Patersonia occidentalis* (swamp variant) was recorded at several mound springs.

IBRA Bioregion: Geraldton Sandplains

CALM Region/District: Midwest Region/Moora District

Local Government Authority: Shire of Three Springs

Recovery Team: Moora District Threatened Flora Recovery Team

Current status: This community was assessed by the Western Australian Threatened Ecological Communities Scientific Committee (TECSC) on the 21 September 2001 as Endangered, which was endorsed by the Western Australian Minister for the Environment on the 8 May 2002.

Habitat requirements: The flora and fauna species present in this community are dependent on specific characteristics of the mound springs particularly the layers of peat that have built up over an extended period and the supply of permanent fresh spring water. The maintenance of hydrological processes in terms of both quality and quantity of water to the mounds is essential to sustain the mound spring community.

Habitat critical to the survival of the community and important occurrences: The habitat critical to the survival of the 'Assemblages of organic mound springs of the Three Springs area' is made up of the occurrences of the mound springs themselves and the surrounding vegetation buffer. The community is also reliant on the hydrological catchment of the Dandaragan Trough which contributes to the 'artesian' aquifer systems that feed the mound springs. Given that the assemblages of organic mound springs of the Three Springs area are listed as Endangered and only 15 occurrences are known, most of which are found on areas of private property, all known habitat for the community is considered critical habitat and all occurrences are important.

Benefits to other species/ecological communities: There are several Priority species within the TEC including *Dryandra stricta* (P3), *Eucalyptus diminuta* (P3) and *Thomasia formosa* (P1) all of which will benefit from the implementation of recovery actions outlined in this recovery plan. Recovery actions specific to occurrence 13 may also have major benefits for occurrences 2 of the endangered ecological community 'Ferricrete floristic community (Rocky Springs type)' which occur on the same land parcel.

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. The "Assemblages of organic mound springs of the Three Springs area" 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.

Affected Interests: Parties affected by the implementation of this plan include CALM's Moora District and Midwest Region who manage two Nature Reserves containing occurrences of the Mounds Springs TEC; three private landholders who own land which contains occurrences of the TEC; and the Shire of Three Springs who maintain a public road adjacent to one of the occurrences. All of these parties have been informed of the importance of the TEC and will provide input regarding the implementation of this IRP.

Role and interest of indigenous peoples: There are no known indigenous communities associated or involved in the management of areas affected by this plan. A search of the Department of Indigenous Affairs Aboriginal Heritage Sites Register indicated that there are no listed aboriginal heritage sites in the area of this ecological community. Input and involvement will be sought from any indigenous groups that have an active interest in the areas covered by the community, and this is discussed in the recovery actions.

Social and economic impacts: As mentioned above, parties affected by this plan include CALM's Moora District and Midwest Region, The Shire of Three Springs, and several private landholders. It is not anticipated that there is likely to be any adverse social or economic impacts to any of these parties as a consequence of the implementation of this plan. The extant occurrences of the TEC are found on private property that is currently fenced for conservation or on areas designated as "A" Class Nature Reserves, and none of these land parcels are subject to current mining leases. The Moora District, Midwest Region, the Shire of Three Springs and surrounding landholders have been informed of the importance of the TEC and their cooperation will be sought to ensure that activities on the land they manage does not affect occurrences of the TEC. Specific involvement, of these and any other parties, in the implementation of the plan is outlined in the appropriate recovery actions.

Evaluation of the plan's performance: CALM, in conjunction with the Recovery Team will evaluate the performance of this IRP. In addition to annual reporting of the recovery team, the plan is to be reviewed within five years of its implementation.

Guide for decision-makers: Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of the occurrences require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the ecological community.

Existing recovery actions: The following recovery actions have been or are currently being implemented;

1. Recovery team has been established.
2. The unvested camping reserve containing occurrence 2 has been upgraded to an "A" Class Nature Reserve.
3. Negotiations have recently been completed and the land parcel containing Occurrence 5 has been purchased by CALM and incorporated into the adjacent 'A' Class Nature Reserve.

IRP Objective(s): To maintain or improve the overall condition of the mound springs and the associated fauna and plant assemblages and reduce the level of threat so that the community does not move into a higher threat category.

Criteria for success:

- An increase in the area of this community under conservation management.
- Maintenance of hydrological and biological processes, taking account of natural changes of the community over time.
- Maintenance of the diversity and composition of native species (both invertebrate and flora species) in the community as defined in appendix 1, taking account of natural changes in the community over time.
- Improvement in the condition of the habitat, in terms of reducing threatening processes as defined in this document.

Criteria for failure:

- Significant loss of area or further modification of the occurrences of the threatened ecological community as a consequence of threatening processes as listed in this document.

Recovery Actions:

1. Coordinate recovery actions	11. Implement the weed control strategy
2. Survey for additional occurrences and map components of the community and critical habitat	12. Develop a fire management strategy
3. Monitor the extent and boundaries of the occurrences	13. Implement the fire management strategy
4. Obtain biological and ecological information on the major components of the community	14. Monitor *Phytophthora sp*. disease and assess the need for disease treatment
5. Compile existing hydrological information and monitor existing bores	15. Mange dieback disease if necessary
6. Design and implement a program to monitor the quality and volume of water within the springs	16. Control introduced animals
7. Design and implement an invertebrate monitoring program	17. Liaise with the shire and private landholders
8. Design and establish a flora monitoring program	18. Design and implement a public awareness program
9. Monitor flora quadrats periodically or after disturbance	19. Review the need for a full Recovery Plan
10. Design a weed control strategy	

1 BACKGROUND

1.1 History, defining characteristics of ecological community, and conservation significance

Mound springs are areas where groundwater discharges at a point which is elevated above the surrounding landscape through the build up of calcarenites or peat forming a mound around the area of discharge (Knott & Jasinska 1998). Calcarenite mound springs occur as outflow points of the great artesian basin in Central Australia (Ponder 1986), while in Western Australia tumulus or peat-formed mound springs are found in a restricted area on the swan coastal plain, at several locations in the northwest of the state (Knott & Jasinska 1998) and along a small section of the Dandaragan Scarp west of Three Springs. Tumulus mound springs are formed around areas of continuous water discharge and may issue from a discrete vent on top of the mound or seep from the whole surface of the mound without a main outflow channel (Jasinska 1998). Because they are permanently damp, mound springs have significant conservation value as mesic refuges for plants and animals in an arid landscape, and they support both endemic species and isolated outliers (Knott and Jasinska 1998).

The mound springs at Ellenbrook on the Swan Coastal Plain have been relatively well studied, and were found to have a unique mound spring faunal assemblage including rare and restricted species of Gondwanan origin. The permanently moist peat mounds provide important habitat for these species that are not resistant to periodic drying and are not found in temporary water bodies on the Swan Coastal Plain (Jasinska, 1998). Mesic plants such as liverworts, bog clubmosses and sundews, usually found only in permanently wet swamps of the lower south-west, are found in the moist environment of the Ellenbrook mound springs (English & Blyth 1999). Little is known of the fauna and flora of the mound springs of north-western Australia but in South Australia, each major group of the 90 calcarenite mound spring complexes has its own unique characteristics and a distinct fauna and flora (Ponder 1985).

The tumulus mound springs in the Three Springs area are less well known but preliminary investigations of surface water invertebrates' show that the complex of springs provide habitat for a diverse array of aquatic fauna (Pindar & Pennifold 2001). While most of the species present are common and widely distributed, there is a small subset of species that appear to be rare or absent in other aquatic habitats in the wheatbelt and taken together form an assemblage that may not occur in other aquatic habitats (Pindar & Pennifold 2001). Preliminary sampling indicates that while the mounds that have been sampled have similar species richness, each has a different assemblage of species, which probably reflects different microhabitats present within each mound (eg extent of surface water, detritus, organic content of soils, soil moisture and vegetation) (Pinder, 2002). These diverse aquatic invertebrate assemblages include an unusual combination of groundwater species, species more typical of the higher rainfall south-west, and at least one species that appears to be regionally restricted and uncommon (*Austrotromella)* (Pinder, 2002).

The vegetation component of the community contains many moisture loving species including an overstorey of *Melaleuca preissiana* trees. *Eucalyptus camaldulensis* and *E. rudis* are also found in a number of the mound springs. The shrub layer often includes *Hypocalymma angustifolium* and *Acacia saligna* over *Baumea vaginalis* and other sedges. The herbaceous *Patersonia occidentalis* (swamp variant) was recorded at several mound springs.

1.2 Distribution

- **Historical**

Field survey indicates that historically there were at least 24 mound springs in the Three Springs area but seven of these have been destroyed through conversion to permanent water points and clearing.

- **Current**

There are currently 17 known occurrences of the mound spring community remaining. Additional occurrences may also occur on private property near populations 16 and 17 and require further survey. Details of the location, estimated area, threats, tenure and vesting are summaries in table 1 and 2 below.

Table 1 Extent and location of occurrences

Occ.	Location	Estimated area	Threats
1	Private land, Shire of Three Springs	0.441 Ha	Hydrological change Track Maintenance Weeds
2	Private land, Shire of Three Springs	0.05 Ha	Hydrological change Track Maintenance Weeds
3	"A" Class Nature Reserve 12705, Bunny Road, Three Springs	0.75 Ha	Hydrological change
4	Private land, Shire of Three Springs	0.75 Ha	Hydrological change
5	"A" Class Nature Reserve 12705, Bunny Road, Three Springs	3.97 Ha	Hydrological change Weeds
6	Private land, Shire of Three Springs	1.5 Ha	Hydrological change
7	Private land, Shire of Three Springs	0.625 Ha	Hydrological change
8	Private land, Shire of Three Springs	0.18 Ha	Hydrological change
9	Private land, Shire of Three Springs	0.75 Ha	Hydrological change
10	Private land, Shire of Three Springs	1.03 Ha	Hydrological change
11	Private land, Shire of Three Springs	0.28 Ha	Hydrological change (partly cleared), weeds
12	Private land, Shire of Three Springs	0.049 Ha	Hydrological change
13	"A" Class Nature Reserve 12705, Bunny Road, Three Springs	0.547 Ha	Hydrological change
14	"A" Class Nature Reserve 37083, Bunny Road, Three Springs	0.049 Ha	Hydrological change
15	Private land, Shire of Three Springs	1.0 Ha	Hydrological change
16	Private land, Shire of Three Springs	< 1 Ha	Hydrological change
17	Private land, Shire of Three Springs	< 1 Ha	Hydrological change

Table 2 Vesting and tenure of occurrences

Occ.	Site ID	Vesting	Purpose	Tenure
1	MSTS01	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
2	MSTS02	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
3	MSTS03	Conservation Commission	Conservation of Flora and Fauna	Nature Reserve
4	MSTS04	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
5	MSTS05	Conservation Commission	Conservation of Flora and Fauna	Nature Reserve
6	MSTS06	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
7	MSTS07	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
8	MSTS08	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act

9	MSTS09	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
10	MSTS10	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
11	MSTS11	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
12	MSTS12	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
13	MSTS13	Conservation Commission	Conservation Of Flora And Fauna	Nature Reserve
14	MSTS14	Conservation Commission	Conservation Of Flora And Fauna	Nature Reserve
15	MSTS15	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
16	MSTS16	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act
17	MSTS17	Private landowner	Freehold – no purpose listed	Freehold – Non CALM act

The mound springs were located using aerial photographs followed by a site visit to confirm the location. Occurrences 1, 2, 5, 11, 13 and 14 were sampled for aquatic invertebrates during 2001. The remaining mound springs are yet to be sampled. Occurrences 3, 4, 6, 7, 8, 9, and 10 are yet to be surveyed. Further sampling and survey is a recommendation of this IRP. The mound springs surveyed to date have an over-storey of *Melaleuca preissiana* and may contain also *Eucalyptus camaldulensis* or *Eucalyptus rudis*. The understorey species vary between mound springs but generally contain a sedge layer of several *Baumea* spp.

Occurrences 3, 5 and 13 are all within Nature Reserve 12705 and contain *Eucalyptus camaldulensis*, *Eucalyptus rudis* and *Melaleuca preissiana* over *Baumea* sedges. Occurrence 5 and 13 are in a section of the reserve which was previously a shire camping reserve and have had very little disturbance. Occurrence 3, the largest of the mound springs, is in a section of the reserve which was previously privately owned and occasionally used as a stock watering point in the past. Some of the understorey has been disturbed in the past and there are weedy grasses and *Solanum nigrum* in a part of the mound spring although generally the reserve is in good condition.

Occurrences 1, 2, 4, 6, 7, 8, 9, 10, 11, and 12 all occur in bush remnants on private property to the south and east of Nature Reserve 12705. These areas have been fenced to exclude grazing and the mound springs are generally in good condition. Occurrences 1 is close to the southern boundary access tracks around the reserve and has had soil pushed up near the mound spring during track maintenance in the past. Occurrence 11 has been partly dredged and converted to a farm dam but the remainder of the occurrences have had little disturbance. Water which seeps from these mounds and those in the adjacent nature reserve drains into a nearby creek and into the Arrowsmith River.

Occurrence 14 is within Wilson's Nature Reserve, 37083, and is in good condition. This small occurrence is a small peaty area on a hill slope which is damp all year round and supports an over-storey of *Melaleuca preissiana* and an understorey of *Baumea* sedges. The surrounding landscape is a proteaceous rich scrub heath.

Occurrence 15 is on private property to the south of the previously mentioned occurrences, near the corner of First North Road and Kangaroo Rd. Much of the surrounding vegetation has been cleared.

Occurrences 16 and 17 have recently been discovered on private property to the north of the other occurrences and aerial photos indicated that another two mound springs may also occur on this property. These two occurrences are in very good condition. Occurrence 15 is the larger of the two and

has an over-storey of *Eucalyptus camaldulensis* and *Melaleuca preissiana* over at least four species of *Baumea*. The smaller occurrence (occurrence 16) has an over-storey of *Melaleuca preissiana* over *Baumea* sedges.

1.3 Biological and ecological characteristics

The mound springs are permanently moist, and some are associated with permanent pools and surface water. Little is known of the biology and ecology of the community and gaining more information about this is a priority in this IRP. Many of the invertebrate animals present are likely to be adapted to this permanent moisture and the occurrences probably act as refugia in this relatively dry landscape.

Appendix 1 provides a preliminary list of the flora and fauna that has been recorded in occurrences.

1.4 Hydrology/Hydrogeology and Water Quality

The source of the water that discharges through the mound springs in the Three Springs area is the semi-confined Parmelia Aquifer (Water and Rivers Commission, 2003). This water is fresh but is overlain in places by a thin layer of shallow, superficial groundwater that is more saline. The Dandaragan Plateau is a sand and laterite-capped plateau overlying cretaceous sedimentary rocks 200 to 300 m above sea level. The plateau is bounded by the Dandaragan Scarp to the West and the Yarra Yarra Region to the east. The base of the Parmelia Formation consists of feldspathic sandstone, siltstone and claystone and it lies above the Yarragadee Formation of the Perth Basin. A layer of sandstones called the Otorowiri Member forms the base of the Parmelia formation and the Dandaragan Scarp coincides with an outcrop of the Otorowiri Member. The Scarp is most prominent in the northeast where it is up to 30m high (the approximate thickness of the Otorowiri Member) and is marked by a line of springs formed where groundwater discharges from the Parmelia Aquifer near the contact with the siltstone (Mory 1994). West of the Otorowiri Siltstone outcrop the water table in the Yarragadee Formation aquifer is much deeper (Commander 1981). See Figure1.

The chain of springs and soaks along the Dandaragan scarp stretch from near Mingenew to east of Eneabba but mound springs appear to be restricted to a small section of the scarp west of Three Springs.

Groundwater is observed to be rising rapidly in the northern Perth Basin. There are two Department of Agriculture groundwater monitoring sites installed in the recharge area east of the Mound springs, both of which are within the same basin subdivision as the mound springs (i.e. the Dandaragan trough) (Speed 2004). The first bore (which is 500m west of the Urella fault shows a rise in groundwater in excess of 0.3m per years since 1998 and the second site about 4km west of the Urella Fault shows a rising groundwater trend in excess of 0.6 m per year since late 2001 (Speed 2004)

Anecdotal evidence also indicates a rapidly rising groundwater level in the mound springs area. A landholder who has several occurrences of the community on his property describes changes that have occurred to the bore that supplies water to his property. The water source of the bore was not artesian when it was installed but has become so over the last few years requiring him to relocate the pump and wiring which had become inundated by the rising groundwater (John Hutchison, personal communication[1]. 2004).

Initial monitoring of two piezometers and an observation bore installed approximately 800m upslope of the nearest mound spring during September 2003 showed that the groundwater (Parmelia aquifer) in this area is under significant artesian pressure (i.e. the groundwater level in the deep piezometer was 1.65 m above the ground surface during March 2004). The groundwater from this bore was found to be fresh (electrical conductivity of about 150 millisiemens per metre) and slightly acidic (ph 1.7-5.6) whereas the narrow band of shallower water intersected by the observation bore was saline (electrical

[1] John Hutchison, Property Owner, Shire of Three Springs

conductivity approaching 2000 millisiemens per metre) (Speed 2004). Water samples collected from the mound springs indicate that they appear to be fed by the deeper, fresher water aquifer. Very small traces of the agricultural chemical Simazine were also detected in the samples from the shallow piezometer and observation bore but no chemicals were detected in the deep piezometer or in water samples taken from the mound springs themselves. Speed (2004) concluded that from the initial results ground water levels are observed to be rising in the recharge area and so it is reasonable to expect the amount of discharge at the springs will continue to increase.

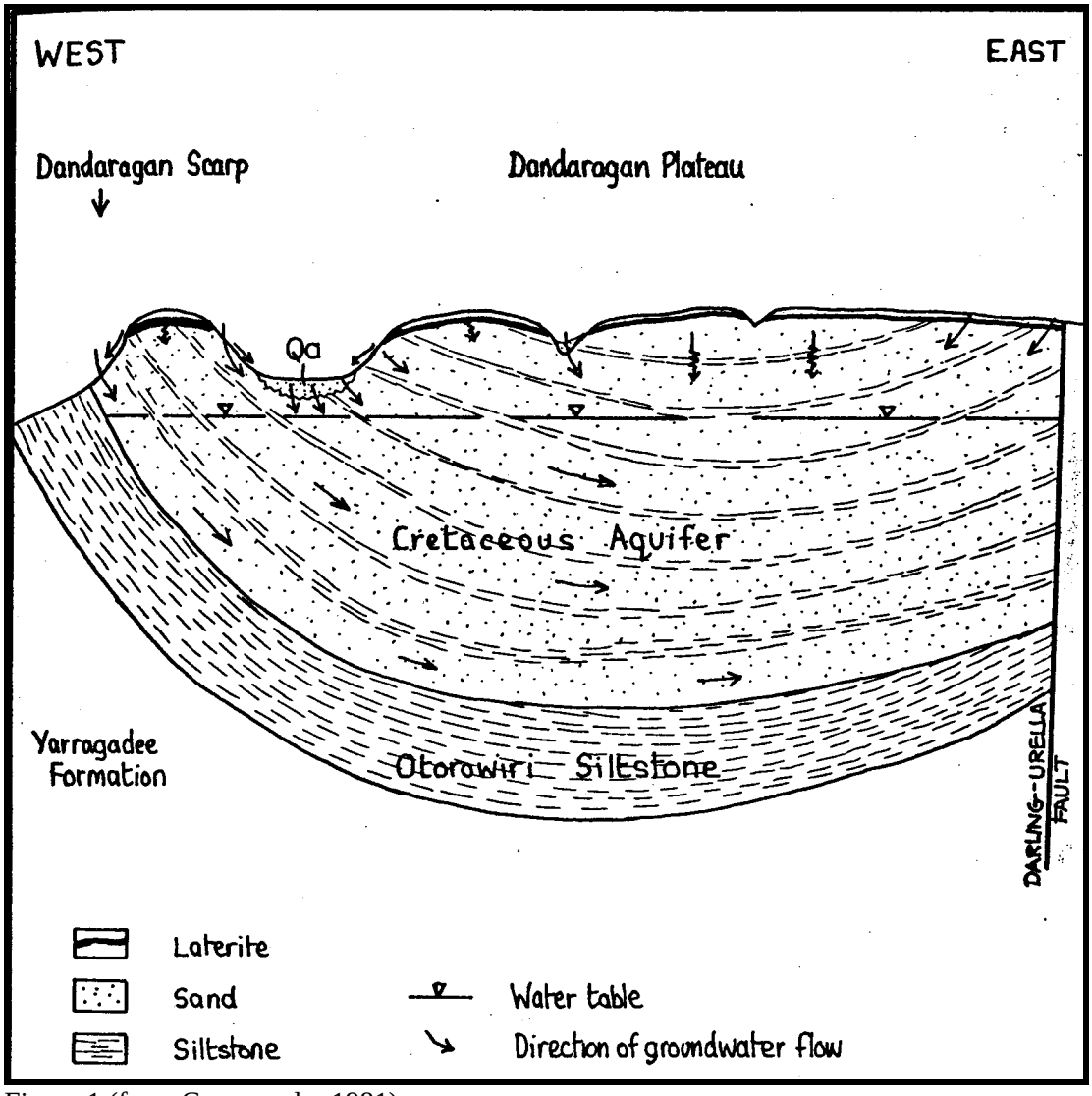

Figure 1 (from Commander 1981)

1.5 Habitat critical to the survival of the community, and important occurrences Habitat critical to the survival of a listed threatened ecological community or listed threatened species is identified as the biophysical medium or media (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (sections 207A and 528 of Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)).

The critical habitat for the 'Assemblages of organic mound springs of the Three Springs area' is made up of the occurrences of the mound springs themselves and the surrounding vegetation buffer. The community is also reliant on the hydrological catchment of the Dandaragan Trough that contributes to the 'artesian' aquifer systems that feed the mound springs. Given that the assemblages of organic

mound springs of the Three Springs area are listed as Endangered and only 15 occurrences are known, most of which are found on areas of private property, all known habitat for the community is considered critical habitat and all occurrences are important.

1.6 Benefits to other species/ecological communities

Several Priority species have been recorded within or immediately adjacent to the TEC including *Eucalyptus diminuta* (P3), *Dryandra stricta* (P3), *Thomasia formosa* (P1) and *Guichenotia quasicalva* (P2). All of these populations will benefit from the implementation of recovery actions outlined in this recovery plan. Recovery actions specific to occurrence thirteen may also have major benefits for occurrence 2 of the endangered ecological community 'Ferricrete floristic community (Rocky Springs type)' which occurs on the same land parcel (now an A Class Nature Reserve).

1.7 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. The 'Assemblages of organic mound springs of the Three Springs area)' community is not listed under any specific international treaty, however, so this IRP does not affect Australia's obligations under any other international agreements.

1.8 Affected interests

Parties affected by the implementation of this plan include CALM's Moora District and Midwest Region who manage two Nature Reserves containing occurrences of Mounds Springs TEC; three private landholders who own land which contains occurrences of the TEC; and the Shire of Three Springs who maintain a public road adjacent to one of the occurrences. All of these parties have been informed of the importance of the TEC and will provide input regarding the implementation of this IRP.

1.9 Role and interest of indigenous peoples

There are no known indigenous communities associated or involved in the management of areas affected by this plan. A search of the Department of Indigenous Affairs Aboriginal Heritage Sites Register indicated that there are no listed Aboriginal Heritage Sites in the area of this ecological community. Input and involvement will be sought from any indigenous groups that have an active interest in the areas of the community, and this is discussed in the recovery actions.

1.10 Social and economic impacts

As mentioned in section 1.9, parties affected by this plan include CALM's Moora District and Midwest Region, The Shire of Three Springs, and several private landholders. It is not anticipated that there is likely to be any adverse social or economic impacts to any of these parties as a consequence of the implementation of this plan. The extant occurrences of the TEC are found on private property that is currently fenced for conservation or areas designated as "A" Class Nature Reserves and none of these land parcels are subject to current mining leases. The Moora District, Midwest Region, the Shire of Three Springs and surrounding landholders have been informed of the importance of the TEC and their cooperation will be sought to ensure that activities on the land they manage does not affect occurrences of the TEC. Specific involvement, of these and any other parties, in the implementation of the plan is outlined in the appropriate recovery actions.

1.11 Evaluation of the plans performance

CALM, in conjunction with the Recovery Team, will evaluate the performance of this IRP. In addition to annual reporting of the recovery team, the plan is to be reviewed within five years of its implementation.

1.12 Historical and current threatening processes

The mound springs in the Three Springs area have been subject to historical disturbance by clearing or conversion to farm water points, alterations to the hydrological system that feeds the mound springs, some disturbance of the native vegetation buffer around the springs by clearing and grazing, and the introduction of weeds. The mound springs are also likely to be subject to future threats, mainly from further hydrological change and possibly inappropriate fire regimes and the introduction of weeds, plant diseases and feral animals.

- **Clearing**

Clearing has been extensive throughout much of the Northern Agricultural areas with 80.3% of the Shire of Three Springs having now been cleared for Agriculture (Shepherd *et. al.* 2002). A number of the mound springs in the Three Springs area have been affected with some being completely cleared and converted to farm dams or partly excavated to provide permanent pools for on farm water use.

- **Hydrological Changes (including salinity and climate change)**

There is mounting evidence that climate change (i.e. lower rainfall) is playing a significant role in the decline in groundwater recharge and levels around Perth (J. Blyth[2] personal communication). Rainfall data have only been collected for the Eneabba area since 1965 and it is not possible to predict long term changes in rainfall for this area. However, a succession of dry winters have been experienced in the Midwest region over the past four years and this may have an impact on the amount of recharge to deeper ground water aquifers like the Parmelia, which could eventually lead to a decline in water levels in this aquifer. Nevertheless, Commander (2000) found that land use changes overshadow the effects of climate variability on deeper groundwater systems. Therefore altered hydrology, due to farming practices in recharge areas, are likely to have a greater effect on the Parmelia formation than climate change in the short to medium term. This is supported by the rising ground water levels reported by Speed (2004) in section 1.4.

If regional rainfall continues to decline the rate of rise in ground water levels will initially decrease and it would probably be a matter of decades before groundwater levels in the Parmelia aquifer started to decline. Thus, over the term of this IRP (and longer) increasing, not declining, water levels are likely to be significant for the biota of the mound springs. The flora and fauna species that are characteristic of the mound springs community are adapted to permanently moist environments and the area of some of the occurrences of the spring community may increase in the short to medium term. However, some or most of the spring species may not be able to cope with longer periods of completely water-logged conditions, if that results from the predicted rising regional water tables, even if the water remains fresh.

The effects of clearing on the hydrology of south-western Australia are well documented with salinity estimated to now affect 1.8 million hectares of the south west (Government of WA, 2000). Significantly increased levels of salinity in the spring waters would be likely to result in the loss of most of the plants and animals currently inhabiting the springs. However, preliminary hydrological investigations show that the water quality of the artesian system maintaining the mounds springs is quite fresh. Thus, although it appears that the volume of water seeping out through the mound springs is increasing, consistent with Commander's view given above, salinity is not currently considered a significant issue for the springs (Speed 2004).

[2] John Blyth, Acting Manager, SCB, CALM

- **Increased weed invasion**

Weeds can have significant impacts on a community through competition with the native species, prevention of regeneration and alteration of fire regimes (Hobbs and Mooney 1993). Disturbances such as fires, nutrient enrichment, grazing and death through disease can predispose areas to weed invasion if weed propagules are present. Weed species have been notes in some areas (eg Occurrence 5) where some weedy grasses and a species of *Solanum* were found. These species are thought to have been introduced as a result of grazing and trampling when this area was used as a stock watering point in the past.

- **Altered fire regimes**

Increase in the frequency of fire can prevent species from completing growth and reproductive cycles, resulting in altered community structure or local extinction of species. Fire can also influence species composition by increasing the number of weeds. Too-frequent fires are a potential concern for all occurrences. Fires are unlikely to be common in the permanently moist habitat of the mound spring but have the potential to burn out the peat mounds themselves if they occur during especially dry periods. Climate change leading to decreased rainfall (as mentioned above) is likely to increase aridity and lead to increased risk of fire. However, the current trend of increasing water levels in the area around the mound springs is likely to counteract this risk, at least in the short to medium term.

- **Disease**

Dieback disease caused by *Phytophthora* spp. plant pathogens is a serious threat as there are high numbers of species likely to be susceptible in and surrounding the TEC (G. Keighery, personal communication[3]). The *Phytophthora* spp. pathogen, which cause the roots to rot and results in death from drought stress, has not been recorded for any of the occurrences of the TEC but are commonly introduced and spread in infected soil, mud and gravel and therefore pose a considerable threat.

- **Introduced animal activity**

Rabbits (*Oryctolagus cuniculus*) occur on all land parcels containing occurrences of the community and may have an impact through increased nutrient levels from their droppings and the introduction of weeds as well as the direct impact of grazing and digging.

- **Access track construction**

Construction of boundary access tracks around the reserves and private property containing occurrences of the TEC has damaged the vegetation surrounding some mound springs and soil has been pushed up into mound spring vegetation near one occurrence. Maintenance of these access tracks causes further damage to the vegetation and has the potential to introduce weeds and disease to these sites.

1.13 Guide for decision-makers

Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of the occurrences require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the ecological community.

1.14 Conservation status

The 'Assemblages of organic mound springs of the Three Springs area' community was assessed in September 2001 as meeting the following criterion for Endangered (EN) ecological communities:

> *B) Current distribution is limited, and:*
> *i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are*

[3] Greg Keighery -Principal Research Scientist, CALM, Woodvale.

likely to result in total destruction throughout its range in the short term future (within approximately 20 years).
ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes.

1.15 Recovery strategy

To design recovery actions for all occurrences, and identify and influence the management of the mound springs themselves and their catchment area, 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 ecology of the community to develop further understanding about the management actions required to maintain or improve its condition.

2 RECOVERY OBJECTIVES AND CRITERIA

2.1 Objective

To maintain or improve the overall condition of the mound spring communities.

2.2 Criteria for success

- An increase in the area of this community under conservation management.
- Maintenance of hydrological and biological processes, taking account of natural changes of the community over time.
- Maintenance of the diversity and composition of native species (both invertebrate and flora species) in the community as defined in appendix 1, taking account of natural changes in the community over time.
- Improvement in the condition of the habitat, in terms of reducing threatening processes as defined in this document.

2.3 Criterion for failure

- Significant loss of area or further modification of the occurrences of the threatened ecological community.

3 RECOVERY ACTIONS

Existing Recovery Actions

The Moora District Threatened Flora Recovery Team (MDTFRT) is the Recovery Team for this community. The Recovery Team membership includes District Nature Conservation staff, local community members, Shire representatives, property owners, Species and Communities Branch (SCB) staff, Regional Herbarium members and botanists with an interest in threatened flora and communities in the Moora District. The Recovery Team reports annually on progress with recovery work to CALM's Corporate Executive.

All known possible occurrences have been surveyed, and no further occurrences have been located.

Negotiations were undertaken to acquire the unvested Shire camping reserve containing occurrence 2. The reserve has now been declared a Class “A” reserve for the purpose of 'Conservation of Flora and Fauna' and was vested in the Conservation Commission in November 2002.

Negotiations were undertaken to acquire a land parcel containing Occurrence 5 for the conservation estate. This property has been purchased by CALM and has been vested as part of the adjacent “A” class reserve.

Future Recovery Actions

The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of the priorities if funding is available for ‘lower’ priorities and other opportunities arise.

1. Coordinate recovery actions

The Moora District Threatened Flora Recovery Team (MDTFRT) will continue to coordinate recovery actions for the Mound Springs (Three Springs area) community and other Declared Rare Flora and communities in their region. They will include information on progress in their annual report to CALM’s Corporate Executive and funding bodies.

Responsibility: SCB and Moora District through the MDTFRT
Estimated Cost: $800 per year
Completion date: Ongoing

2. Survey for additional occurrences and map components of the community and critical habitat

It is a requirement of the EPBC Act that spatial data relating to critical habitat be determined. Although critical habitat is described in Section 1, the areas as described have not yet been mapped and that will be done under this action. Survey for additional occurrences will be carried out at the same time and if any additional occurrences are located, then critical habitat will also be determined and mapped for these locations.

Responsibility: SCB and Moora District through the MDTFRT
Estimated Cost: $3,900 in first year
Completion date: Year 1

3. Monitor the extent and boundaries of the occurrences

The size of each occurrence will be determined, the extent monitored, and their condition determined and compared. The boundary of each occurrence will be monitored regularly and can be determined from current aerial photographs and annual ground-truthing. This information will be added to CALM’s TEC database as recommended in English and Blyth (1999).

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $1,800 per year
Completion date: Ongoing

4. Obtain biological and ecological information on the major components of the community

Research designed to increase understanding of the biology and ecology of the major aquatic invertebrate and flora components of the mound springs will provide a scientific base for the management of the community. Research will include:

1. Documentation of the invertebrate species present across the range of mound springs
2. Investigations of the biology of the invertebrate species present in the community and their requirements for reproduction.
3. Investigations of aquatic species response to changes in salinity and periods of inundation, particularly at different stages of their life-cycles.
4. Study of plant reproductive biology including levels of flower and fruit production, germination requirements, and the role of various factors (disturbance, competition, rainfall and grazing) in recruitment and seedling survival.
5. Investigation of fire history and the recovery of the community from fire.

Responsibility: SCB and Moora District through MDTFRT in liaison with the Science Division
Estimated cost: $40,000 in first year, $35,000 p/a subsequent years
Completion date: On-going.

5. Compile existing hydrological information and monitor existing bores

Preliminary hydrological data have been provided by the WA Department of Agriculture and a set of monitoring bores have been installed on private property adjacent to the mound springs. These bores will continue to be monitored periodically and the results compiled to identify any changes in groundwater levels and quality. Results will also be added to the threatened ecological communities database as recommended in English and Blyth (1999).

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $1,100 per year
Completion date: Ongoing.

6. Design and implement a program to monitor the quality and volume of water within the springs.

A monitoring program will be established to examine the quality and volume of water within the mound springs. This may involve the installation of depth gauges to monitor changes in water depth and periodic sampling and analysis of water quality of individual springs to identify changes between seasons and years. Additional monitoring may also be undertaken at strategic times, for example after large rainfall events. Data collected will then be entered onto a database and analysed. Results will also be added to the threatened ecological communities database as recommended in English and Blyth (1999). This information is essential for determining changes in the community over time and the effects of disturbance events.

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $1,700 in first year to design and set up $3,150 p/a subsequent years to monitor
Completion date: Ongoing.

7. Design and implement an invertebrate monitoring program

An invertebrate monitoring program will be established for all occurrences. Data collected should include invertebrate species located in the mounds and open water areas, and should coincide with water quality monitoring. Occurrences will be monitored regularly to provide information on condition. Data collected will then be entered onto a database and analysed. Results will also be added to the threatened ecological communities database as recommended in English and Blyth (1999). This information is essential for determining changes in the community over time and the effects of disturbance events.

Responsibility: SCB and Moora District through the MDTFRT

Estimated cost: SCB and Moora District to determine cost
Completion date: Ongoing.

8. Design and establish a flora monitoring program

A flora monitoring program will be established for all occurrences. The line intercept method is proposed. This involves installing a transect or a suite of transects. Species present at set intervals along the transect will be recorded. Results will also be added to the threatened ecological communities database as recommended in English and Blyth (1999).

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $11,250 in year one
Completion date: Year one

9. Reassess flora monitoring sites periodically or after disturbance

The flora monitoring sites established under point 5 will be monitored every four years, or following a major disturbance event, such as fire, to provide information on condition, and changes, in the community. Data collected will then be entered onto a database and analysed. Results will also be added to the threatened ecological communities database as recommended in English and Blyth (1999). This information is essential for determining changes in the community over time and the effects of disturbance events.

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $11,250 in fourth year
Completion date: Year four

10. Design weed control strategy

A weed control strategy will be developed that considers the nature of each occurrence and the need for continued maintenance. The weed control program will include:
1. Determining which weeds and native species are present (see recovery action 8).
2. The selection of the appropriate control methods and the setting of priorities for treatment.

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $900 in first year
Completion date: year one

11. Implement weed control strategy

The weed control strategy will be implemented taking into consideration the nature of each occurrence and the need for continued maintenance. The weed control program will include the control of invasive weeds by hand or spot spraying as soon as the weeds emerge.

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $2,100 per year
Completion date: Ongoing

12. Develop a fire management plan

A fire management plan will be developed. The plan will deal with minimising wildfires, the requirements for firebreaks/fire-fighting access tracks, fire management (including the need for and design of prescribed burns), and fire suppression. The plan will include an annual fire monitoring and reporting schedule. A fire-history map of the occurrences will also be developed and updated regularly.

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $1,000 in first year
Completion date: Year one

13. Implement the fire management plan

The fire management plan will be implemented in CALM managed land as part of the Districts annual fire monitoring and reporting schedule. Private landholders will be encouraged to implement the fire management strategy on their property containing occurrences of the TEC.

Responsibility: Moora District through the MDTFRT
Estimated cost: $4,000 per year ($2,000 per reserve area)
Completion date: Ongoing from year two

14. Monitor *Phytophthora* sp. disease and assess the need for disease treatment

If suspected, the presence of dieback disease will be determined through mapping, and collection and testing of suspected soil and plant samples. Priority areas for dieback treatment in the community will be determined using CALM's Dieback Management Guidelines (Department of Conservation and Land Management 1999). Data on dieback presence and impact, and future biodiversity implications, such as the loss or decline of structurally or functionally important taxa, are likely to be important determinants of the priority of treatment of individual occurrences.

Responsibility: SCB and Moora District through the MDTFRT
Estimated Cost: $2,000 for initial assessment
Completion date: Year one

15. Manage *Phytophthora* sp. disease if required

The presence of dieback disease will be determined (see Action 14) and if treatment is required it will be implemented as recommended in the current Dieback Management Guidelines (Department of Conservation and Land Management 1999) for infected areas, commencing with the highest priority areas. The protocol will incorporate results of monitoring from current and future methods of experimental dieback treatments.

If phosphite spraying is undertaken, the dieback front will be mapped accurately using differential GPS, and a photo monitoring point set up. The dieback front will be monitored at least every two years in summer.

Responsibility: SCB and Moora District through the MDTFRT
Estimated Cost: SCB and Moora District to determine cost
Completion date: Ongoing (if required)

16. Control introduced animals

All land parcels containing occurrences of the TEC are impacted by rabbits to some degree. In addition to grazing of the flora, the soil is being disturbed, and this combined with the increased nutrient levels and the presence of weed seed in rabbit droppings is introducing weeds into the habitat. Baiting will be undertaken in and around the habitat as required.

Responsibility: SCB and Moora District through the MDTFRT
Estimated Cost: $1,200 per year
Completion date: Ongoing

17. Liaise with the Shire and private landholders to manage their properties in ways sympathetic to the community.

Liaise with the Shire of Three Springs to ensure that any road maintenance activities or fire break controls do not compromise the conservation values of the community and the reserve, particularly in regard to drainage and potential introduction of weed propagules. Liaise with private landholders to encourage and assist them to manage their properties containing the community, particularly in regard to drainage, feral animal control, fire and stock movement. Liaise with the surrounding landholders/managers to minimise impacts upon the community and the reserve.

Responsibility: SCB and Moora District through the MDTFRT
Cost: $1,100 per year
Completion date: Ongoing.

18. Develop and implement a public awareness program

The importance of biodiversity conservation and the protection of the Mound Springs TEC will be promoted to the public through the local print and electronic media, and poster displays. An A4 sized information sheet, that provides a description of the Mound Springs TEC and information about threats and recovery actions, will also be developed. These promotional materials will be used for school educational activities, displays at local shows, media releases and circulation to landholders and managers who have occurrences of the TEC on their properties. It is hoped that the poster and information sheets will result in increased public awareness that should in turn lead to improved protection of the TEC and perhaps the discovery of new occurrences.

Responsibility: SCB, Moora District and Corporate Relations through the MDTFRT
Estimated cost: $1,500 in first year and $500 per year thereafter
Completion date: Ongoing

19. Review the need for a full Recovery Plan

At the end of the fourth year of its five-year term this Interim Recovery Plan will be reviewed and the need for further recovery actions will be assessed. If the ecological community is still ranked as Endangered at that time a full Recovery Plan may be required.

Responsibility: SCB and Moora District through the MDTFRT
Estimated cost: $17,500 in Year 5
Completion date: Fifth year (if required)

4 TERM OF PLAN

This IRP will operate from December 2004 for 5 years but will remain in force until withdrawn or replaced.

5 REFERENCES

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Appendix 1. Some of the species found in each occurrence of the Mound Springs (Three Springs area)

Flora

Acacia alata var. *tetrantha*
Acacia microbotrya
Acacia pulchella
Acacia saligna
Actinostrobus pyramidalis
Anthocercis ilicifolia subsp. *ilicifolia*
Baumea articulata
Baumea rubiginosa
Baumea vaginalis
Dampiera alata
Drosera gigantea subsp. *gigantea*
Drosera macrantha subsp. *macrantha*
Dryandra stricta
Eucalyptus camaldulensis
Eucalyptus diminuta
Eucalyptus rudis
Gahnia trifida
Hypocalymma angustifolium
Labichea lanceolata
Leptosema aphyllum
Leucopogon allittii
Melaleuca preissiana
Melaleuca viminea subsp. *viminea*
Patersonia occidentalis
Pterostylis vittata
Thomasia formosa

Invertebrates

Ablabesmyia notabilis
Aedes ratcliffei
Aedes sp.
Aeolosoma sp.
Antarcodrilus horwitzi
Archaeosynthemis occidentalis
Bathynella sp.
Bezzia sp.1
Bezzia sp.2
Bezzia sp.3
Candona sp.
Candonopsis sp.
Chironomus alternans aff
Culiseta atra
Culiseta sp.2
Darwinula sp.
Harrisius sp.A
Hydracarina sp.
Liodessus inornatus
Liodessus inornatus
Mesocyclops brooksi
Metacyclops arnaudi
Mixocyclops sp.
Paracyclops chiltoni
Paracyclops timmsi nr
Paralimnophyes pullulus
Paramerina levidensis
Pentaneurini sp. F
Platynectes decempuntatus var. *polygrammus*
Polypedilum convexum nr
Polypedilum nubifer
Pristina longiseta
Scirtidae sp.
Setodes sp.
Tanytarsus bisponosus nr

Appendix 2. Summary of costs for each Recovery Action

Recovery Action	Year 1	Year 2	Year 3	Year 4	Year 5
Coordinate recovery actions	800	800	800	800	800
Survey for additional occurrences and map components of the community and critical habitat	3,900				
Monitor the extent and boundaries of the occurrences	1,800	1,800	1,800	1,800	1,800
Obtain biological and ecological information on the major components of the community	40,000	35,000	35,000	35,000	35,000
Compile existing hydrological information and monitor existing bores	1,100	1,100	1,100	1,100	1,100
Design and implement a program to monitor the quality and volume of water within the springs	1,700	3,150	3,150	3,150	3,150
Design and implement an invertebrate monitoring program	*	*	*	*	*
Design and establish a flora monitoring program	11,250				
Monitor flora quadrats periodically or after disturbance					11,250
Design weed control strategy	900				
Implement weed control strategy		2,100	2,100	2,100	2,100
Develop a fire management strategy	1,000				
Implement the fire management strategy		4,000	4,000	4,000	4,000
Monitor *Phytophthora sp*. disease and assess the need for disease treatment	2,000				
Mange dieback disease if necessary		*	*	*	*
Control introduced animals	1,200	1,200	1,200	1,200	1,200
Liaise with the shire and private landholders	1,100	1,100	1,100	1,100	1,100
Develop and implement a public awareness program	1,500	500	500	500	500
Review the need for a full Recovery Plan					17,500
Total	**68,250**	**50,750**	**50,750**	**50,750**	**79,500**

* Moora District Threatened Flora Recovery Team to determine and seek funds

Totals

Year 1	$68,250
Year2	$50,750
Year 3	$50,750
Year 4	$50,750
Year 5	$79,500
OVERALL TOTAL	**$300,000**