



# Bull Creek Wetlands Management Plan

September 2004



— City of —  
**Melville**

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## Bull Creek Wetlands Management Plan 2004 - 2009

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# Summary

## Bull Creek Wetlands Management Plan 2004 - 2009

The Bull Creek Wetlands straddles the municipal boundary between the City of Melville and the City of Canning, but the focus of this Management Plan is the 20 hectares of bushland within the City of Melville. The Study Area has had several previous management plans, however the last Management Plan was released in 1995 and now needs to be reviewed and updated. The 2004 Management Plan incorporates information from previous management plans, and new information gathered from site visits, stakeholder consultation and public workshops.

In spite of rehabilitation efforts within the Wetland, by the City of Melville and the community, 12.7 hectares (64%) of the site remains in *Poor* to *Very Poor* condition. This reflects the extent and intensity of disturbance that has occurred onsite over a considerable time period. Regardless of this, the site remains of regional significance as bushland (which is recognised in its listing as a *Bush Forever* Site) and as a biological filter for stormwater entering the Swan-Canning Estuary.

The site retains key elements of riverine and estuarine vegetation, as well as the Bassendean Vegetation Complex that naturally occurs on the site. This combination of elements is uncommon in the bushland reserves within the City of Melville and accounts for the diversity in flora (137 native and 72 introduced species) and the occurrence of uncommon species (such as *Albizia* which is associated with rivers).

Forty-one recommendations were made for the Bull Creek Wetlands. These are listed in the table below and are based on fulfilling the principal management objectives for Bull Creek Reserve, which are to:

- ensure the long-term conservation of the remnant bushland, develop wildlife corridors and significant habitat;
- monitor and examine water quality, impacts and ways in which to maintain good water quality and prevent potential contamination of the water entering the system over the long term;
- undertake effective liaison between the City of Melville and community regarding the appropriate environmental management for the area in balance with the area's recreation objectives;
- restore and rehabilitate riparian and bushland communities to ensure the long-term viability of existing flora and fauna;
- educate local residents and the wider community in relation to arson and promote reserve protection; and
- establish a baseline environment data set and overall vegetation inventory for the City of Melville.

### Summary of Recommendations for Study Area

NB Works implemented will be determined by budget availability.  
All costs are estimates only.

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
1.1	Continue monitoring water quality parameters, using standardised measurements and noting significant findings.	High	2004	on	CoM / consultant	\$2,000 / annum
1.2	Share water quality results, and seek cooperative management, with the Swan River Trust.	Medium	2004	on	CoM / SRT	N/A
1.3	Investigate significant aberrations in water quality parameters, if and when they occur, through further sampling	High	2004	2004	CoM / consultant	\$3,000 - \$5,000
1.4	Continue to investigate and implement streamlining options for stormwater drainage within the study area	High	2004	2009	CoM / Community Groups / SRT / Water Corp / DoE	\$10,000 / annum
1.5	Investigate the feasibility of bank reshaping and realignment at the drainage line originating from Richard Lewis Park where it runs through Bateman Park	Low	2008	2009	CoM / Water Corp / SRT / DoE	\$2,000
1.6	Seek funding to plan and carry out water quality improvements from Rivercare and the Swan-Canning Cleanup Program	Medium	2004	on	CoM / Community Groups / SRT	N/A
2.1	Undertake ongoing prioritised weed control using the strategies outlined in this management plan.	High	2004	2009	CoM, interest groups, DMR	see Section 8 <sup>1</sup>
2.2	Remove inappropriate amenity plantings according to invasiveness and replace with local native amenity plants	Medium	2005	2006	CoM	\$2,000
2.3	Undertake monitoring to determine the effectiveness of rehabilitation strategies using Bushland Condition Mapping	Medium	2009	2009	CoM / consultant	\$2,000
2.4	Establish monitoring quadrats to determine the effectiveness of rehabilitation strategies.	Medium	2004	2004	CoM / community groups / consultant	\$1,000

<sup>1</sup> Costs for weed control vary considerably depending on community involvement, conditions etc. It is therefore difficult to provide an estimate of cost, however as a general guide, a single application of Glyphosate should be calculated at 10c / m<sup>2</sup>, and a single application of Fusilade should be calculated at 30c / m<sup>2</sup>. Rehabilitation estimates given in Section 8.0 include the cost of weed control and plant establishment.

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
2.5	Assess rehabilitation success using monitoring quadrats	Medium	2008	2009	CoM / community groups / consultant	\$2,000
2.5	Undertake a targeted flora search for <i>Caladenia huegelii</i> and if found focus weed control efforts in its habitat.	Low	2008	2008	CoM	\$1,500
3.1	Continue to concentrate intensive rehabilitation efforts in the High Priority Areas shown in Map 3	High	2004	on	CoM, community groups, Schools	(see recc. 4.2)
3.2	Revegetate either side of the timber bridge adjacent to Karel Avenue with groundcovers such as <i>Hemiandra Pungens</i> to suppress Veld Grass, which present a fire hazard to the structure;	Medium	2005	2008	CoM, community groups, Schools	\$5,500 <sup>2</sup>
3.3	Continue revegetation in the north-east of Richard Lewis Park	Medium	2004	2006	CoM, Lions Club	\$3,000 / annum <sup>3</sup>
3.4	Remove Geraldton Wax from the eastern end of Rossmoyne High School	Medium	2007	2007	CoM, Rossmoyne High School	\$1,000
3.5	Investigate the replacement of the exotic trees on the outside of the fence on the northern boundary of the All Saints' Oval with local species and/or the construction of path linking Bull Creek Park to Reg Bourke Reserve along this alignment	Low	2009	2009	CoM, Community Groups and schools	\$2,000
3.6	Foster the formation of a volunteer 'Friends' network (to assist in the management of the wetlands) through provision of coordination and logistical support.	Medium	2004	ongoing	CoM	N/A
4.1	Prioritise rehabilitation works based on Maps 2 and 3.	High	2004	2004	CoM	N/A.
4.2	Revegetation should be undertaken using the guiding principles outlined in this management plan.	High	2004	on	CoM, Community groups, schools, organisations	\$14,000 / annum <sup>4</sup>
4.3	Utilise and add to the City of Melville's Native Seed Bank using material from the Bull Creek Wetlands.	Medium	2005	on	CoM, Community groups, schools, organisations	\$1,000 / annum
5.1	Include the Bull Creek Wetlands into the City of Melville's <i>Restricted Areas Register</i> to ensure dogs are kept on leashes.	Medium	2004	2004	CoM	N/A.

<sup>2</sup> Estimated 10 m on either side of bridge @ \$5.00 / m<sup>2</sup>.

<sup>3</sup> Based on cost of rehabilitation after 3<sup>rd</sup> year of rehabilitation (\$0.50 / m<sup>2</sup>)

<sup>4</sup> This is based on \$700 per hectare per annum average expenditure on revegetation within the City of Melville.

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
5.2	Erect signage at strategic path intersections to notify the public that dogs must be on leads and keep to pathways	Medium	2005	2005	CoM	\$2,000 <sup>5</sup>
5.3	Undertake public awareness campaign to encourage local residents to keep their cats indoors at night.	Low	2006	2008	CoM	\$500
5.4	Investigate and implement control, if feasible, of Speckled Mosquito Fish.	High	2005	2005	CoM, Tertiary Institutions	\$2,000
5.5	Monitor Speckled Mosquito Fish population.	High	2006	2009	CoM, Tertiary Institutions, Fisheries Dept	\$3,000
5.6	Continue to liaise with Murdoch University with regards to the presence of <i>Petalura hesperia</i>	Medium	2005	2009	CoM, Murdoch Uni	\$3,000
6.1	Implement relevant recommendations of the City of Melville Bushfire Management Strategy in the Bull Creek Wetlands.	High	2004	2009	CoM, FESA, Local fire brigades	N/A
6.2	Undertake fuel reduction activities through the control of grassy weeds and Bracken ( <i>Pteridium esculentum</i> ) according to the guidelines in this management plan.	High	2004	2009	CoM	\$3,000 / annum
6.3	Undertake community education in the form of interpretive signage and / or pamphlet drops at the onset of summer.	Medium	2004	2009	CoM	\$500 <sup>6</sup>
6.4	Establish a database of bushfires in the City of Melville linked to the city's GIS.	High	2004	2005	CoM	N/A.
7.1	Maintain hygiene protocols for Council operations within bushland	High	2005	2006	CoM	N/A
7.2	Monitor bushland for signs of plant pathogens and map occurrences.	Medium	2004	2009	CoM	\$1,000
8.1	The bridge linking Bateman Park to Thomas Middleton Park should be rebuilt and linked into a Dual Use Path on the Spinaway Crescent side of the creek;	Medium	2007	2008	CoM	\$45,000
8.2	Upgrade limestone tracks to Bitumen in Bull Creek Reserve	Low	2009	2009	CoM	\$36,000 <sup>7</sup>
8.4	Rationalise existing signs and erect interpretive signage in strategic locations outlined in text	Medium	2005	2005	CoM / Rossmoyne / All Saints	\$1,500 <sup>8</sup>
8.5	Repair existing interpretive shelter at south end of Bull Creek Park	High	2004	2004	CoM	\$250
8.6	Install subheading sign to reserve entry statements	High	2004	2004	CoM	\$2,000 <sup>9</sup>

<sup>5</sup> calculated at \$250 / sign

<sup>6</sup> This cost refers to the pamphlet drops only. Interpretive signage costs are included in Section 7.8.

<sup>7</sup> 740 m of path @ \$120 / m

<sup>8</sup> 3 signs @ \$500 each

<sup>9</sup> 4 signs @ \$500 each

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
8.7	Install map advisory signage near entry points to the Wetlands	Medium	2006	2006	CoM	\$1,500
8.8	Install seats near interpretive signage locations	Low	2009	2009	CoM	\$3,000 <sup>10</sup>
8.9	Install picnic table at small park on southern end of Bull Creek Park	Low	2008	2008	CoM	\$1,000

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<sup>10</sup> 3 seats @ \$1,000 each

# 1.0 Introduction

## Bull Creek Wetlands Management Plan 2004 - 2009

### 1.1 General Introduction

The Bull Creek Wetlands comprises 20 ha of bushland located within the City of Melville and the City of Canning. The Wetland is one of a very limited number of naturally vegetated areas on the Canning Estuary and has particular conservation significance as it provides habitat and linkages for fauna (Government of Western Australia, 2000), as well as serving other important functions including stormwater filtration prior to it entering the Canning River, and providing an important conservation reserve for the suburbs of Rossmoyne and Bullcreek. The location of the study area is shown in yellow in Figure 1.1.



**Figure 1.1 Study Area**

The Bull Creek Wetlands are reserved for Parks and Recreation and has important regional conservation value. It is listed in Bush Forever (Site 338) and is also protected under the Commonwealth EPBC Act, 1999 (Government of Western Australia, 2000). The Swan-Canning Estuary, of which the Bull Creek is part of, is listed in the Directory of Important Wetlands in Australia which has national significance.

The area is vulnerable to a number of threatening processes, particularly impacts derived from adjacent land uses. Intensive surrounding residential development, frequent fires, weed invasion, unmanaged recreation and vegetation fragmentation is causing degradation of the Bull Creek Wetlands and its associated reserves.

The City of Melville has recommended that an Environmental Management Plan be undertaken for Bull Creek Reserve to address the issues of degradation and enable the sustainable management of the reserve.

## 1.2 Principal Management Objectives

The principal management objectives for Bull Creek Reserve are to:

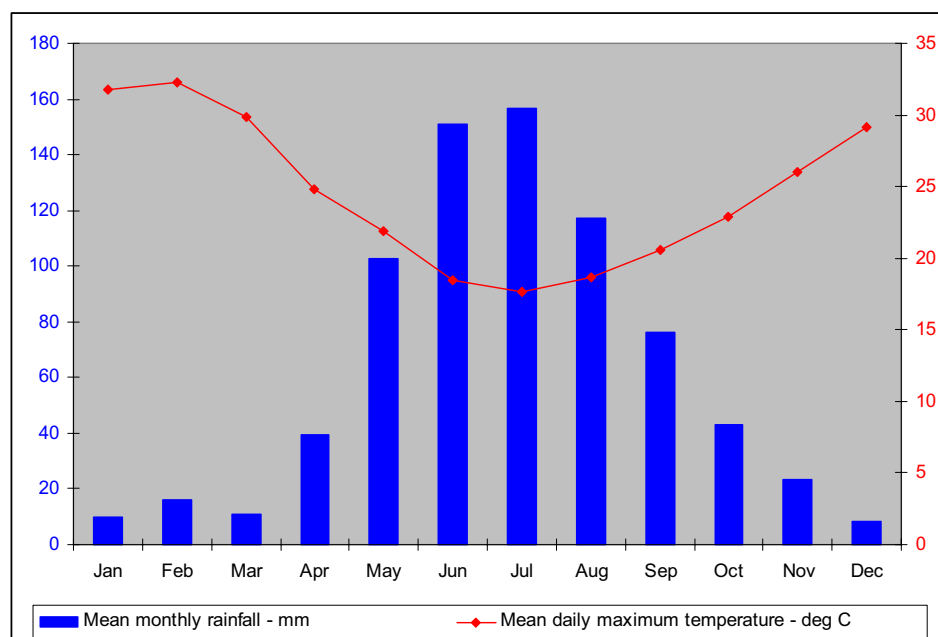
- ensure the long-term conservation of the remnant bushland, develop wildlife corridors and significant habitat;
- monitor and examine water quality, impacts and ways in which to maintain good water quality and prevent potential contamination of the water entering the system over the long term;
- undertake effective liaison between the City of Melville and community regarding the appropriate environmental management for the area in balance with the area's recreation objectives;
- restore and rehabilitate riparian and bushland communities to ensure the long-term viability of existing flora and fauna;
- educate local residents and the wider community in relation to arson and promote reserve protection; and
- establish a baseline environment data set and overall vegetation inventory for the City of Melville.

## 2.0 Biophysical Environment

### Bull Creek Wetlands Management Plan 2004 - 2009

## 2.1 Climate

The City of Melville has a Mediterranean climate. Rainfall averages 870 mm per annum with the majority of precipitation occurring between May and October. Figure 2.1 shows the mean rainfall and daily maximum temperature for Bentley, the closest weather station to the City of Melville.



**Figure 2.1 Melville Climate (Bentley Weather Station)**

There is an average rainfall of 869mm, most of which occurs between April and October. The maximum rainfall is recorded in the month of June, with 186.8mm. The mean maximum temperatures range from 31.8°C in February to a mild 17.7°C in July, while mean minimum temperatures range from 17.4°C in February to 8.1°C in July.

## 2.2 Geomorphology and Soils

Perth is located on the Swan Coastal Plain, which comprises a series of dunes running parallel to the coast. The dune systems closest to the coastline (Quindalup Dunes) are the youngest dunes and they become progressively older further inland (Spearwood and Bassendean)

The Bull Creek Wetlands are situated within the Bassendean Dune System which is the oldest series of dunes on the Swan Coastal Plain and consists of poorly sorted, fine – medium grained quartz sand (Biggs, *et al.*, 1980).

## 2.3 Hydrology

The groundwater is less than two metres from the surface throughout the study area and may meet the surface in Richard Lewis Park and along the Bull Creek Drain Line during winter wet periods (Bull Creek Wetlands Working Group, 1995). A steep groundwater gradient exists in this area rising 1 m approximately every 50 m from Bull Creek southwards, and rising from 1 m AHD to 16 m AHD at the Bull Creek Drive/Gleddon Rd intersection (Water and Rivers Commission, 1997).

The Bull Creek Wetlands drain into Bull Creek, a backwater of the Canning River. The stormwater drains that feed into Bull Creek are associated with the suburbs of Bull Creek, Leeming, Willetton, Bateman and Kardinya and the catchments cover an area of approximately 1070 hectares (Bull Creek Wetlands Working Group, 1995). Stormwater catchments are shown in Figure 2.1.

The following drains feed into Bull Creek.

- Bull Creek Main Drain flows all year round and drains stormwater and local groundwater;
- Mandala Crescent Branch Drain flows in response to rainfall;
- Brentwood Main Drain flows in response to rainfall and when flood control pumps at Frederick Baldwin Lake and Kingston Place, Kardinya are in operation.

Monitoring of surface water quality has been undertaken by the City of Melville, since the late 1970's. Over time the precision and accuracy of monitoring has increased and long-term data is available. Results of consistent monitoring in the Bull Creek Wetlands are shown in Appendix 5.

## 2.4 Vegetation

### 2.4.1 Vegetation Complexes

Vegetation complexes broadly describe the structural formations of the vegetation based on the life-form, height and foliage cover of the tallest stratum (Heddle, *et al.*, 1980). Vegetation complexes in the Perth Region have been mapped at a scale of 1:250 000 (which is appropriate for management at a regional scale) by Heddle, *et al.* (1980).

The vegetation complex described for the Bull Creek Wetlands is the Bassendean Complex – Central and South (Government of Western Australia, 2000). This complex ranges from woodlands of *Eucalyptus marginata* / *Allocasuarina* species / *Banksia* species on sand dunes to low woodlands of *Melaleuca* species and sedgelands in low lying depressions and swamps (Heddle, *et al.*, 1980)

The Bassendean Central and South Complex is regionally significant as there is only 27% remaining of the estimated pre-European extent {below the 30% nationally agreed target for minimum conservation of ecological communities as outlined in the *National Objectives and Targets of Biodiversity Conservation 2001-2005* (Commonwealth of Australia, 2001)}. Moreover just 0.7% (527 ha) of this vegetation type is in secure reserves {below the 15% recommended level protected under a comprehensive, adequate and representative reserve

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system (JANIS, 1997)}. The Bull Creek Wetlands contribute to 0.02% of the estimated pre-European extent of this vegetation complex.

### 2.4.2 Floristic Community Types

Floristic Community Types (FCT's) classify vegetation according to the species composition. Two FCT's have been inferred for the Bull Creek Wetlands (Government of Western Australia, 2000):

- FCT 16 *Highly Seasonal Saline Wetlands*
- FCT S7 *Northern Woodlands to Forests over Tall Sedgelands alongside Permanent Wetlands.*

### 2.4.3 Vegetation communities

The vegetation in the study area has been modified to varying degrees by fire, clearing and weed invasion. This is illustrated by the changes which have occurred at Richard Lewis Park since 1945 (Maps 6a-6e).

Vegetation communities were classified on the basis of structure (height and density) and floristics (species composition). The 1995 Management Plan mapped the vegetation on the basis of level of disturbance as well as structure and floristics. In this update of the Plan, disturbance has been mapped separately (as Bushland Condition) from vegetation communities to facilitate the development of performance indicators and simplify management strategies.

The structure of the vegetation within the study area can change between management plans due to the influence of fire. For example there can be a dramatic reduction in vegetation height after fire but species such as *Albizia* (*Paraserianthes lophantha*), which is killed by fire, can also rapidly grow from a seedling up to 7 m in 4 years (Powell, 1990). The vegetation community have been mapped as if no fires had recently occurred to avoid the need to change the vegetation map with each review of the management plan and allows the direct comparison of sites without reference to time since fire.

The floristics of the study area has generally been heavily modified by the introduction of weeds and loss of native species. Some of the variation in native species composition reflects loss of species rather than changes in vegetation types that would have existed in pre-European times. The bushland on Richard Lewis Park has regenerated on a site that was largely cleared in 1945 and Smith (1984) suggests that the noticeable absence of *Banksias* at this site was due to commercial tree felling of *Banksias* for firewood. Smith (1984) also noted that the construction of Leach Hwy appears to have altered the hydrology of the site, which in turn would have altered the vegetation onsite.

## 2.5 Flora

There are 137 native and 73 introduced species recorded within the study area. This should include most of the species present as the 49 native taxa and 48 exotic taxa recorded for the adjacent wetland in the *Yagan Wetland Reserve Draft Management Plan* (Brooker, 1995) was considered to include more than 90% of the expected flora (Government of Western Australia, 2000).

The flora indigenous to the site is listed in Appendix 1 and the weeds are listed in Appendix 2. The species inventory has been compiled from all the preceding management plans for the Bull Creek Wetlands (Smith, 1984, Smith, 1987 Bull Creek Wetlands Working Group 1995) and field surveys undertaken as part of this study.

A number of species previously recorded have had name changes since the previous reports were written and the appropriate nomenclatural changes have been made in incorporating them into the current plan.

All species were included unless significant doubt regarding the identification resulted from an examination of plant distributions or other considerations. The omissions were:

- *Daviesia benthamii* (syn. *Daviesia aphylla*) recorded by Smith (1987) which tends to occur more inland – this may be a misidentification of *Daviesia divaricata* or *Daviesia physodes*; and
- *Juncus holoschoenus* recorded by Smith (1984) tends to occur further south. This may be a misidentification of *Juncus articulatus*, an introduced species; and
- Grand Spider Orchid (*Caladenia huegelii*). This is a Declared Rare species that occurs from Perth to Yallingup in deep sands in mixed Jarrah/Banksia woodland, was recorded as being present at the site by Smith (1987) but has not been included in the species inventory for the site as there have been changes to the taxonomy since that time resulting in the description of a new species *Caladenia paludosa* (Hoffman and Brown, 1992). Moreover a search of *FloraBase*, the CALM's online flora database, found no registered occurrences of *C. huegelii* in the vicinity of the Bull Creek Wetlands. A targeted survey during flowering between September and October would be required to confirm the presence of *C. huegelii*.

### 2.5.1 Significant Species

#### Declared Rare and Priority Flora

*Cartonema philydroides* was listed as a Priority 3 species in the 1995 Management Plan. Since this time the conservation status of the species has been reviewed and is no longer considered threatened and has therefore been delisted as a Priority species. On this basis it is not the subject of specific management strategies within this Management Plan.

#### Locally Uncommon Species

Albizia (*Paraserianthes lophantha*), Swamp Peppermint (*Agonis linearifolia*), Jointed Rush (*Baumea articulata*) and Bullrush (*Typha domingensis*) are uncommon along the Swan-Canning River System (Bull Creek Wetlands Working Group, 1995). These species, with the exception of the Bullrush, are conspicuous elements of the Bull Creek wetland system.

## 2.6 Bushland Condition

Bushland condition is a measure of the degree to which vegetation has been degraded and is based on the proportion weeds and the amount of change in structure (i.e. height and density of vegetation layers). An understanding of the natural structure is required to determine whether the structure has been changed.

The bushland condition in the study area has been assessed using the criteria and the extent of each class within the Bull Creek Wetland is shown in Table 2.1.

**Table 2.1 Bushland Condition within the Study Area (Kaesehagen, 1995)**

Condition Rating	Criteria	Extent (hectares)
Very Good – Excellent	<ul style="list-style-type: none"> <li>80 – 100% Native Flora composition</li> <li>Vegetation structure intact or nearly so</li> <li>Cover/abundance of weeds less than 5%</li> <li>Minor signs of disturbance</li> </ul>	1.94
Fair – Good	<ul style="list-style-type: none"> <li>50 – 80% Native Flora composition</li> <li>Vegetation structure modified or nearly so</li> <li>Cover/abundance of weeds 5 – 20%</li> <li>Disturbance influence moderate</li> </ul>	5.25
Poor	<ul style="list-style-type: none"> <li>20 – 50% Native Flora composition</li> <li>Vegetation structure completely modified</li> <li>Cover/abundance of weeds 20 – 60%</li> <li>Disturbance incidence high</li> </ul>	3.83
Very Poor	<ul style="list-style-type: none"> <li>0 – 20% Native Flora composition</li> <li>Vegetation structure disappeared</li> <li>Cover/abundance of weeds 60 – 100%</li> <li>Disturbance incidence very high</li> </ul>	8.85

The bushland condition for vegetation within the Bull Creek Wetlands is shown in Map 2. This map can be used as a tool for determining restoration strategies, as it expresses the impacts of disturbance factors that cause changes to vegetation structure, floristic composition and weed invasion.

## 2.7 Fauna and Fauna Habitat

Fauna recorded in the study area are listed in Appendix 3. Native species of significance are described below.

### 2.7.1 Native Species of Significance

#### Bandicoots or Quendas (*Isodon obesulus*)

There is anecdotal evidence that Bandicoots or Quendas (*Isodon obesulus*) are present in the study area.

Quendas are mammals that are similar in appearance to rats but are approximately the same size as rabbits. They can live in close proximity to humans but they have distinct territories and their preferred habitat is where the understorey is dense, particularly near

watercourses and wetlands. Their diet consists largely of bulbs and invertebrates such as insect larvae and earthworms. Dawn and dusk are the best time for seeing them, but they also leave evidence of their presence with conical diggings. (Johnson & Thomas-Dans, 2003).

Quendas are opportunistic feeders and are non-habitat specific, therefore it is possible that they occur in the Bull Creek Wetlands. They are very vulnerable to predation by foxes and cats, and can be outcompeted for food and habitat by rabbits. Bushland areas can be managed for quendas by maintaining dense vegetation to provide cover from predators (J. Dell *pers. comm.*).

**Water-Rat (*Hydromys chrysogaster*)**

Water-Rats or Rakali (*Hydromys chrysogaster*) occasionally inhabit lakes, streams or rivers in the metropolitan area (Johnson & Thomas-Dans, 2003), however they have not been recorded as being present at the site, and they are generally found further upstream in the tributaries and streams of the Canning River (J. Dell *pers. comm.*).

Water-Rats have dense fur, rounded muzzles, short, rounded ears, and partially webbed back feet. They are black to dark grey on the back and cream to orange underneath. The tail is usually black with a white tip. (Johnson & Thomas-Dans, 2003)

Their presence can be detected by feeding platforms. These are usually flat rocks or fallen trunks on which the remains of meals (consisting of gilgies, large aquatic insects, mussels, birds and fish) are left. They live in nests dug into river banks with underwater entrances (J. Dell *pers. comm.*), or sometimes in hollow logs. (Johnson & Thomas-Dans, 2003).

Due to declining numbers their status is being monitored and reviewed (Johnson & Thomas-Dans, 2003).

**Western Petalura Dragonfly (*Petalura hesperia*)**

The Western Petalura Dragonfly is the largest species of dragonfly in Western Australia with a wingspan of 10 cm and body length of 13 cm. The species has been recorded at 19 localities, one of which is Bull Creek. (Barrett & Williams, 1998)

Barrett & Williams (1998) suggest that the habitat requirements of the species appear to be a major contributing factor to the rarity of the species and state that:

*'Petalura hesperia is restricted to boggy marshes or seepages beside freshly oxygenated water sources. Sites with extensive under- and overstorey vegetation appears to be essential, perhaps to maintain moist soils and to provide roots and peripheral vegetation to burrow among.'*

The species was detected at three sub-sites at Bull Creek (Reserves 32563, 29130 and 30646). The survey dates and number of individuals recorded are shown in Table 2.2.

**Table 2.2 Number of Western *Petalura* Dragonfly Recorded Onsite**

Year of Survey	Number of individuals
1957	28
1965/66	19
1970/71	2
1991	1
1994	2
1995	1

Although there have been no subsequent records, detecting and estimating populations for the Western *Petalura* Dragonfly is difficult. This is due to the following factors referred to by Barrett & Williams (1998):

- Larval habitats are small, localised and scattered;
- The species is associated with dense understorey;
- The most reliable indicator, exuviae (layers of skin or cuticle shed by animals), is difficult to locate;
- The adults can only be effectively surveyed during the short annual flight period which can occur between October and February but usually in December and early January.

It is also worth noting that the larval period is thought to be between 5 and 6 years. This means the even if all adults were eliminated from the site mature individuals could still emerge from the larval stage after this period of time.

Of the nineteen populations one is now extinct and four are under threat from urbanisation. Barrett & Williams (1998) suggested that isolated populations such as the one at Bull Creek be given priority for conservation as it is likely to represent an important of genetic diversity within the species.

## 2.7.2 Introduced Species

### **Rabbits (*Oryctolagus cuniculus*)**

Rabbits were seen in Richard Lewis Park during the field survey and are undoubtedly widespread within the study area. Rabbits threaten native plants, particularly juvenile plants, through grazing. Rabbits also outcompete many native animals

### **Foxes (*Vulpes vulpes*)**

There is anecdotal evidence that Foxes are present in the study area. Foxes and cats exact a heavy toll on native animals in the 35g – 8 kg weight range (CALM, 1996) and pose a direct threat to mammals, reptiles and birds within the Bull Creek Wetlands.

### **Speckled Mosquito Fish or One Spot Livebearer (*Phallocerus caudimaculatus*)**

During sweep netting undertaken by Wild (2002) at Bull Creek large numbers of Speckled Mosquito Fish or One Spot Livebearer (*Phallocerus caudimaculatus*) were captured. This was only the second location where this potentially harmful aquarium species from South American, had been recorded in the wild in Western Australia. This fish is a declared *Class 2* Noxious Fish under the NSW Fisheries Management Act ,1994, and Bull Creek is one of the few sites it has been recorded across Australia. (Wild, 2002, NSW Fisheries, 2004)

The Speckled Mosquito Fish is a popular aquarium fish around the world as they are brightly coloured, hardy and relatively easy to breed. The males have distinctive irregular black speckling and grow to 2.5 cm in length. Females grow to 6 cm. They give birth to live young and produce broods of up to 80-100 offspring. They are similar in size and shape to the related Mosquito Fish (*Gambusia holbrooki*) but are more yellow. *Gambusia holbrooki* is a well established, major environmental pest in Australia. (NSW Fisheries, 2004)

Competition with, and predation by, the omnivorous Speckled Mosquito Fish (*Phallocerus caudimaculatus*) is likely to be impacting upon the fauna at Bull Creek given it belongs to the Poeciliidae family which generally are considered to be highly invasive (Wild, 2002). The closely related Mosquito Fish (*Gambusia holbrooki*) has been implicated in the decline of a number of native fishes and frogs, including some threatened species through predation, competition for food and habitat, direct aggression and the introduction of parasites (NSW Fisheries, 2004). This fish has the potential to pose a serious threat to biodiversity.



**Plate 2.2 The Speckled Mosquito Fish (*Phallocerus caudimaculatus*)**

(Source Jodi Rowley Photo on NSW Fisheries Website)

### **Dogs**

Unrestrained dogs can have an impact on the natural environment as well as posing danger or distress to other recreational users. Dog faeces pose a hazard to health and must be removed by the dog owners under council by-laws. There is little scope for dog-exercising areas within the study area due to potential conflicts between other users and threats to natural areas.

### **Other species**

It is also likely that Cats (*Felis catus*), Black Rats (*Rattus rattus*) and House Mice (*Mus domesticus*) are also present in the study area.

## 3.0 Social Environment

### Bull Creek Wetlands Management Plan 2004 - 2009

### 3.1 European History of Bull Creek

Henry Bull, seeing the potential for a river port and a farm with two fresh water streams, was one of the first Europeans to settle beside the inlet which now bears his name. (Cooper and McDonald, 1989).

In April 1830 Henry Bull was allocated Canning Location 26 and by the end of the year the inlet was being referred to as 'Bull's Creek'. John Adams settled on the adjacent Canning Location 27 in May of the same year and quickly established a house, stores, boatshed and planted a garden, vines and fruit trees. Adams and Bull jointly constructed a jetty which they hoped would emerge as a river port. (Cooper and McDonald, 1989)

Thomas Middleton developed Location 28, and despite moving the family to Perth and unsuccessfully seeking tenants, his family continued farming the site until the late 1860s. The port at Bull Creek never developed as agricultural development in the district was tentative and sporadic. The settlement eventually was abandoned in the face of ongoing Aboriginal hostilities. (Cooper and McDonald, 1989)

Location 27 was bought by veterinarian Robert Weir in 1902. Charles Purdie purchased Location 26 in 1903 and farmed it until 1927 when it was consolidated into Weir's property.

The suburban development of the area was relatively late as road construction concentrated in the western portion of Melville (Cooper and McDonald, 1989) and the suburbs of Bull Creek, Willetton and Rossmoyne were not developed until the 1960s and 1970s (Bull Creek Wetlands Working Group, 1995).

The names of the Reserves within the Bull Creek Wetlands refer to those who contributed to the settling of the area:

- Richard Lewis was a long serving Melville Councillor;
- Reg Bourke was a member of the Melville Roads Board members from 1931-1932; and
- Henry Bull, original settler of Melville

### 3.2 Aboriginal Heritage

The Bull Creek area is significant to the Beeliam Aborigines as a traditional source of food during summer months (Bull Creek Wetlands Working Group, 1995).

Tensions existed between the European settlers and the local Aborigines from the early days of co-occupation. Shortly after initial settlement in the Bull Creek area, in October 1830, Aborigines wounded John Phillips, burnt down John Adams house and drove off 40 of Adams' sheep (Cooper and McDonald, 1989).

The chief of Beeliam at that time was Midgegooroo. His son, Yagan, has an important place in history. Yagan developed a friendship with Henry Bull and became known and respected for his advocacy of peace.

However in 1833 Yagan was amongst a group of Aborigines who avenged the death of his brother Domjum by killing two settlers. Yagan evaded capture for several months but was shot the same year by William Keats, one of Henry Bull's workers. Keats in turn was speared to death. Yagan's head was smoked and taken to England for display (Bull Creek Wetlands Working Group, 1995). In July, 2003 Yagan's remains were formally handed back by the Liverpool City Museum.

The public disclosure of explicit details for Aboriginal Sites is not permitted under the general licensing agreement for access to the Aboriginal Sites Register but it can be confirmed that there is one Registered Aboriginal Site in the study area, Site Number S00195, and there is another in the immediate vicinity, Site Number S00765.

### **3.3 Current Social Environment**

The Bull Creek Wetlands are located within an urban setting but are surrounded and bisected by a variety of land uses and natural features, including:

- schools (Rossmoyne Senior High School and All Saints College)
- residential housing;
- a Western Power electricity substation;
- a Water Corporation water pumping station;
- Leach Highway; and
- The Swan-Canning Estuary.

During public consultation it was suggested that the largest number of people who access the bushland were high school students, although residents of the Royal Australian Air Force Association Retirement Village on Bull Creek Drive frequently use the path around Richard Lewis Park.

## 4.0 Stakeholder Consultation

### Bull Creek Wetlands Management Plan 2004 - 2009

A meeting for the community and stakeholders was held at Piney Lakes Environmental Centre at 6.30pm on February 25, 2004. The meeting was open to the public and was advertised in *The Melville City Times* on January 27 and February 17, 2004.

The attendees of the meeting were:

Rob Davies	Lions Club
Kent Williams	All Saints College
Sandra Swain	Rossmoyne Senior High School
Mike Casley	Rossmoyne Senior High School
Don Phillips	Friends of Wireless Hill
Gemma George	Local Resident
Russell Aubrey	City of Melville - Councillor
Jackie Stansfield	City of Melville - Environmental Officer
Ian Davis	City of Melville - Env. Programmes Manager
Abe Francis	Ecoscope
Andrew Waters	Ecoscope

The key values of the Bull Creek Wetlands were perceived as:

- a greenbelt providing a bushland experience in an urban setting;
- a small area in which there is a diversity of vegetation;
- an education opportunity that is tangible rather than theoretical;
- an opportunity for individuals to contribute to their community through involvement in management;
- as an important component of the Swan-Canning Estuary;
- an opportunity for walking for local residents; and
- fauna habitat, in particular bird habitat.

The key threats to the Bull Creek Wetlands were perceived as:

- weeds;
- fire;
- feral animals;
- vehicles been driven off road; and
- antisocial behaviour.

The visions for the Bull Creek Wetlands were:

- the maintenance of the green space the reserves provide;
- the maintenance and enhancement of the biological assets;
- a raised profile amongst surrounding residents;
- co-operative community involvement in management;
- An single identity for the Bull Creek Wetlands based on it being an integrated biological system rather than a series of nearby reserves; and

- a pathway providing a bushland experience in the urban environment and link the different reserves that make up the Bull Creek Wetlands together.

With regards to increasing the profile of the Bull Creek Wetlands it was concluded that this should not be at a regional scale due to concerns about the capacity of the system to cope with large visitation volumes.

In addition the following relevant points were also raised:

- Whilst the Bull Creek Wetlands are an integrated system, particular stakeholders had interests in particular portions of the study area. The two adjacent schools were most interested in Bull Creek itself and the Lions Club most interested in memorial trees in Richard Lewis Park;
- Community involvement, in particular from the schools and the Lions Club, has been ongoing in terms of activities such as growing seedlings, planting trees, weeding and water quality monitoring for more than 10 years.

## 5.0 Management Framework

### Bull Creek Wetlands Management Plan 2004 - 2009

#### 5.1 Introduction

The City of Melville manages approximately 247 hectares of bushland within 24 reserves ranging in size from 0.38 hectares to 61 hectares. The values of the individual remnants vary with their size, condition, vegetation type, and context in terms of connection with other areas of bushland and public. As a reflection of the values of remnants and community expectations these remnants are managed for a range of purposes, including passive recreation, visual amenity, education, and the conservation of flora and fauna.

Given the numerous factors that need to be considered in managing bushland, management plans need to be integrated with other management initiatives, relevant documents, guidelines and policies. Brief outlines of the documents relevant to this management plan are given below.

#### 5.2 Previous Management Plans

##### *Bull Creek Wetlands Management Plan*

(City of Melville, 1995)

The aims of the study were:

- to produce a management plan which addresses all issues associated with the development, conservation and management of the Bull Creek Wetlands; and
- to develop networking relationships between the community and key professionals in innovative processes and strategies designed to enhance the heritage and environmental integrity of the Bull Creek Wetlands.

53 recommendations were made, of which 37 recommendations are being implemented or involve on-going works. The 1995 Management Plan will be superseded by the 2004 Management Plan.

##### *Bull Creek Management Plan*

(Smith, 1987)

Objectives for the management of the reserve for conservation of flora and fauna and passive recreation were established. These were:

1. Rehabilitation of native vegetation;
2. Fire prevention and management; and
3. Management of the level of impact from reserve based recreation.

The recommendations to rehabilitate the site to a near natural state were through:

1. Weed control (involving physical, chemical and biological control);
2. Fire management (fuel reduction through weed control, firebreak maintenance and education); and
3. Planting native species in degraded areas (in natural Communities using local seed stock).

The recommendations to manage the site for other purposes were through:

1. the construction of a pathway system including concrete paths, boundary log fencing, screen planting and interpretative signs;
2. encourage the use of the reserve for educational purposes;
3. discourage trail-bike riding;
4. upgrade and maintain the weir through removal of weeds including *Typha orientalis*, silt and rubbish.

### **Management Plan Reserve No. 32863**

**(Smith, 1984)**

The objectives for the reserve were established as:

1. Conservation and rehabilitation of the wetland through fire protection and management, prevention of disturbance and establishment of exotics, upgrading of some areas of the reserve which have been disturbed and invaded, and maintenance of the reserve.
2. Use of the wetland reserve for recreation by encouraging the use of the reserve for passive recreational activities.
3. Use of the reserve for education by instituting a small scale education programme for the reserve involving local schools and developing a 'wetland experience reserve'.

Monitoring was considered an essential component of the management plan, with specific mention of the need to monitor Bulrush (*Typha orientalis*) infestations.

## **5.3 Policy Context**

### **5.3.1 Local Government – City of Melville**

#### **City of Melville Bushfire Management Strategy**

**(City of Melville, 1995)**

The strategy was established with the following objectives:

1. to protect human life and property from harm by bushfire occurring on lands controlled by the Council;
2. to protect and conserve the environmental values of remnant bushlands in the City of Melville from the harmful impacts of wildfires;
3. to observe statutory obligations upon the Council associated with bushfire management and control; and
4. to increase community awareness of bushfire management issues in the City of Melville.

The strategy included 23 recommendations based on fuel management, fire suppression and community education. These recommendations have been incorporated without alteration into the 2004 Management Plan for the Bull Creek.

### ***Green Plan for the City of Melville***

**(Alan Tingay & Assoc, 1999)**

The aims of the Green Plan were to:

- ensure the long term conservation of remnant bushlands, wildlife corridors and significant habitat;
- attempt to establish ecological links between significant habitat areas;
- restore and rehabilitate vegetation communities and ensure that long term viability of existing flora;
- establish a baseline environmental dataset and overall vegetation inventory for the City of Melville, which will act as a toll for environmental planning and management, and also provide important information on the conservation status of vegetation communities;
- maintain and increase the flora of the City, which is a predominant and attractive feature of the City of Melville;
- educate the local community on vegetation management issues and foster its involvement in maintaining remnant bushlands, whilst encouraging local residents to participate in the regeneration or enhancement of public or private land.

The recommendation for Bateman was to 'increase plantings at potential green sites, i.e. schools' and for Bull Creek the recommendations were 'Street tree plantings north of Parry Avenue and Street tree plantings on significant biolinks'.

### ***Stormwater Management Strategy***

**(City of Melville, 1997)**

The management objectives of the Strategy are to:

- reduce the negative impacts of stormwater on surface waters receiving stormwaters generated from the City of Melville;
- support the Swan-Avon Integrated Catchment Programme and the Swan and Canning Rivers Cleanup Programme;
- investigate options for the re-use of stormwater;
- increase community awareness of catchment hygiene issues; and
- develop toxic spill contingency plans for all catchments draining to surface waters.

The recommendations in the report include:

- That application of fertilisers to road verges be undertaken by hand to minimise overthrow on to road surfaces;
- That all fertilisers used by the City of Melville be of slow release formulation;
- That verge mowing be undertaken in such a manner as to avoid deposition of grass clippings on road surface;
- That weed control along kerbs be undertaken using hot water;
- That nutrient and irrigation plans be progressively prepared for large grassed parks;

- That the Engineering Policy on sweeping of roads be reviewed with the aim of increasing sweeping frequency for catchments draining into lakes, and specifying when those catchments are to be swept taking into account seasonal factors; and
- That in-line pollutant removal structures such as pits, soak wells, gross pollutant traps and infiltration tanks be inspected and cleaned on annually.

### ***Foreshore Restoration Strategy***

**(Alan Tingay & Assoc., 1997)**

The objectives of the Strategy were:

- To minimise erosion damage to foreshores and associated vegetation and infrastructure;
- To restore native vegetation to those portions of the foreshore which have no native vegetation remaining and ensure the long term viability of the existing vegetation;
- To control and eradicate where practicable, invasive introduced plants;
- To provide habitat for native fauna;
- To maintain and improve the visual amenity of foreshore reserves;
- To take into account vistas of the Swan and Canning Rivers from adjacent public and private lands;
- To provide for appropriate recreational use of foreshore areas;
- To increase community awareness of foreshore management issues; and
- To take into account existing management strategies relevant to the study area.

The Foreshore Restoration Strategy considered the portion of the study area within Bateman Park as Section 17 – Bull Creek.

Site specific recommendation for Bull Creek was S10 'Continue to implement the recommendations of the Bull Creek Wetlands Management Plan'.

Bull Creek was ranked as a medium priority Precinct. Within the Precinct weed control was given a high priority and erosion control and revegetation given low priorities.

## **5.3.2 State Government - West Australia**

### ***Aboriginal Heritage Act 1972***

There are registered Aboriginal Sites in the vicinity of the study area. Aboriginal Sites, regardless of whether they are they are registered or not, are protected under the Aboriginal Heritage Act, 1972:

- **Section 5** defines sites as places of importance where objects connected with traditional life have been left, stored or taken from; ceremonies have been conducted; some ethnographic interest;
- **Section 15** requires that findings be reported;
- **Section 17** makes it an offence to excavate, destroy, damage, conceal or in any way alter any Aboriginal site; and
- **Section 18** establishes the conditions for certain uses of land unaffected by the Act.

## ***Bush Forever***

### **(Government of Western Australia, 2000)**

*Yagan Wetland and Adjacent Bushland, Rossmoyne to Bull Creek* is registered as Bush Forever Site Number 338 and contains regionally significant bushland (Government of Western Australia, 2000). The Bush Forever Site Recommendation is for protection through Local Reserve Mechanisms.

## ***Conservation Reserves for Western Australia – System 6***

### **(Department of Conservation and Environment, 1983)**

The System 6 Conservation Reserve System developed by the Department of Conservation and Environment (1983) was the precursor of the Bush Forever System. The DCE included within Site M74, Bull Creek, Reserve C32563, which is within the study area, and Reserve C29130, which is adjacent to the study area.

The following four recommendations were made for this site:

- M74.1 that the respective purposes of Reserves C29130 and C32563 be amended to Conservation of Flora and Fauna;
- M74.2 that the triangular portion of vacant Crown land abutting the northern boundary of reserve C32563 be declared a Class C Reserve for Conservation of Flora and fauna and that the Reserve be vested with in the City of Melville;
- M74.3 that preparation of management plans for the whole area be encouraged and that any management plan be done in consultation with the Department of Fisheries and Wildlife;
- M74.4 that both the Cities of Canning and Melville (where appropriate) together with the WA Wildlife Authority request Rossmoyne Senior High School and the Anglican Church to recognise the importance of the area for conservation of flora and fauna in the management of their adjacent land.

### **5.3.3 Commonwealth Government - Australia**

#### ***Environmental Protection and Biodiversity Act, 1999***

The site is subject to protection under the Commonwealth EPBC Act, 1999 (Government of Western Australia, 2000).

The tidal wetlands of Bull Creek are considered part of the Swan-Canning Estuary. The Swan-Canning Estuary is listed as a wetland of national importance in the Directory of Important Wetlands in Australia. It is stated in *The Directory of Important Wetlands in Australia* that the Swan-Canning Estuary (Wetland WA091) covers 3 300 hectares and is a good example of a shallow estuarine system that has substantial tidal exchange with significant areas of tidal flats and marshes, that is in reasonable condition and is situated in a major urban centre. It is a major nursery area for fish, a major migration stop-over area for shorebirds and a vital feeding area for thousands of Cormorants that breed in nearby lakes.

## 6.0 Vision for the Bull Creek Wetlands

### Bull Creek Wetlands Management Plan 2004 - 2009

#### 6.1 Strategic Objectives

One of the principal management objectives for the Bull Creek Wetlands is to ensure the long-term conservation of the remnant bushland, develop wildlife corridors and significant habitat. Recreating the vegetation as it was prior to European settlement of the site is not achievable because:

- Urban development and the construction of Leach Highway have altered the hydrology of the Bull Creek Wetlands;
- The Bull Creek Wetlands have a high level of weed infestation which are unlikely to be completely eradicated;
- Much of the Bull Creek Wetlands has previously been cleared;
- *Phytophthora* Dieback is present at Bull Creek Wetlands; and
- The Bull Creek Wetlands are frequently burnt.

Consideration therefore needs to be given to the type of vegetation to be maintained. The visions for the Bull Creek Wetlands suggested during public consultation were:

- the maintenance of public green space;
- the maintenance and enhancement of biological assets;
- a raised profile amongst residents in the immediate vicinity;
- co-operative community involvement in management;
- the identity of the Bull Creek Wetlands needs to be based on it being an integrated biological system rather than a series of nearby reserves; and
- a pathway providing a bushland experience in the urban environment and linking the components of the Bull Creek Wetlands together.

On this basis, this objective should be interpreted as to:

- restore and maintain a diverse and robust functioning ecosystem that is representative of the Bassendean Vegetation Complex; and
- enhance and maintain riparian and wetland habitat.

The other objectives for the Management Plan, stated in the brief are to:

- monitor and examine water quality, impacts and ways in which to maintain good water quality and prevent potential contamination of the water entering the system over the long term;
- undertake effective liaison between the City of Melville and community regarding the appropriate environmental management for the area in balance with the area's recreation objectives;
- restore and rehabilitate riparian and bushland communities to ensure the long-term viability of existing flora and fauna;
- educate local residents and the wider community in relation to arson and promote reserve protection; and

- establish a baseline environment data set and overall vegetation inventory for the City of Melville.

To meet these objectives, the following issues are discussed below:

- Water Quality;
- Weeds;
- Rehabilitation;
- Revegetation;
- Fauna;
- Fire;
- Plant Pathogens; and
- Recreation and Infrastructure.

These issues are discussed in Section 7 – Plan for Management. Whilst rehabilitation and revegetation are inherently the same process, these are discussed in separate sections to make the information more accessible. The Rehabilitation section provides the priorities for the revegetation and the Revegetation section discusses the techniques involved.

# 7.0 Plan for Management

## Bull Creek Wetlands Management Plan 2004 - 2009

### 7.1 Water Quality Management

#### 7.1.1 Objectives

The objectives for water quality management as outlined in the Stormwater Management Strategy are to:

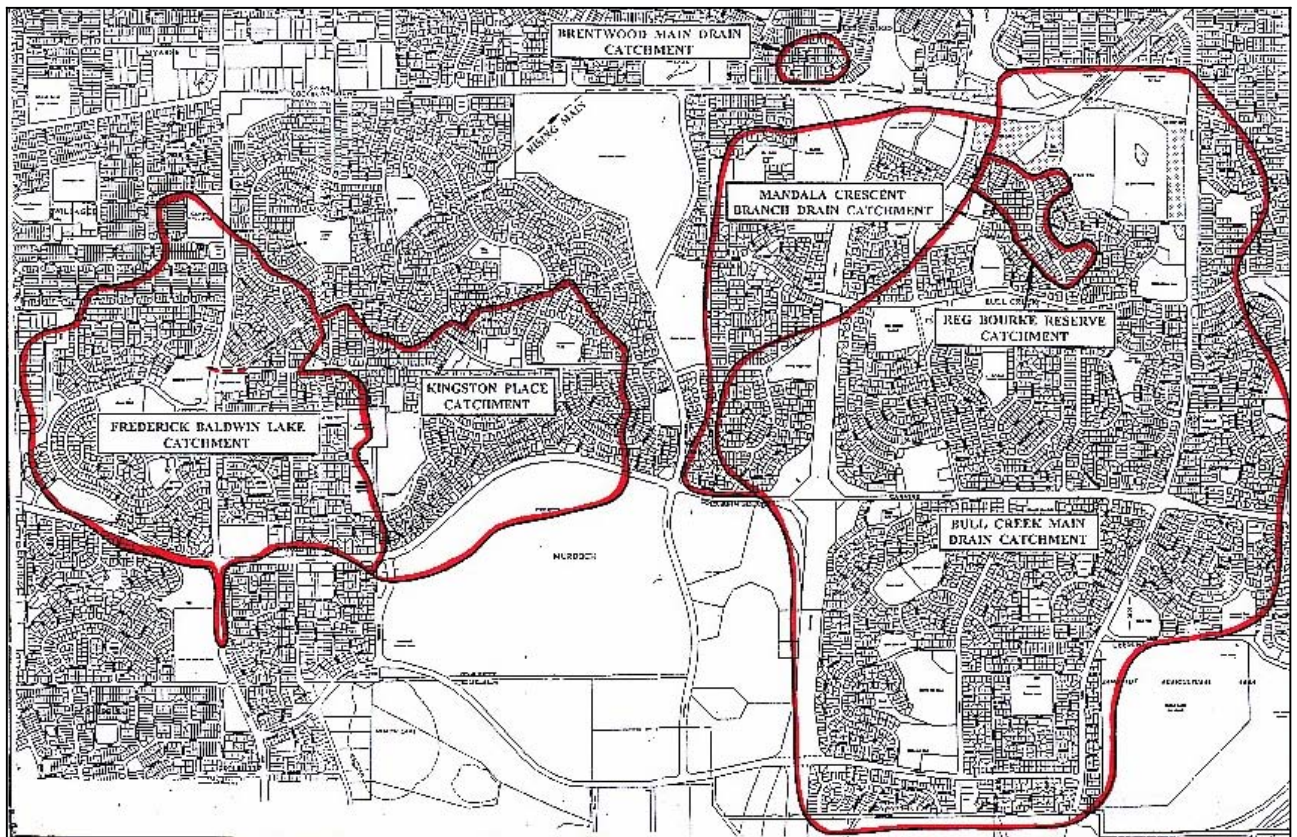
- reduce the negative impacts of stormwater on surface waters receiving stormwaters generated from the City of Melville;
- support the Swan-Avon Integrated Catchment Programme and the Swan and Canning Rivers Cleanup Programme;
- increase community awareness of catchment hygiene issues; and
- develop toxic spill contingency plans for all catchments draining to surface waters.

This section will examine how these objectives can be met in the context of the Bull Creek Wetlands. Most strategies to increase water quality will necessitate catchment-wide solutions, with the majority of works undertaken outside the study area. This should be done in accordance with the *City of Melville Stormwater Strategy* (City of Melville, n.d.) and the *Swan-Canning Cleanup Program Action Plan* (Water and Rivers Commission, 1999). A forthcoming manual for stormwater management is also soon to be published by the Swan River Trust.

#### 7.1.2 Background

The Bull Creek Wetlands receive storm water from the Bull Creek Main Drain, the Mandala Crescent Branch Drain, and the Brentwood Main Drain when flood control pumps at Frederick Baldwin Lake and Kingston Place are in operation. Water quality monitoring has been in place at Bull Creek since 1979. The following graphs show the main water quality parameters at two locations within the study area: Bull Creek Park and Bateman Park. Bull Creek Park receives flow from the Bull Creek Main Drain while Bateman Park receives flow from the Brentwood Main Drain and Mandala Crescent Branch Drain. These two drains represent the majority of storm water passing through the study area (see Figure 7.1)

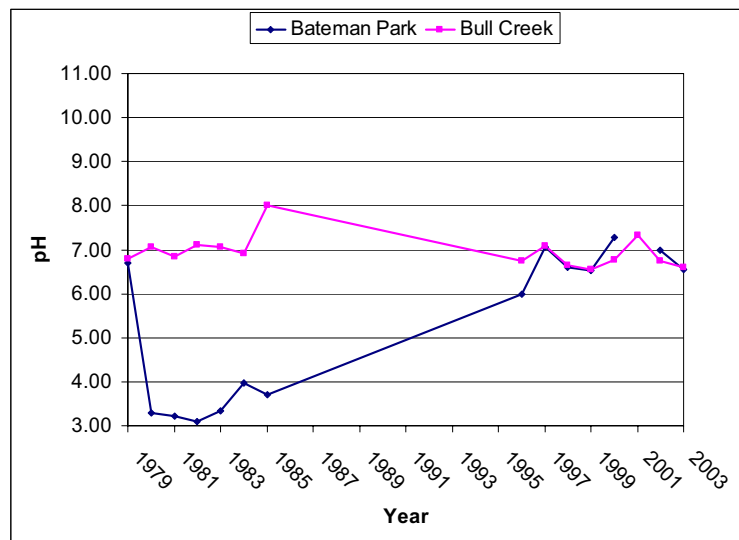
The following includes selected water quality parameters [pH, Dissolved Oxygen, Conductivity, Total Dissolved Solids Total Phosphorous and (organic) phosphate] from data collected in Bull Creek Park and Bateman Park over at least the past six years. These results should be treated with caution as there have been inconsistencies in the sampling regime and some parameters are highly variable depending on rainfall events. The results for each year consist of the average of all results taken that year. It should also be noted that there was no sampling undertaken between 1985 and 1995.



**Figure 7.1 Catchment area of the Bull Creek Wetlands**

**pH**

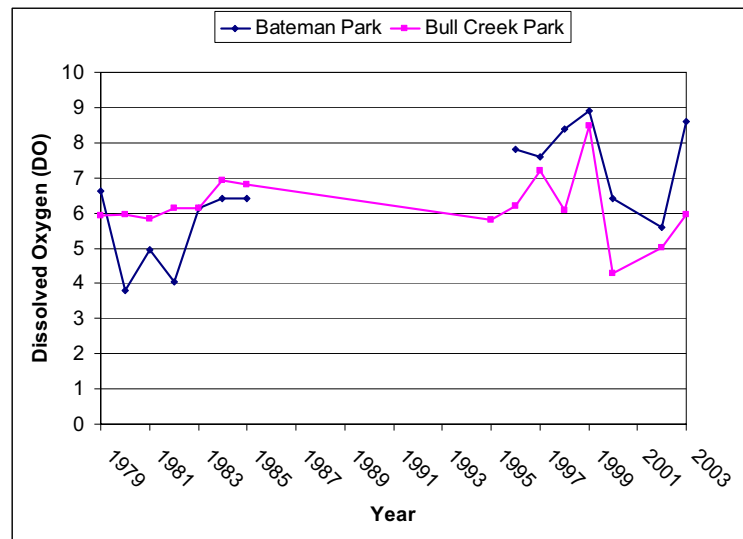
As shown in Figure 7.2 the pH levels in Bull Creek Main Drain have generally remained neutral since 1979 whilst the Brentwood Main Drain passing through Bateman Park experienced very low pH levels from 1980 through to some time between the mid 1980's to mid 1990's. The pH levels are currently within water quality guidelines, although are still slightly lower than the ideal, pH values between 7 and 8 are optimal for supporting a diverse aquatic ecosystem.



**Figure 7.2 pH at Bateman Park and Bull Creek (1979-2003)**

### **Dissolved Oxygen (DO)**

As shown in Figure 7.3 dissolved oxygen fluctuates widely in both drains. Dissolved oxygen is an important indicator of water quality as aquatic fauna are killed if dissolved oxygen falls below required levels. While DO levels fluctuate with temperature, very low levels of dissolved oxygen can indicate an influx of organic pollutants, or high bacterial activity as a result of algal blooms. The data was unable to be compared with water quality standards as the units of measurement were not recorded. Large reductions of DO compared with previous observations should instead be used to indicate poor water quality.

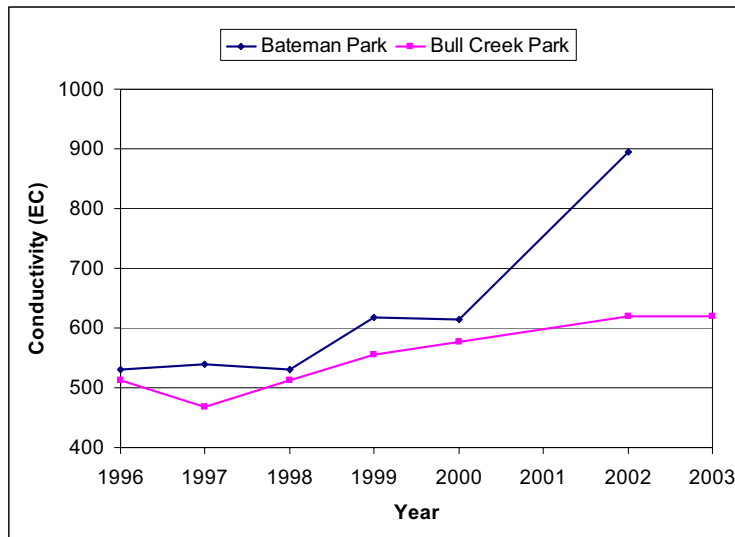


**Figure 7.3 Dissolved Oxygen at Bateman Park and Bull Creek**

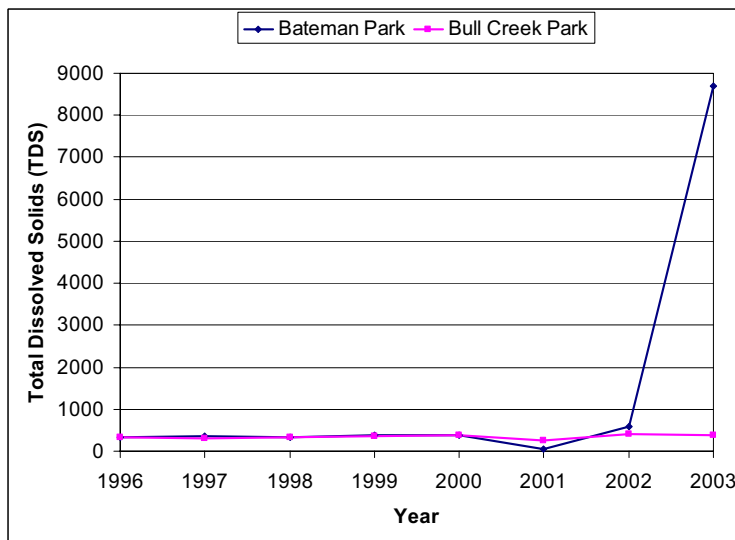
### **Electrical Conductivity and Total Dissolved Solids**

Electrical conductivity is a measure of conductivity and is related to the level of dissolved salts in the solution. Total Dissolved Solids (TDS) is a related measure and includes dissolved salts as well as other dissolved particulate matter. As shown in Figure 7.4 EC has been increasing since 1996, particularly in the Bateman Park. Total Dissolved Solids, shown in Figure 7.5, dramatically increased in the Brentwood Main Drain between 2002 and 2003. This may be a result of increased sedimentation, possibly due to nearby developments. Ongoing monitoring will determine whether this increase represents a trend or a one off event. An increase of this magnitude suggests a point source for contamination. Such increases should be investigated at the time they are recorded by sampling along the drainage system (e.g. at outfalls starting at the Canning River and working along the Brentwood Main and Mandala Crescent Branch Drains).

The data was unable to be compared with water quality standards as the units of measurement were not recorded. Large increases of EC and TDS compared with previous observations should instead be used to indicate poor water quality.



**Figure 7.4 Electrical Conductivity (EC) at Bateman Park and Bull Creek**

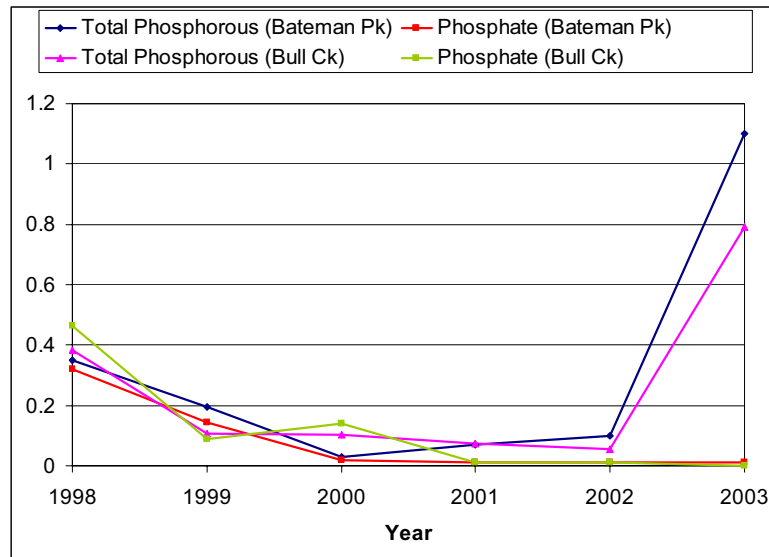


**Figure 7.5 Total Dissolved Solids (TDS) at Bateman Park and Bull Creek**

### **Total Phosphorous and Phosphate Levels**

Total Phosphorous (TP) refers to inorganic phosphorous, generally derived from human sources whereas phosphate (PO<sub>4</sub>-P) refers to phosphates derived from living plants and animals and their remains. Most of the phosphate in healthy, natural waters is derived from this.

High levels of phosphorous lead to eutrophication and can contribute to algal blooms. Figure 7.6 shows both the Bull Creek Main Drain and Brentwood Main Drain experienced high levels of inorganic phosphorous between 2002 and 2003. Prior to this, both drains had experienced a gradual decline since 1998.



**Figure 7.6 Total Phosphorous and Phosphate Levels at Bateman Park and Bull Creek**

Draft ANZECC guidelines have the following categories for Total Phosphorous which are shown below in Table 7.1. Five year water quality targets for total phosphorous are 0.2 mg/L and 0.1 mg/L over 20 years. It should be noted that Total Phosphorous is highly variable with rainfall events and the results above should be treated with caution. More intensive sampling over a month will give a better picture of phosphorous levels in the study area.

**Table 7.1 ANZECC draft guidelines for fresh water**

Phosphorous Range	Category
< 0.1	Low
0.1 – 0.2	Moderate
0.2 – 0.3	High
0.3 – 0.5	Very High
> 0.5	Extreme

### Discussion

Overall results of water quality show that while some parameters are currently within acceptable limits (pH and DO), others show that water quality has reduced considerably over the past few years. Salinity, Total Dissolved Solids and Total Phosphorus in the Brentwood Main Drain have increased dramatically. The sudden nature of the increase suggests that a point source is responsible, possibly due to sedimentation as a result of runoff from a nearby development. Such sources are much easier to address than more diffuse sources of poor water quality. Other significant sources may include:

- runoff from the Leach Highway and South Street; and
- heavy fertiliser use on lawns and ovals.

There are no industrial areas indicated by the Metropolitan Region Scheme in catchments that feed the Bull Creek Main Drain and the Brentwood Main Drain. This makes the recommendation in the *City of Melville Stormwater Strategy* (City of Melville, n.d.) that requires the development of toxic spill contingency plans for all catchments draining to surface waters a lower priority at this site than others. However there is still the possibility that a spill could be caused by a truck accident on Leach Highway and spill management procedures be required.

### 7.1.3 Strategy

#### ***Streamlining existing infrastructure***

The strategy outlined below has been adapted from a report for a drainage improvement framework for the Mills Street Main Drain Catchment (Swan River Trust, 2003). A detailed investigation of would be appropriate for the City of Melville, so that more detailed management strategies can be formulated.

The options for storm water management include:

1. Redesign options for existing stormwater infrastructure;
2. Use of Water Sensitive Urban Design Principles for additional infrastructure (e.g. in new developments)
3. 'Streamlining' infrastructure by enhancing natural nutrient stripping and retention processes. This should not compromise the drain's stormwater conveyancing functions

The options for redesigning existing stormwater infrastructure can be undertaken as part of a wider water quality management strategy in the City of Melville. The use of water sensitive urban design principles should also be adhered to, however Melville has been developed for a long time, and few new developments occur. The exception to this is the Brentwood development to the north and east of the study area.

'Streamlining' includes many options that can be implemented in the study area and its catchments. Streamlining can involve the following actions:

#### **1. Establish hydraulic Capacity of the Drainage System**

Establishing the hydraulic capacity of the Bull Creek and Brentwood Main Drains should be carried out as a preliminary. This will allow the capacity of modifying the existing system to be estimated. This should be done as part of a general drainage improvement strategy for the City of Melville. Additional data should also be collected on groundwater fluctuations and precipitation effects for the catchments in question.

#### **2. Increase stability of Banks**

Erosion of unstable banks increases nutrient and sediment loading in the receiving drains. Stability can be increased by planting native vegetation along banks. The banks should be divided into upper, medium and lower sections and appropriate species planted in each. Lower sections should be restricted to riparian vegetation of sedges and rushes, while upper levels should be planted with drier species reflective of the surrounding native vegetation. Middle areas should be planted with tall shrubs that can tolerate some inundation such as *Astartea fascicularis*, *Pericalymma ellipticum*, *Hypocalymma angustifolium*, *Oxylobium lineare*, *Viminaria juncea*. Jute matting can be used in conjunction with revegetation to maintain stability of the banks until it has fully revegetated.

This should be implemented within the study area, particularly in association with weed control of blackberry and other problem species (see Section 7.2).

### **3. Reduce impacts from Branch Drain Inflows**

Branch and local drains entering the Main Drain can sometimes carry high levels of pollutants. In these areas the following can be undertaken:

- trapping of contaminants (e.g. floating booms)
- filtering particulate materials (e.g. reed beds)
- enhancing aeration of the water (through reduced incidence)
- reducing scouring from high flows (e.g. rock spalls at the inlet of small drains – this also promotes aeration)

This step should be implemented throughout the catchments, and should be done in conjunction with enforcement of contamination regulations.

### **4. Increase Shading**

Shading stabilises water temperatures and reduces algal growth by limiting light. Planting large trees and tall shrubs adjacent to the drains can help shade the Bull Creek and Brentwood Drains. This is particularly important on the northern sides of these drains. To adequately shade the drains, planting density needs to be high.

Currently Bull Creek is very highly shaded by a combination of natives and weeds, (particularly Blackberry). Removal of blackberry needs to be replaced with native species that provide adequate shade. Additional Albizia, Swamp Peppermints, Paperbarks and Flooded Gums are appropriate for this function. Planting layout should also consider maintenance access requirements, fire risks and security.

The Brentwood Drain at Bateman Park would benefit from increased shading and replacement of grassy weeds with native trees and shrubs.

### **5. Replace exotic annual grasses with perennial native species**

Annual grasses are a poor buffer and require mowing. Grass clippings that are not removed also block flow and increase nutrient levels. Annual grasses also die off over summer reducing nutrient stripping capacity over this period. The first rains of the season can be highly nutrient enriched, and the lack of nutrient stripping capability at this time exacerbates the impacts of these first flush events.

Native surrogates such as *Carex divisa* and *Neurachne alopecuroides* can be used where a grass-like groundcover is required for access, aesthetics, security or fire concerns.

### **6. Reduce weed-based nutrient release**

This involves replacing exotic annual and biannual grasses with perennial native vegetation. The vegetative parts of annual and biannual species die off outside the growing season and can contribute to sudden nutrient release into waterways. Similarly large exotic tree species such as willows overhanging drains and waterways can decompose too rapidly for macroinvertebrates to process adding to nutrient loading in the system. These species should also be replaced by native species.

### **7. Increased nutrient interception instream**

Instream vegetation, particularly during low flows, enhances nutrient removal by microbes. Conditions suited to this process can be created by:

1. altering the shape and bathymetry of the drain to a meandering, less linear creekline to increase detention times and promote habitat diversity. Natural flows can be replicated by creating riffle zones consisting of rocks at intervals which also promotes oxygenation of the water and creates additional habitat for macroinvertebrates.
2. Vegetating drains and basins with instream plants to maximise flow interception e.g. *Eleocharis acuta* planted in 5 m wide bands every 30 m. If the drain is undersized and hydraulic roughness needs to be minimised, *Carex divisa* and *Bolboschoenus caldwellii* are more suitable.
3. Increasing hydraulic retention time in compensating basins by positioning outlet and inlet opposite each other and planting in the flow path. Other means of altering bathymetry in compensating basins can also be used such as bunds.

#### **8. Improved groundwater interception in basins and drains**

Riparian planting can increase nutrient removal from groundwater seeping into the drainage system. Bull Creek Main Drain flows all year round as it is partly groundwater fed and therefore this strategy is appropriate.

#### ***Opportunities for Streamlining in the Bull Creek Wetlands***

The Bull Creek Wetlands offer a number of opportunities for streamlining that will effectively strip nutrients from stormwater. Many of the strategies outlined above can be implemented as part of the weed control and revegetation strategies outlined in Sections 7.2.

It is recognised that only general strategies for improving water quality have been outlined. To develop specific works programs, calculations of flow requirements and hydrology need to be undertaken prior to implementing the strategies outlined above. The main waterways and wetlands within the study area and the revegetation options for these areas are outlined below (see Map 1 for locations):

1. Weed control and riparian revegetation at Bull Creek Park. This area is highly infested with weeds, and while it should be noted that the weeds are serving some nutrient stripping functions, removal and replacement with native species is preferable so that aesthetic and ecological functions can also be improved. Replacement with appropriate wetland plants will also enhance nutrient stripping as well as improving flow characteristics of the drain. Bull Creek Main Drain continues through Yagan Reserve (within the City of Canning) before entering the Canning River. Bull Creek Drain, while heavily weed infested, is locally important in both in terms of ecological functions (connectivity, and habitat value) and as an important educational resource for Rossmoyne High School and All Saints College. Much previous work has been undertaken and this work should be followed up and built upon for these reasons.

2. The creek line running through Reg Bourke Park is similar to Richard Lewis Park in that it is a relatively natural drainage line which is overgrown with weeds, notably blackberry, in several areas. Weed control and replanting understory species at its eastern end will enhance its nutrient stripping functions.
3. The creek line in Richard Lewis Park consists of a semi-natural drainage line opening up to a dampland within the *Eucalyptus rudis* woodland (see Map 1 – Vegetation). The creek line runs under Leach Highway and ultimately enters the Canning River in Bateman Park. This drainage line in Bateman Park is infested with weeds in many places, but is also relatively intact in many other areas. Restoration using native dampland plants in Richard Lewis Park would be appropriate, as well as controlling grassy weeds (Kikuyu and Couch) along the part of the creek line in Bateman Park. The Bateman Park section may be suitable for increasing nutrient retention by changing the shape and bathymetry of the drain to a more meandering shape, with riffle zones. Much of this area is highly degraded making it potentially suitable for earthworks to be undertaken with minimal impact to native vegetation. A study into the feasibility and impacts of such an action should be undertaken before works commence.
4. The drainage line fed by the Brentwood Main Drain running through the western side of Bateman Park is steep and linear, with most of the characteristics of an artificial drain. There appears to be little scope for changing the shape and bathymetry of the drain as there is little room between housing developments and intact woodland. It would also be expected that the capacity of this drain needs to be kept at a high level for heavy rainfall events. There is however high potential for bank stability enhancements and shading by stratified revegetation as outlined in the previous section. It is important that the hydraulic capacity and requirements are accurately measured before works are planned and commence. This should be done in close liaison with the Water Corporation. Advice should also be sought from the Swan River Trust.

### **Other Strategies**

Other strategies should form part of a wider campaign to increase water quality in the City of Melville. These opportunities are as follows:

1. continue existing education campaigns to promote awareness of water quality issues. This includes the 'Rivers of Blue' campaign and the Swan-Canning Cleanup Program
2. redesign options for the stormwater network should be examined in the context of increasing water quality of stormwater. Spatial and hydrological data should be collected to determine appropriate management responses and works carried out in liaison with the Swan River Trust, The Department of Environment and the Water Corporation.
3. Funding should be sought to assist in addressing water quality issues in the City of Melville, funding is available under the Rivercare branch of the Natural Heritage Trust and also through other sources including the Swan-Canning Cleanup Program.

### 7.1.4 Monitoring

Water quality monitoring has been carried out at the City of Melville for 25 years in some locations. This data is highly valuable to determine the effectiveness of water quality mitigation strategies as it provides a baseline of data and highlights where water quality improvements and shortfalls have been made. Unfortunately some of the data is inconsistent and appear not to have been measured in the same units over time. Some of these results should therefore be treated with caution.

An audit of the existing data should be undertaken, to standardise the sampling units and rectify inaccuracies in the datasets. This should ideally be done in cooperation with the Swan River Trust, and the data made available to the Trust to improve data for the Swan-Canning Cleanup Program.

Since 1996 water sampling has been carried out by MPL Pty. Ltd., which have tested water quality parameters and contamination. While this is important and should continue, annual interpretation of the results should also be undertaken and compared with previous data, so that reductions in water quality can be acted upon in sufficient time to prevent significant degradation or Improvements of water resources. This will allow targets for water quality to be set and enable early warning of significant pollution events.

Monitoring data must be in a standard format, minimising other parameters as much as possible. Data should be measured in the units used by the Department of Environment and ANZECC (1999) guidelines where possible. Water and air temperature data should also be collected at the sampling point to detect thermal pollution.

### 7.1.5 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
1.1	Continue monitoring water quality parameters, using standardised measurements and noting significant findings.	High	2004	on	CoM / consultant	\$2,000 / annum
1.2	Share water quality results, and seek cooperative management, with the Swan River Trust.	Medium	2004	on	CoM / SRT	N/A
1.3	Investigate significant aberrations in water quality parameters, if and when they occur, through further sampling	High	2004	2004	CoM / consultant	\$3,000 - \$5,000
1.4	Continue to investigate and implement streamlining options for stormwater drainage within the study area	High	2004	2009	CoM / Community Groups / SRT / Water Corp / DoE	\$10,000 / annum
1.5	Investigate the feasibility of bank reshaping and realignment of the drainage line originating from Richard Lewis Park where it runs through Bateman Park	Low	2008	2009	CoM / Water Corp / SRT / DoE	\$2,000

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
1.6	Seek funding to plan and carry out water quality improvements from Rivercare and the Swan-Canning Cleanup Program	Medium	2004	on	CoM / Community Groups / SRT	N/A

## 7.2 Weed Control

### 7.2.1 Objectives

The objectives for weed control are to:

- identify and control existing weeds with the highest priority for control;
- prevent introduction of additional weed species;
- prevent further encroachment of weeds into bushland areas;
- minimise any detrimental effects of the weed control programme on the native biota; and
- integrate the weed control programme with bushland restoration programmes.

### 7.2.2 Background

Environmental weeds are plants that establish themselves in natural ecosystems and modify natural processes, resulting in the decline of the communities they invade. Impacts on ecosystem function by environmental weeds include:

- resource competition, as weeds often outcompete native species;
- prevention of seedling recruitment of native species;
- alteration to geomorphological processes, such as increased erosion;
- changes to soil nutrient status;
- alteration of fire regime, usually through increased fire frequency;
- changes to the abundance of indigenous fauna due to less diverse habitat;
- loss of genetic diversity;
- loss of species diversity; and
- changes to the structure of vegetation communities, often by the removal of the shrub layer or native ground covers.

The fire-weed cycle that is a primary cause of the degradation of bushland and loss of understorey species is particularly prevalent on the deep sands of the coastal plain. The shrubs, herbs and sedges are gradually replaced by weed species, notably grassy weeds as fire frequency increases. Grassy weeds have characteristics which enable them respond quickly to fires, and which support more frequent fire events, than many of the native perennial understorey shrubs. Some of the contributing factors to the fire-weed cycle are summarised below:

- weed species are often advantaged by the burst of nutrients available immediately after a fire;
- weed species, particularly grassy weed species, accumulate biomass rapidly, increasing fuel loads to levels that will sustain fires;
- high growth rates of weed species allows them to outcompete native species;
- grassy weeds, and many other weed species, are able to set seed within a single year;
- grassy fuels have a different structure to shrubby fuels. The grasses have a fine, evenly spread structure, compared with the more heterogeneous, discrete structure of native understorey shrubs. This affects fire behaviour and rate of spread, particularly in the initial stages of a fire;

- native seeder species require time between fires not only to set seed but also to replenish their seed stocks. This may take several years. Frequent fires deplete seed stocks, rapidly eliminating these species from the species assemblage; and
- native resprouting species (ie. species that have an underground lignotuber) can also succumb to frequent fires if fire recurs before the new growth has had time to harden.

The processes that contribute to the spread of weeds include:

- clearing;
- trampling;
- off-road vehicles;
- increased fire frequency;
- rubbish dumping, including soil and garden waste; and
- movement of weed seed, especially by vectors along the numerous tracks in the area.

The 71 weeds identified within the study area are listed in Appendix 4.

### 7.2.3 Strategy

#### **Prioritisation**

Weeds in the Bull Creek Wetland must be prioritised for control as there are a large number (more than 69 species) of weeds with different levels of invasiveness and impact on natural ecosystems. There are two forms of weed prioritisation:

1. Species-led control;
2. Site-led control;
3. Resources-led Control;
4. Threatened Species / Communities led Control.

The Bull Creek Wetlands require a combination of site-based and weed-based control due to different levels of infestation, vegetation communities and weed species. Site-based control is required where relatively small and discrete areas are degraded and where removing weeds may produce bare slopes that are unstable and aesthetically unpleasant. Species-based control is appropriate for highly invasive species.

#### **1. Species-led Control**

Species-led control is a proactive strategy to prevent introduction, establishment, survival, reproduction and dispersal of an emerging weed before it becomes a major problem within the study area. Initiatives should be undertaken at a local level to prevent the introduction and spread of weed species through control of degrading processes.

Generally, it is recommended that species-led control be undertaken prior to site-led control. Weed species were placed in this category if they:

- Have small populations;
- Are relatively easy to remove;
- Have a high potential to spread and therefore become a problem in the future; and
- Are located in areas that will not be continually reinfested from the soil weed seed bank or from surrounding areas.

These weed species should be tackled on a weed by weed basis, using the guiding principles described below.

Given the high diversity of weed species present, the discussion below focuses only on highly invasive weeds, which can exclude native species and are difficult to control. The 3 characteristics used for determining the *Environmental Weed Strategy for Western Australia* (EWSWA) (CALM, 1999a) rating are:

- invasiveness – ability to invade bushland in good to excellent condition, and waterways;
- distribution – wide current or potential distribution including consideration of known history of wide distribution elsewhere in the world; and
- environmental Impacts – ability to change the structure, composition and function of ecosystems. In particular to form a monoculture in a vegetation community.

The weed priority ratings, are based on these characteristics in the following way:

- High – weeds that have all 3 of the characteristics;
- Moderate – weeds that have 2 of the characteristics;
- Mild – weeds that have 1 of the characteristics; and
- Low – weeds that are not deemed to have any of the characteristics.

This rating has been used in conjunction with an examination of the dominance and extent of weeds on-site and resources.

High Priority and widespread Moderate Priority weed species in the Bull Creek Wetlands are shown below in Table 7.2. Control notes for these species are described in Appendix 6.

**Table 7.2 High Priority and Widespread Moderate Priority Weeds, EWSWA Priority and Extent in the Bull Creek Wetlands**

Scientific Name	Common Name	EWSWA Priority	Extent in BCW
<i>Cortaderia selloana</i>	Pampas Grass	High	Clumped in drainage lines
<i>Ehrharta calycina</i>	Perennial Veldt Grass	High	Widespread in disturbed areas
<i>Eragrostis curvula</i>	African Love Grass	High	Widespread in disturbed areas
<i>Freesia</i> sp	Freesia	High	not in flower during 2004 survey
<i>Moraea flaccida</i>	Cape Tulip	High	not in flower during 2004 survey
<i>Leptospermum laevigatum</i>	Victorian Tea-tree	High	limited roadside plantings
<i>Lupinus cosentinii</i>	Sandplain Lupin	High	limited roadside and disturbed areas
<i>Pelargonium capitatum</i>	Pelargonium	High	patchy distribution
<i>Romulea rosea</i>	Guildford Grass	High	disturbed areas
<i>Typha orientalis</i>	Bullrush	High	widespread in creeklines
<i>Zantedeschia aethiopica</i>	Arum Lily	High	Clumped in creeklines

Scientific Name	Common Name	EWSWA Priority	Extent in BCW
<i>Acacia longifolia</i>	Sydney Golden Wattle	Moderate	Widespread in creeklines
<i>Briza maxima</i>	Blowfly Grass	Moderate	Widespread in disturbed areas
<i>Cyperus polystachyos</i>	Bunchy Sedge	Moderate	Widespread in creeklines
<i>Gladiolus caryophyllaceus</i>	Gladiolus	Moderate	Widespread in uplands
<i>Paspalum distichum</i>	Water Couch	Moderate	Widespread along riverbank
<i>Pennisetum clandestinum</i>	Kikuyu	Moderate	Widespread along riverbank
<i>Rubus fruticosus</i>	Blackberry	Low <sup>11</sup>	Widespread in creeklines

## **2. Site-led Control**

Site-led control focuses on identifying areas that require weed control to maintain their ecological and commercial values. Site-led control is appropriate for most of the Wanneroo coast. Generally, it is recommended that site-led control be undertaken after control of weeds recommended for species-led control. Weed species can be placed in this category if they:

- have wide-spread and well-established populations;
- require concentrated and/or long-term efforts to remove; and
- are highly detrimental to ecological functions of bushland if left unchecked.

Site-based weed control should always be undertaken in conjunction with revegetation to prevent reestablishment of invasive or disturbance-related weeds. Site led control is appropriate for much of the bushland in *Poor* and *Very Poor* condition. Given the degraded nature of much of the study area a combination of species-led and site-led control will be appropriate, for example removal of blackberries in the Bull Creek Main Drain.

## **3. Resource-Led Control**

Resource-based weed control is recommended where a particular species is known to be within a defined area, and thereby can provide a focus for community projects. A resources led approach matches volunteer and professional labour to the best possible weed control outcomes. For example, volunteers may be best suited to target small populations of highly visible weeds which are readily removed by simple manual or chemical methods and are ideal for essential follow up and monitoring. Professional contractors should be used where spraying or machinery is required.

There are a number of different groups with different areas of interest in the Bull Creek Wetlands. These include the following:

- Lions club control and revegetation at Richard Lewis Park
- All Saints college participation at Reg Bourke Reserve and Bull Creek Wetlands
- Rossmoyne High School participation at Bull Creek Reserve

<sup>11</sup> While blackberry has been given a low priority in the EWSWA, it has been included in the priority weeds list due to its extent in the Bull Creek Wetlands.

More coordination of these groups and sharing of resources needs to be undertaken by the City of Melville. This should be done by:

1. establishing a register of resources held by different groups (equipment / human / potential to obtain funding)
2. determining the overriding objectives of potential participants (e.g. main area of interest, education, amenity improvement)
3. coordinating resources to direct effort to high priority areas / species as identified in this management plan.

#### **4. Threatened Species / Communities led Control**

This approach to weed control focuses on the ecological significance of threatened flora species or vegetation types. If a particular site is known to contain either of these, weed control in these areas becomes a priority to protect the ecological integrity of the site, and thereby promote the long-term survival of the species or community.

The Declared Rare Flora species, the Grand Spider Orchid *Caladenia huegelii* is recorded as occurring in the Bull Creek Wetlands (Smith, 1987) however since that time there has been taxonomic changes to the species, including the separation of *C. huegelii* and *C. paludosa*, the latter being recorded in a subsequent survey (Bull Creek Wetlands Working Group, 1995). There is therefore some considerable doubt as to whether this species occurs in the study area. A targeted flora survey should be undertaken between September and October to determine its presence in the Bull Creek Wetlands. Its growth is known to be suppressed by weed invasion and therefore if found, an intensive weed control program should be initiated in its habitat.

#### ***General Weed Control Action Plan***

A general Weed Control Action Plan is shown in Table 7.3, based on the guiding principles and approaches outlined previously. It is provided as a general guide for determining the priority for weed control activities. More detailed weed control action plans would require greater detail on the cover/abundance and distribution of priority weed species in these sections. This information could be gained by carrying out grid-based searches of each study area and recording cover/abundance values for priority weeds at defined intervals, for example every 100 or 200 metres. Cover/abundance should be measured using a standard scale, such as the Braun-Blanquet scale (Appendix 7) (Mueller-Dombois and Ellenberg, 1974). This task could be undertaken by environmental officers, consultants, community groups or students.

**Table 7.3 General weed control action plan**

<b>Priority</b>	<b>General Procedures</b>
<b>Priority 1 Start with species-led control</b>	<p><b>Species-led control:</b></p> <ol style="list-style-type: none"> <li>1. Select weeds for control on a species basis according to time of year and available resources.</li> <li>2. For each weed species, use bushland condition maps to: <ul style="list-style-type: none"> <li>• Start control efforts in <i>Very Good-Excellent</i> condition bushland</li> <li>• Move to <i>Good-Fair</i> condition bushland</li> <li>• Move to <i>Poor</i> condition bushland</li> </ul> </li> </ol> <p>The above represents primary weed control. Secondary weed control and long-term monitoring of weed populations will also need to be undertaken.</p>
<b>Priority 2 Move to site- led control</b>	<p><b>Site-led control:</b></p> <ol style="list-style-type: none"> <li>1. Select sites suitable for site-based control.</li> <li>2. Use bushland condition and weed distribution maps to: <ul style="list-style-type: none"> <li>• Start control efforts in <i>Very Good-Excellent</i> condition bushland</li> <li>• Move to <i>Good-Fair</i> condition bushland</li> <li>• Move to <i>Poor</i> condition bushland</li> </ul> </li> </ol> <p>Depending on resources and time of year it may be necessary to undertake control of different site-led species, prior to moving to other areas. Again, the above represents primary weed control. Secondary weed control and long-term monitoring of weed populations will also need to be undertaken.</p>
<b>Priority 3 Move to resource-led control</b>	<p><b>Resource-led control:</b></p> <ol style="list-style-type: none"> <li>1. Select sites suitable for resource-based control.</li> <li>2. Use bushland condition and weed distribution maps to: <ul style="list-style-type: none"> <li>• Start control efforts in <i>Very Good-Excellent</i> condition bushland</li> <li>• Move to <i>Good-Fair</i> condition bushland</li> <li>• Move to <i>Poor</i> condition bushland</li> </ul> </li> </ol> <p>Again, the above represents primary weed control. Secondary weed control and long-term monitoring of weed populations will also need to be undertaken.</p>

### **Weed Control Methods**

Control options for environmental weeds include:

- controlling ecosystem degradation processes;
- manual control; and
- herbicides.

These options are further discussed below.

#### **Controlling Ecosystem Degradation Processes**

Controlling degradation processes that increase ecosystem vulnerability to weeds is often the most effective way to control weeds in the long term. The main degrading processes in the study area are caused by disturbance (mostly fire and inappropriate access), plant pathogens and fragmentation. Fire management is described in Section 7.6, access management is described in Section 7.8 and plant pathogen management is described in Section 7.7.

### **Manual Control**

Manual control refers to the physical removal of the weed by mechanical or human effort. This includes hand weeding, pulling and digging or grubbing out and relates to small infestations of weeds (Dixon and Keighery, 1995). It is often the most expensive form of weed removal but it is generally the most appropriate method in circumstances where there are small infestations in largely natural bush areas. It is particularly valuable for small infestations, where chemical control is inappropriate and resources available.

Manual control needs to be carefully managed in order to avoid gross soil disturbance which can encourage further weed infestation. When undertaking manual weed control, the Bradley method (Appendix 5) should be used, and revegetation or assisted natural regeneration undertaken in conjunction with weed removal. Hand-pulling of weeds can be as time-efficient as spraying where low numbers exist in a localised, well-vegetated area of bush and in these situations should be given priority over herbicide spraying.

### **Herbicide Control**

The application of herbicides is often the most cost-effective method for weed control and a wide range of herbicides are available for different weed species. It is important that herbicides should always be used strictly in accordance with directions on the label and their application must be undertaken by personnel trained and licensed in the use of herbicide chemicals in public open spaces.

Dixon and Keighery (1995) identified three methods of herbicide control:

#### 1. Herbicide Wipe, Stem Injection and Cut Stump Application

- Herbicide Wipe – wipe herbicide onto part of the plant (for example a leaf/leaves) using a weeding wand, wick applicator (rope), waterproof (pesticide resistant) glove or modified hand sprayer;
- Stem Injection – use a small axe to make cuts at 8 cm intervals at a 45° angle and 4-5 cm long to penetrate the sapwood beneath the bark, or drill at 45 ° angle with holes 5 cm apart. If the plant is multi-stemmed, treat all stems at chest height. Use a special injector calibrated to deliver the right amount or use a syringe; and
- Cut Stump Application – when the plant is actively growing, cut the stump almost to ground level and apply the herbicide immediately using a paint brush.

#### 2. Herbicide Spot Spraying

- When spot spraying, avoid spraying non-target species unless using selective herbicides such as Fusilade®. Special shields can be purchased or, if necessary, made for spraying close to non-target species.

#### 3. Herbicide Blanket Spraying

- When blanket spraying, spray over large area using boom spray or similar, when the plant is actively growing (early June to no later than mid-August or when specified).

Two of the major herbicides recommended for use are glyphosate (e.g. Roundup®) and fluazifop (Fusilade®). Glyphosate is a systematic non-selective herbicide, which is useful for controlling most weeds, particularly bulbous species. Glyphosate should not be blanket sprayed in areas containing native species as it will also kill them. Fluazifop is a monocot-selective herbicide that is effective on most grassy weeds and does not affect native dicots. It may however impact on native monocots such as orchids and native grasses, rushes and sedges. A dye should be added to the herbicide to mark areas sprayed. Herbicides should not be sprayed in wetland areas, nor should a wetting agent or surfactant be added to herbicides in these areas. Alternatives to spraying include wick applicators and other methods that target individual plants. A “frog-friendly” version of Roundup® (known as Roundup® Bioactive™) is available for use near wetland areas.

### **Guiding Principles for Weed Control**

When undertaking weed control programmes, the primary guiding principle is to work from areas in the best condition to those in the worst condition, and all works should be undertaken in conjunction with a restoration strategy (Bradley, 1971; Bradley, 1988; Buchanan, 1989). The bushland condition map (Map 2) has been used in preparing the map which shows priorities for rehabilitation (Map 3).

Using bushland condition to determining weed control priorities ensures that:

- *Very Good - Excellent* condition bushland is maintained;
- *Fair - Good* condition bushland is enhanced, moved closer to being in *Very Good - Excellent* condition, and prevented from deteriorating to *Poor* condition bushland; and
- *Poor* condition bushland is enhanced, moved closer to being in *Fair - Good* or *Very Good - Excellent* condition, and prevented from deteriorating to *Very Poor* condition bushland.

The *Very Poor* condition bushland areas are generally not suitable for targeted weed control in the absence of intensive rehabilitation works. Instead, weeds in these areas should be addressed within the context of a comprehensive restoration plan.

When working in *Very Good - Excellent* and *Fair - Good* condition bushland, the Bradley method of weed control is recommended (Appendix 5). Essentially, this method involves assisted natural regeneration of native plants from seed banks, rather than the use of replanting programmes.

### **Post-fire Weed Management**

Following fire, weed species have an opportunity to increase in density and abundance. Ongoing weed management must also include post-fire weed management to break the fire-weed cycle. Training should be provided to staff carrying out these duties, or specialist bush regenerators employed in order to achieve the desired outcome without compromising the ability of the bushland to regenerate. The post-fire environment is susceptible to further damage, and weed control works should be undertaken at a time that will give the vegetation the greatest chance of successful regeneration. Implementation of weed control in the post-fire environment should incorporate the following factors:

- If the fire occurs in early summer, weed control should be carried out three months after a fire;
- after later summer fires, inspections should be carried out at four, six and eight weeks after the fire in order to assess the most appropriate interval at which to carry out weed control which will be determined by weather;
- the affected area should be monitored and, if necessary, a follow-up treatment should be applied; and
- as with all weed control programmes in natural areas, it should be linked to a regeneration programme. Assessment of individual situations is required to determine the needs for each site.

### **Amenity Plantings**

There are numerous amenity plants that are now recognised as having invasive capabilities. This includes numerous Australian (and West Australian) plants that do not naturally occur in the vicinity. Amenity plants that have, or have the potential to become invasive include:

- Geraldton Wax (*Chamelaucium uncinatum*) planted along Leach Highway and Karel Avenue;
- Peppermint<sup>12</sup> (*Agonis flexuosa*) planted in the north west of Bull Creek Park near Rossmoyne High School;
- River Oak (*Casuarina cunninghamiana*) planted along the south western edge of Bull Creek Park;
- Weeping Willow (*Salix babylonica*) a large specimen planted near the southern extreme of Bull Creek Park;
- Lombardy Poplar (*Populus nigra* var. *italica*) planted near the bridge from Rossmoyne High School in Bull Creek Park;
- Showy Honey Myrtle (*Melaleuca nesophila*) escaping from a garden on the western edge of the unnamed reserve west of Bull Creek Park;
- Lemon-scented Gum (*Eucalyptus citriodora*) planted in Reg Bourke Reserve;
- Swamp Mahogany (*Eucalyptus robusta*) planted near the bridge from Rossmoyne High School in Bull Creek Park;
- River Gum (*Eucalyptus camaldulensis*) along the north west of Bull Creek Park opposite All Saints College Oval.

The number of these amenity plants that are established in the bushland will increase if the practice of establishing and nurturing exotic plants along the periphery of the bushland continues. Some of the more invasive species above should be removed (Geraldton Wax, Peppermint, Weeping Willow, Showy Honey Myrtle) while the others should be monitored to determine if they are becoming invasive. Access to the large Willow on Bull Creek will become more difficult as revegetation progresses, and therefore the prioritisation of its removal is largely determined by the logistics of removing it.

### **Selected Environmental Weeds**

A brief overview of selected weeds is given below. Specific control methods for weeds are given in Appendix 6

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<sup>12</sup> WA Peppermint, while naturally occurring in the Perth area, is expanding beyond its natural range and is highly invasive. This species should not be planted outside its 'natural' habitat.

**Sydney Golden Wattle (*Acacia longifolia*)**

Is a dense bushy shrub or small tree to 10 m with dark grey bark. Two subspecies have become established in Perth. Two features can be used to differentiate between the Sydney Golden Wattle and the local Golden Wreath Wattle, *Acacia saligna*, which as a similar size and bark.

- Sydney Golden Wattle has its bright yellow flowers are in cylindrical clusters, as opposed to Golden Wreath Wattle which has a spherical flower arrangement.
- Sydney Golden Wattle has two distinct veins, one of which tends to be more distinct, on its 'leaves' (the technical botanical term is phyllodes), as opposed to Golden Wreath Wattle which has one conspicuous midrib.

**Bulrush or Broadleaf Cumbungi (*Typha orientalis*)**

Bulrush (*Typha orientalis*) is a native of eastern Australia that has been introduced to Western Australia. Bulrush competes with both the local Bulrush or Narrow Leaf Cumbungi (*Typha domingensis*) and Freshwater Paperbark (*Melaleuca raphiophylla*) for preferred habitat on the fringes of rivers and permanent lakes. It usually out competes the local Bulrush and where fire is frequent it also out competes Paperbarks. (Powell, 1990)

**Blackberry (*Rubus fruticosus*)**

Blackberry is a prickly perennial European shrub that has become a serious weed along creeklines in Western Australia (Hussey *et al.*, 1997). The impacts of this weed include displacement of native vegetation, modification of stream bank characteristics, changes in deposition of woody debris which led to changes in stream flows and changes in leaf litter composition. Seeds for the plant are spread by birds and foxes (Hussey *et al.*, 1997). However, Blackberry appears to be contributing to the habitat requirements for several significant species of fauna including the Quenda (*Isoodon obesulus*), Freshwater Crayfish (*Cherax quinquecarinatus*), and the dragonfly *Petalura hesperia*. Revegetation considerations for Blackberry control are explored in Section 7.5.3.

***Indigenous Species with potential to be misidentified as Weeds******Bulrush (*Typha domingensis*)***

Both the introduced *Typha orientalis* (Bulrush or Broadleaf Cumbungi) and the native *Typha domingensis* (Yanget, Bulrush or Narrowleaf Cumbungi) have been identified within the study area. Intermediates exist between the species and it can be difficult to differentiate between the two (Hussey *et al.*, 1997). In general *T. domingensis* has narrower leaves and inflorescences and a more upright stand structure (Chambers *et al.*, 1995). The characteristics listed in Table 7.4 can aid in identification.

**Table 7.4 Comparison of *Typha orientalis* with *Typha domingensis***

<b>Characteristics</b>	<b><i>Typha orientalis</i></b>	<b><i>Typha domingensis</i></b>
Height	up to 4.5 m	up to 3 m
Leaf blade width	5 - 14 mm	5 - 8 mm
Separation between male and female flower cluster	0 – 60 mm	5 - 25 mm
Width of female flower cluster	10 – 30 mm	8 - 15 mm
Colour of female flower cluster	cinnamon brown	chestnut brown
Stem width below flower cluster	4 - 7 mm	2.5 – 5 mm

Chambers *et al.* (1995)

### **Bunchy Sedge (*Cyperus polystachyos*)**

The identification of Bunchy Sedge (*Cyperus polystachyos*) in the study area has some uncertainty surrounding it. Differentiating between Bunchy Sedge (*Cyperus polystachyos*) and Scaly Sedge (*Cyperus tenuiflorus*), an invasive weed, requires examination of the flowers under a microscope. Bunchy Sedge is sometimes regarded as a native but it has probably originated in eastern Australia and become naturalised in W.A. (because it appears to be restricted to gardens, farmland and other disturbed sites in W.A.) (Marchant *et al.*, 1987).

### **Bracken Fern (*Pteridium esculentum*)**

Bracken Fern has been recorded as a weed in previous management plans but is recorded as a local species in the *Green Plan for the City of Melville* (Alan Tingay & Assoc, 1999). This species is common in moist sandy soils of the Perth metropolitan area, along creeks in the Darling Range and Gingin, and in the Eucalyptus forest near Byford and is distributed from Esperance to Moora throughout the southwest in forests and along watercourses. It becomes more dominant at disturbed sites and is considered a serious weed in poorly managed paddocks. (Hussey *et al.*, 1997, Marchant *et al.*, 1987 & Wheeler *et al.*, 2002)

Even though this species is native, its dominance to the point of it forming a monoculture in many areas reflects the level of disturbance in these areas. Simple control of this species without revegetation is unlikely to be effective in the long-term and may reduce habitat value of the area by reducing fauna habitat cover (see Section 2.7). Control of Bracken may be required at specific sites to allow a greater diversity of native plants to be come established. Establishment of overstorey species will also act to thin out the bracken and allow more native understorey plants to emerge. Bracken should therefore only be controlled in conjunction with revegetation activities, and to reduce fire hazard in areas where the occurrence of bushfire is likely to result in loss of property and risk to surrounding residents.

## **7.2.4 Monitoring and Evaluation**

Monitoring and evaluation are key actions that need to be undertaken during weed management to measure the success of control strategies. Performance indicators should be developed to objectively assess the success of weed control strategies. This will not only contribute to accountability where public funds are involved, but also provide a mechanism for modifying the strategy and maintaining its flexibility.

### **Monitoring**

When monitoring site specific projects, the following strategies are suggested:

- Establish monitoring quadrats in areas subject to weed control programmes to record the effectiveness of control methods;
- For species-led control – monitor effectiveness of control of discrete weed populations or patches, including presence or absence, and, if present, the degree of new infestation;
- For site-led control – establish monitoring quadrats and survey and record annually;
- For both control methods – monitor the effectiveness of different control methods used (manual vs. chemical control; spot spray vs. blanket spray; contractor vs. community control). The use of photographs from set points enhances this process; and

- Monitor quadrats for establishment of new weed species.

The overall extent and dominance of weeds is also measured indirectly through bushland condition mapping. Mapping using the same scale should be repeated every five years to provide an overall measure of the effectiveness of weed control and bushland restoration.

In addition to this, individual environmental weeds can be mapped to allow the monitoring of specific control measures and increase awareness of which species are exotic. Weeds that could be considered for this form of monitoring are:

- Bulrush (*Typha orientalis*) – this is extremely important as it differentiates between populations of *T. orientalis* and *T. domingensis*,
- Sydney Golden Wattle (*Acacia longifolia*) – this could be used in interpretative material to increase awareness of the issue of Australian natives becoming weeds when introduced to areas outside their natural range.
- Pampas Grass – obtaining GPS locations of plants will be useful as the locating individual plants within dense vegetation is critical to its control;
- Blackberry (*Rubus fruticosus*) – the benefits of any monitoring will only be of interest over long periods of time given the extent and density of the population, and the difficulty in elimination.

#### **Performance Criteria**

In order to determine the effectiveness of any weed control programme, there needs to be a method of determining success and ongoing progress. The following are appropriate performance criteria:

- Removal of five priority weed species from the targeted areas over the next five years; and
- Reduction in the area of priority weed infestations by 5% over 5 years.

## 7.2.5 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
2.1	Undertake ongoing prioritised weed control using the strategies outlined in this management plan.	High	2004	2009	CoM, interest groups, DMR	see Section 8 <sup>13</sup>
2.2	Remove inappropriate amenity plantings according to invasiveness and replace with local native amenity plants	Medium	2005	2006	CoM	\$2,000
2.3	Undertake monitoring to determine the effectiveness of rehabilitation strategies using Bushland Condition Mapping	Medium	2009	2009	CoM / consultant	\$2,000
2.4	Establish monitoring quadrats to determine the effectiveness of rehabilitation strategies.	Medium	2004	2004	CoM / community groups / consultant	\$1,000
2.5	Assess rehabilitation success using monitoring quadrats	Medium	2008	2009	CoM / community groups / consultant	\$2,000
2.5	Undertake a targeted flora search for <i>Caladenia huegelii</i> and if found focus weed control efforts in its habitat.	Low	2008	2008	CoM	\$1,500

<sup>13</sup> Costs for weed control vary considerably depending on community involvement, conditions etc. It is therefore difficult to provide an estimate of cost, however as a general guide, a single application of Glyphosate should be calculated at 10c / m<sup>2</sup>, and a single application of Fusilade should be calculated at 30c / m<sup>2</sup>. Rehabilitation estimates given in Section 8.0 include the cost of weed control and plant establishment.

## 7.3 Rehabilitation

### 7.3.1 Objectives

The objectives for bushland rehabilitation are to:

- minimise the impact of activities that could result in degradation to vegetation communities through the use of appropriate management strategies;
- improve the overall condition of vegetation communities within the park; and
- optimise use of resources by prioritising areas for rehabilitation.

### 7.3.2 Background

The visions for the Bull Creek Wetlands identified during public consultation included:

- the maintenance of the green space the reserves provide;
- the maintenance and enhancement of the biological assets; and
- co-operative community involvement in management.

Ecological restoration involves restoring the vegetation and habitats through means of reinforcing and reinstating the system's ongoing natural regenerative processes. This involves reducing or eliminating disturbance factors, removal of inhibitors to natural regeneration such as weeds, and the reconstruction of the ecosystem in highly disturbed areas where the potential for natural regeneration has been markedly reduced or lost.

#### **Assisted natural regeneration**

This method is used where a remnant of vegetation exists in *Fair – Good to Very Good – Excellent* condition and retains its natural regenerative capacity. It can also be used once a reconstructed community regains its natural regenerative capacity. Assisted natural regeneration involves removing weeds and disturbance factors from the environment.

#### **Reconstruction**

This technique is applicable where a bushland remnant is seriously depleted – for example where only some overstorey species are left, or when there is no remnant vegetation left. Reconstruction relies on methods to re-establish vegetation such as replanting, topsoil relocation and direct seeding.

### 7.3.3 Strategy

#### **Prioritisation**

The restoration of the vegetation should aim to maintain the resilience of good areas while restoring disturbed areas of the site. The restoration plan should follow three basic principals of bush regeneration known as the Bradley method (Appendix 5). This method involves selective weeding around native species to decrease competition, increase the size and number of native plants and gradually improve the condition of the bushland. The underlying principals of this method are:

1. Work from areas in good condition to areas in poor condition. Start regeneration work in areas with least disturbance to increase its resilience and then gradually work into areas with more weeds.
2. Minimise disturbance while working. This is important so that regeneration work does not simply create conditions suitable for weed invasion. Minimise disturbance to soils and trampling of plants.
3. Let the rate of natural regeneration determine rate of weed removal. This can be important as over-weeding will leave large bare areas that can be reinvaded by more or different weeds.

Assisted natural regeneration following the Bradley method should be guided by the bushland condition map (Map 2) undertaken in bushland in *Fair – Good* condition or better. Most of the study area however in *Poor to Very Poor* condition. Replanting and reconstruction is required in much of these areas as the exclusion of disturbance will not lead to significant regeneration.

Priorities for intensive rehabilitation works are shown in Map 3. These priorities are based on:

- expanding and linking better condition bushland;
- sites with high visibility; and
- previous weed and revegetation measures.

Some better condition sites are shown as low priorities for intensive work but it is assumed that less intensive work such as weed control will continue.

Priorities should be reassessed after bushfire events, given that it can influence the relative competitiveness of weeds and native plants in the short term. Until 2000 the midstorey of much of the upstream site at Bull Creek was dominated by Blackberry. In the summer of 2000 there was an intense fire which was followed up by intensive control of Blackberry and Sydney Golden Wattle. Since this time there has been intense regeneration of *Agonis linearifolia* and *Acacia saligna*.

### **Community Involvement**

There has been ongoing community involvement in management of the study area over the last decade. This includes the planting and maintenance of trees by the Lions Club and the propagation and planting of seedlings by Rossmoyne Senior High School and All Saints College.

The planting of locally occurring tree species and the construction of paths through them by the Lions Club and City of Melville is consistent with the objectives for the study area and should continue.

This management plan can not be enforced on land not managed by the City of Melville but the complementary management of areas adjacent to the study area within the bounds of Rossmoyne Senior High School and All Saints College is important to the viability of the bushland given its high area to perimeter ratio.

Activities that could be considered by Rossmoyne Senior High School and All Saints College:

- Removal of Geraldton Wax from the eastern end of Rossmoyne Senior High School followed by replanting;
- removal of exotic trees on the outside of the fence on the northern boundary of the main playing fields to be replaced by either native species and/or the construction of a path that links in with the Dual Use Paths within the study area;
- ongoing removal of Blackberry; and
- the propagation of seedlings for planting within the study area.

It was a recommendation of the previous management plan that the formation of a volunteer 'Friends' network (to assist in the management of the wetlands) be fostered through provision of coordination and logistical support. A 'Friends' groups has yet to be formed for Bull Creek, but should remain a priority for involving the community.

#### **7.3.4 Monitoring**

Bushland Condition mapping should form the basis for monitoring the success of restoration. In addition to this photographs should be taken from reference points each year to form a record of site's condition that can be understood by non-specialist.

### 7.3.5 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
3.1	Continue to concentrate intensive rehabilitation efforts in the High Priority Areas shown in Map 3	High	2004	on	CoM, community groups, Schools	See recc 4.2
3.2	Revegetate either side of the timber bridge adjacent to Karel Avenue with groundcovers such as Hemiandra Pungens to suppress Veld Grass, which present a fire hazard to the structure;	Medium	2005	2008	CoM, community groups, Schools	\$5,500 <sup>14</sup>
3.3	Continue revegetation in the north-east of Richard Lewis Park	Medium	2004	2006	CoM, Lions Club	\$3,000 / annum <sup>15</sup>
3.4	Remove Geraldton Wax from the eastern end of Rossmoyne High School	Medium	2007	2007	CoM, Rossmoyne High School	\$1,000
3.5	Investigate the replacement of the exotic trees on the outside of the fence on the northern boundary of the All Saints' Oval with local species and/or the construction of path linking Bull Creek Park to Reg Bourke Reserve along this alignment	Low	2009	2009	CoM, Community Groups and schools	\$2,000
3.6	Foster the formation of a volunteer 'Friends' network (to assist in the management of the wetlands) through provision of coordination and logistical support.	Medium	2004	ongoing	CoM	N/A

<sup>14</sup> Estimated 10 m on either side of bridge @ \$5.00 / m<sup>2</sup>.

<sup>15</sup> Based on cost of rehabilitation after 3<sup>rd</sup> year of rehabilitation (\$0.50 / m<sup>2</sup>)

## 7.4 Revegetation

### 7.4.1 Objectives

The objectives for revegetation are to:

- reinstate indigenous flora and vegetation communities, where they have been disturbed and/or depleted; and
- ensure that vegetation communities are self-sustaining and are capable of natural regeneration.

### 7.4.2 Background

There has been considerable revegetation already undertaken within the study area. This has been undertaken by the City of Melville and by community groups and volunteers, particularly Rossmoyne High School, All Saints College and the Lions Club. Given the limited resources available, revegetation efforts should initially focus on consolidating existing rehabilitation areas by ongoing weed control (See section 7.2) and by infill planting to increase density and survivorship in these areas. Additional rehabilitation areas should focus on increasing visual amenity (such as along the Leach Highway and Karel Avenue) and improving the condition in *Fair-Good* and *Poor* condition bushland. *Very Poor* condition bushland should only be tackled once works have been undertaken in all other areas and sufficient resources still exist. It is possible that this will not occur during the life of this management plan.

### 7.4.3 Strategy

Revegetation priorities should be guided by Map 2 – Bushland Condition and Map 3 – Priorities for Rehabilitation. Map 1 – Vegetation communities should be used to help determine the mix of species used for revegetation. Much of the vegetation in the study area has been highly modified so a practical approach to species selection should be adopted rather than trying to recreate a pre-European landscape.

#### ***Plant Material***

##### **Seedlings**

It has been noted that there have been low survival rates of seedlings planted within the study area. To maximise survival rates the seedling must be disease-free, sun-hardened, have well-developed roots; not be root bound, and be planted to the correct depth in late autumn - early winter. It is preferable for planting to occur as early after the break of season as practicable, when the soil is thoroughly moist and follow-up rain expected. The longer the plants to establish an adequate root system in the ground before the first summer the higher the success rate can be expected.

Seedlings which have grown beyond post-emergent stage (around four to nine months, depending on species growth rates) in square plastic pots (e.g. 75 x 75 x 100 mm or similar) are considered most suitable for planting. Mature stock, although less suitable, do provide an obvious statement to the general public that a regeneration programme is underway and are useful in some places. Native seedlings should include a range of groundcovers, herbaceous perennials, shrubs and trees with a view to achieving the floristic and structural composition of the original vegetation community.

Seedlings should be well watered before planting. No fertilisers should be used at the time of planting. Seedlings should not be staked for support. Free standing plants become more durable and strong. Care should be taken that plants are not evenly spaced or planted in rows. Seedlings should be randomly clumped or spaced to achieve a natural effect.

Tree guards are useful in reducing grazing pressure on seedlings by rabbits and should be used in areas where rabbits are evident. Tree-guards have become less regarded in recent times however, due to their expense and increased labour requirements. Other options should also be examined such as rabbit-proof fencing around the study site and/or Pindone baiting.

### **Direct Seeding**

Direct seeding can be a useful technique in the reconstruction areas if weeds can be suppressed. Some seed will need scarification, or smoke or heat treatment before broadcasting. Areas to be seeded should be weed free and the ground lightly tilled to create random furrows approximately 50 mm deep in which the seed can lodge. The seed should be mixed and bulked with an inert material before broadcasting by hand. Application rates for direct seeding should be 5 kg/ha, although this will depend on the viability of seeds of individual species.

While direct seeding often has a lower survivorship and can take longer to produce results, it has distinct advantages in that a more 'natural' arrangement and composition of plants can be undertaken. It is also less labour intensive and much less expensive than seedling planting, and so is an attractive option in many areas. Good site preparation is critical to successful direct seeding projects. Trial plots are also very useful to determine the best preparation, conditions and local requirements of the revegetation species.

### ***Site Preparation***

#### **Weeding**

Adequate ground preparation is important for good plant establishment. A small area approximately 50 cm in diameter should be cleared of weeds either by using a weedmat, manual hoeing or herbicides.

#### **Mulch**

Thick layers of mulch can help retain soil moisture for seedlings whilst denying weed seeds access to light and thereby restrict their growth. Following the application of the manual and herbicide control, weed-free mulch can be spread around seedlings in bare areas to help reduce weed growth. Care must be taken in sourcing mulch to ensure that it is not contaminated with weed seeds or disease.

A light cover of mulch (1-2 cm deep) is recommended over the direct seeded areas. If there are large quantities of mulch available, for example from pruning works, then 5-10 cm is optimum for areas planted with seedlings.

#### **Stabilising Steep Slopes**

Steep slopes are not a common feature of the study area, however there are localised areas of steep slopes along the drains within the study area.

Jutemat<sup>®</sup> or equivalent should be used on slopes exceeding 25°, particularly where native vegetation is sparse and soils either loose or shallow. This organic fibremulch should be laid horizontally on slopes less than 35° and vertically on steeper slopes, with pegs driven into it 50 cm spacing and a 20 cm overlap between rolls. Holes will need to be cut into the Jutemat<sup>®</sup> with carpet or heavy duty fabric scissors at 50cm spacings. In very steep or unstable areas chickenwire can be laid underneath the Jutemat<sup>®</sup> for increased strength, but this will also require cutting through when seedlings are planted. All slope stabilisation works should be undertaken when soils are most stable. This is during summer and autumn when the soils are dry. (Meney, 1999)

### **Sourcing Plant Material**

Ideally plant material should be sourced from near the site, with no more than one third of the available seed being collected from any individual plant and numerous “parent” plants used. This avoids issues of:

- Inbreeding where too few “parents” are used and the seedlings produced lack vigour; and
- genetic pollution due to the introduction of dissimilar genetic material (from a different area) which can result in depressed vigour in the surrounding population

Sourcing material close to rehabilitation projects can often be difficult due to extensive disturbance and/or clearing in the vicinity and information on the genetic requirements of individual species is often unavailable. The City of Melville has established a Provenance Seed Bank in an initiative funded by Lotterywest's Gordon Reid Foundation for Conservation and supported by Green Skills Inc. This should be utilised for rehabilitation projects, and seed from the Bull Creek Wetlands collected and added to the bank.

### **Species Selection**

#### **Coloniser Species for Highly Degraded Sites**

Seedling establishment is to a large degree determined by rainfall and soil moisture over the first few years after planting, but regardless not all plant species will establish equally well in the exposed conditions of highly degraded areas.

Given this, hardy relatively short-lived colonizer species could be planted in bare areas in the first year of rehabilitation. In the second and subsequent years these initial plants would provide some shading in which the less hardy species could establish more easily.

Shrubs and trees that occur within the study area which would be expected to establish relatively easily in highly disturbed sites include *Acacia saligna*, *Adenanthos cygnorum*, *Allocasuarina fraseriana*, *Allocasuarina humilis* and *Gompholobium tomentosum*, *Jacksonia furcellata* and *Jacksonia sternbergiana*.

Groundcover species that occur within the study area that would be expected to establish well in highly degraded areas include *Conostylis aculeata*, *Conostylis setigera*, *Hardenbergia comptoniana* and *Hemiandra pungens*.

Species that are difficult to establish in bare areas include *Banksia attenuata*, *Banksia illicifolia* and *Banksia menziesii*.

The importance of soil moisture should not be used as a basis for introducing reticulation into rehabilitation areas without consideration of the following:

- There is dieback within the study area and watering sites may increase the extent of the infected areas.
- reticulation will increase weed abundance and therefore necessitates resources to ensure the rehabilitation site does not become overrun with weeds; and
- reticulation operated frequently will produce plants that are not hardened to bushland conditions and will die in the absence of artificial watering.

Degraded areas with poor soil moisture are shown in Map 4.

#### **Height restriction near powerlines**

Trees may be no more than 3 m high within 10 m of Transmission Lines, and no higher than 6 m within 10 m of Distribution Lines. These areas are shown in Map 4.

The native plants recorded onsite that have the potential to grow taller than 6 m are: *Allocasuarina fraseriana*, *Banksia attenuata*, *Banksia illicifolia*, *Banksia menziesii*, *Eucalyptus rudis*, *Eucalyptus todtiana*, *Melaleuca preissiana*, *Melaleuca raphiophylla* and *Nuytsia floribunda*

In addition to these species, the following plants can grow higher than 3 m *Acacia saligna*, *Agonis linearifolia* and *Viminaria juncea*

This does not mean that these trees can not be planted near powerlines, but they may need to be pruned to the required height if they are planted in these areas.

#### **Height restriction along property boundaries**

The City of Melville Bushfire Management Strategy states that perimeter firebreaks will be maintained such that there is no foliage overhanging the property boundary or within three metres of the boundary between 0.5 and 5 metres above ground level, and that foliage lower than 0.5 m will not be removed.

#### **Dieback Infected Areas**

The following species should not be planted extensively where dieback has been confirmed due to the likelihood of high mortality rates: *Adenanthos cygnorum*; *Adenanthos obovatus*; *Allocasuarina fraseriana*; *Banksia attenuata*; *Banksia illicifolia*; *Banksia menziesii*; *Dasypogon bromeliifolius*; *Eucalyptus marginata*; *Hibbertia hypericoides*; *Macrozamia riedlei*; *Patersonia occidentalis*; *Stirlingia latifolia*; and *Xanthorrhoea preissii*.

#### **Wetland Areas**

Wetland areas have a high priority for revegetation, particularly after weed removal in wetland areas to help prevent recolonisation. Creeks, riverbanks and Stormwater drains in the Bull Creek Wetlands help reinstate important habitat and also improve water quality (see Section 7.1). Plant species suitable for revegetating wetland areas are listed in Appendix 7.

#### 7.4.4 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
4.1	Prioritise rehabilitation works based on Maps 2 and 3.	High	2004	2004	CoM	N/A.
4.2	Revegetation should be undertaken using the guiding principles outlined in this management plan.	High	2004	on	CoM, Community groups, schools, organisations	\$14,000 / annum
4.3	Utilise and add to the City of Melville's Native Seed Bank using material from the Bull Creek Wetlands.	Medium	2005	on	CoM, Community groups, schools, organisations	\$1,000 / annum

## 7.5 Fauna Management

### 7.5.1 Objectives

The objectives for fauna management are to:

- maintain the suite of native animals present through habitat preservation and supplementation;
- minimise predation and competition pressure on native animals; and
- minimise grazing pressure on native plants and seedlings by rabbits.

### 7.5.2 Background

The native animals that are confirmed as being present includes the Freshwater Crayfish (*Cherax quinquecarinatus*). Significant native animals that may be present include the Western *Petalura* Dragonfly (*Petalura hesperia*) and Bandicoots or Quendas (*Isodon obesulus*).

### 7.5.3 Strategy

#### ***Habitat Preservation and Supplementation***

The Freshwater Crayfish (*Cherax quinquecarinatus*) appears to show a preference to blackberry dominated habitats compared to eucalyptus dominated habitats (Wild, 2002). The removal of blackberry is therefore likely to impact on this species.

Barrett & Williams (1998) state that '*Petalura hesperia* is restricted to boggy marshes or seepages beside freshly oxygenated water sources. Sites with extensive under- and overstorey vegetation appears to be essential, perhaps to maintain moist soils and to provide roots and peripheral vegetation to burrow among.'

The preferred habitat of Bandicoots or Quendas (*Isodon obesulus*) is where the understorey is dense, particularly near watercourses and wetlands (Johnson & Thomas-Dans, 2003).

The preferred habitat for all of the above species is for dense riparian vegetation. This should be considered before carrying out Blackberry control near streams. It is critical to re-establish a dense native vegetation cover as soon as possible after the Blackberry has been removed. This will also help discourage re-establishment of weeds. The following plants should be considered for revegetation after weed control in these areas (See Section 7.4 for revegetation methods):

- local native rushes and sedges (see appendix seven for species) for cover, habitat and bank stabilisation;
- tree species particularly Albizia (*Paraserianthes lophantha*), Flooded Gum (*Eucalyptus rudis*) and Freshwater Paperbark (*Melaleuca raphiophylla*), Swamp Peppermint (*Agonis linearifolia*) to provide shade to help prevent Blackberry re-establishment; and
- native vines such as *Hardenbergia comptoniana* to provide additional dense cover.

Waterbirds use Freshwater paperbark (*Melaleuca raphiophylla*) more than any other tree or shrub around Perth due to its tendency to form multiple trunks and hollows, and its association with open water (Powell, 1990). Stout Paperbark (*Melaleuca preissiana*), shown in Plate 7.4, is less used due to its greater distance from water. Both these trees are present in the study area, as well as Flooded Gum (*Eucalyptus rudis*), which is an important source of nectar for birds and insects given its extended flowering period from winter to early summer (Powell, 1990). The maintenance of these trees especially those with hollows, such as the Stout Paperbark shown on Plate 7.4, is an important part of maintaining fauna habitat within the study area.



**Plate 7.4 Stout Paperbark with hollows in Canning Loc. 03827**

## **Introduced Fauna**

### **Pets**

Given the potential presence of species such as Quendas, dogs should be kept on leads at all times within the Bull Creek Wetlands. This will necessitate adding the Bull Creek Wetlands to the City of Melville's *Restricted Areas*. Signage should also be erected to notify users that dogs must be kept on leads. Signage can be included in the interpretive signage described in Section 7.8 as well as specific signage placed in the following locations:

- path entrance at the Brockman Ave end of Bull Creek Park;
- Mossman Cres entrance to Bull Creek Park;
- Leach Hwy entrance to Bull Creek Park;
- Leach Hwy and Camm Ave entrances to Richard Lewis Park; and
- at each end of the Shared Use Path through Bateman Park.

A public awareness campaign should also be initiated to encourage nearby residents to keep their cat indoors at night. This can include public notices in the local newspaper, posters in council offices and libraries and / or pamphlet drops to surrounding residents.

### **Foxes, rabbits and Feral Cats**

The urban locality of the Bull Creek Wetlands mean that effective control options for foxes and cats is limited. The use of poison baits such as 1080 is inappropriate in these areas, although Pindone baiting to control rabbits could be undertaken. This effectively limits direct control to trapping programs. As foxes and cats are widespread throughout the Perth Metropolitan Area, such a program would need to be ongoing and perpetual.

A more appropriate way to protect native fauna from fox and cat predation may be to provide habitat that is dense enough to provide adequate cover to native fauna. In many areas of the Bull Creek Wetlands this already exists in the form of dense stands of blackberry (*Rubus fruticosus*) and other weeds, as well as bracken fern (*Pteridium esculentum*), a disturbance dependant native species. While these species are currently under control programs, the habitat needs of native animals should be taken into account. Immediate replacement by native species that offer a similar degree of cover and protection should be undertaken. Bracken control should also be limited to areas where revegetation of a broader spectrum of species is being undertaken and where its presence poses a fire hazard and other areas set aside in these areas to provide cover for Quenda, Fairy Wrens, Scrub Wrens and other species (*J. Dell pers comm.*).

### **Speckled Mosquito Fish (*Phalloceros caudimaculatus*)**

The Speckled Mosquito fish is a serious pest in New Zealand, is rapidly becoming a serious pest in New South Wales and has the potential to become a serious pest in Western Australia. There is a resident population of this species in Bull Creek and there is a high potential for it to spread to other areas with a significant cost to biodiversity in the Perth Metropolitan Area.

It is currently known from just a few populations in Perth and was probably introduced by an aquarium enthusiast to Bull Creek. Monitoring of this species at Bull Creek to determine its biology has recently been completed by Dr. David Morgan of Murdoch University. The species has a high potential to spread to other areas as it breeds all year round (*D. Morgan pers. comm.*).

Control of this species at this early stage is critical before it becomes a major pest of Perth waterways. The most appropriate strategy for this is to reduce the numbers as much as possible by electrofishing before restocking with the native predatory fish: the Western Minnow (*Galaxias occidentalis*) and the Nightfish (*Bostockia porosa*). Monitoring should preferably be undertaken either quarterly or every six months to determine the relative abundances of the Speckled Mosquito Fish and the native predators (*D. Morgan pers comm.*).

This work should ideally be undertaken by, or in conjunction with, a tertiary institution. Dr. Morgan and the Biological Sciences Division of Murdoch University have a good knowledge of the location and habits of this fish. Support should also be sought from the Department of Fisheries, Department of Environment (DoE) and the Department of Conservation and Land Management (CALM).

### 7.5.4 Monitoring

Whilst it was not recorded during the last survey, monitoring the presence of *Petalura hesperia* should continue for the time being as:

- there are difficulties associated with detecting and estimating populations for the Western *Petalura* Dragonfly mentioned in Section 2.7.1;
- the larval period is thought to be between 5 and 6 years; and
- its habitat requirements can be dramatically altered by otherwise standard bushland management practices (such as weed control).

Ongoing monitoring of Speckled Mosquito Fish should be undertaken to assess the effectiveness of strategies, if implemented, such as restocking to determine the relative abundance of Mosquito Fish, Western Minnow and Nightfish.

### 7.5.5 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
5.1	Include the Bull Creek Wetlands into the City of Melville's <i>Restricted Areas Register</i> to ensure dogs are kept on leashes.	Medium	2004	2004	CoM	N/A.
5.2	Erect signage at strategic path intersections to notify the public that dogs must be on leads and keep to pathways	Medium	2005	2005	CoM	\$1,400 <sup>16</sup>
5.3	Undertake public awareness campaign to encourage local residents to keep their cats indoors at night.	Low	2006	2008	CoM	\$500
5.4	Investigate and implement control, if feasible, of Speckled Mosquito Fish.	High	2005	2005	CoM, Tertiary Institution	\$2,000
5.5	Monitor Speckled Mosquito Fish population.	High	2006	2009	CoM, Tertiary Institution, Fisheries Dept	\$3,000
5.6	Continue to liaise with Murdoch University with regards to the presence of <i>Petalura hesperia</i>	Medium	2005	2009	CoM, Murdoch Uni	\$3,000

<sup>16</sup> calculated at \$250 / sign

## 7.6 Fire Management

### 7.6.1 Objectives

The objectives of the City of Melville Bushfire Management Strategy are:

1. to protect human life and property from harm by bushfire occurring on lands controlled by the Council;
2. to protect and conserve the environmental values of remnant bushlands in the City of Melville from the harmful impacts of wildfires;
3. to observe statutory obligations upon the Council associated with bushfire management and control; and
4. to increase community awareness of bushfire management issues in the City of Melville.

### 7.6.2 Background

#### ***Policy Context***

The City of Melville Bushfire Management Strategy contains 23 recommendations and is based on fuel management, fire suppression and community education. The philosophy and recommendations of the Bushfire Management Strategy are incorporated in the Bull Creek Management Plan, with additional consideration given to post-fire recovery and incident analysis.

#### ***General Impacts of Fires on the Biological Environment***

To ensure that all species have adequate time to build up a seed bank between fires Burrows and Wardell-Johnson (2002) recommend that fire regimes have a fire frequency twice the period required for the slowest maturing species at a site to set seed. Wetlands systems generally tend to require greater intervals between fires than dryland vegetation (Burrows and Wardell-Johnson, 2002).

The time required to establish seedbanks can be placed in context by the following timeframes. Grey Stinkwood (*Jacksonia furcellata*), which is killed by fire, can set large amounts of seed within two or three years after germination (Powell, 1990) but other species can take considerably more time. Jarrah and Marri do not flower for approximately 4 years following intense fires that cause crown damage and their ability to resprout declines with age (Burrows and Wardell-Johnson, 2002). Freshwater Paperbark (*Melaleuca raphiophylla*) takes about five years to set seed after resprouting from fire damage (Powell, 1990). Holly-leaved Banksia (*Banksia ilicifolia*) may take up to ten years to flower from seed (George, 1996).

The relative intervals for setting seed after fire and the different fire-adaptation strategies for fire (such as resprouting as opposed to setting seed) results in specific plants being favoured by particular fire frequencies.

Freshwater Paperbark (*Melaleuca raphiophylla*) often competes with Bulrush (*Typha orientalis*) for preferred habitat on the fringes of rivers and permanent lakes. In the absence of frequent fire the Paperbarks often dominate, whilst Bulrushes often dominate where fire is

frequent (which they favour by providing high fuel loads when they dry during summer). (Powell, 1990)

Blackberry (*Rubus fruticosus*) typically responds positively to fire but fire can also be taken as an opportunity to control it , as occurred after a fire in summer 2000 (Wild, 2002).

The intensity of fires is also important as low intensity fires may not kill mature individuals of many tree species but may reduce their vigour and change components of the understorey. The intensity of fires also affects the destruction and creation of hollows.

## ***Assets Requiring Protection***

### **Natural and Cultural Assets**

Natural and cultural assets that require protection include:

- Fire sensitive species;
- Rehabilitation sites; and
- Memorial trees planted by the Lion's Club.

Stands of Holly Leaf Banksia (*Banksia ilicifolia*) are interspersed throughout the upper areas in the south west corner of Bull Creek Park. *Banksia ilicifolia* woodlands are 'poorly reserved' on the Swan Coastal Plain (Gibson *et al.*, 1994). Holly Leaf Banksia will withstand low intensity fires (Powell, 1990) but should be protected from fires where practical given the long period it takes to in the order of 10 years (George, 1996) to mature and set seed.

Grand Spider Orchid (*Caladenia huegelii*) is a declared rare species that occurs from Perth to Yallingup in deep sands in mixed Jarrah/Banksia woodland that was recorded as being present at the site by Smith (1987). This may have been a misidentification (see Section 2.5.1). A targeted survey during flowering between September and October would be required to confirm whether this identification is correct. This species is killed by fire if the above ground parts are present during the fire (August – November) (Brown, *et al.*, 1998).

Rehabilitation sites should be protected from fire, as a fire through these areas during the first years of establishment can result in the loss of all seedlings. The same consideration applies to the Lions Club memorial trees. Rehabilitation sites are identified in Section 0.

### **Infrastructure**

Infrastructure that requires protection includes:

- adjacent houses;
- adjacent schools
- bridges;
- Western Power sub-station; and
- Water Corporation sub-station.

The City of Melville's obligations with regards to the protecting infrastructure adjacent to the study area (utilities and houses) should be met through height restrictions on plants described in Section 7.4.3 and the general recommendations below.

The need to protect Council infrastructure within the study area (such as bridges) is borne out by the fact that the bridge linking Bateman Park to Thomas Middleton Park was burnt down in 2002. Some of these assets require specific measures for their protection such as the establishment of an adjacent low fuel zone.

Infrastructure requiring protection is shown in Map 5.

### **Fire History and Ignition Risk**

Fire has had a significant and ongoing influence on the vegetation in the study area, and this has been noted in the previous two management plans. Smith (1984) noted that there was 'a large amount of fire' in the preceding 10 years. Smith (1987) recorded 12 fires from 1983 to 1986, one of which burnt out 70% of the reserve. The Bull Creek Wetlands Working Group (1995) noted Bull Creek Park had a least 4 separate fires from 1987 until 1995 and Reg Bourke Park was burnt during 1992-93. There have also been at least 7 fires since 2000 (J. Stansfield, *pers comm.*). Anecdotal evidence suggests that the majority of fires result from arson.

## **7.6.3 Strategy**

### **Fuel Management**

Hazard reduction involves actively reducing fuel levels and the incidence of fire ignition.

#### **Fuel reduction**

Given the small, fragmented degraded nature of the Bull Creek Wetlands, the urban nature of the study area and its proximity to local residents, the risks associated with controlled burns outweigh any benefits gained from this activity. Furthermore, the high incidence of arson-related burns, means that the regeneration of some species is being adversely affected by the short interval between fires and that the minimum fuel loads required before controlled burns are initiated (8 tonnes / ha) are unlikely to be reached.

Instead fuel reduction activities should be focussed on reducing fuel loads through weed control and careful placement of low fuel zones (e.g. fire breaks and use of specific plants).

Control of grassy weeds should be undertaken at the perimeters of reserves in the Bull Creek Wetlands. Where this is to be done in conjunction with revegetation activities, Spraying with Fusilade before revegetation will yield good results. If no revegetation is planned immediately after control, slashing or mowing may at times be appropriate but it is often not favoured due to the adverse impact on any native seedlings that have the potential to establish..

In some areas Bracken (*Pteridium esculentum*) poses a fire hazard to infrastructure and bushland. Control of this species through slashing or spraying should be undertaken with the objective of fuel reduction only unless it is done in conjunction with revegetation using local natives. For example large areas of bracken should have a 3-4 m wide border slashed around the perimeter rather than control of the entire area so that fauna habitat can be preserved (see Section 7.5).

## Community Education

The rate of ignition is high within the study area, and this is thought to be largely the result of arson. It is worth noting that 48% of fires over a 50 year period in Kings Park are known to be arson and that large fires occur every 10-15 years during extreme conditions (Dixon, 1995). Unfortunately, arson is difficult to police and offenders are rarely caught.

Interpretative signs within the study area should make reference to the destructive cumulative effects of frequent fire on flora and fauna. The message could include reference to the frequency of fire in the study area, impacts on flora and fauna, and loss of infrastructure such as bridges. Messages should include a contact number for the City of Melville Rangers and the Police to report any suspicious activity. All calls of this nature should be followed up promptly. Even if the offenders are not caught rapid response to a potential wildfire will reduce the likelihood of damage to natural assets and infrastructure.

Another method is to circulate pamphlets or letters to residents immediately adjacent to reserves in the Bull Creek Wetlands at the onset of summer. This should highlight the dangers of uncontrolled fires to their properties, infrastructure and the surrounding bushland.

## Fire Suppression

Fire suppression involves fire-fighting application once a fire has started and taken hold.

The Fire and Emergency Services Authority is the peak fire fighting body in Western Australia. The Authority administers the: *Fire and Emergency Services Authority of Western Australia Act 1998*; *Fire Brigades Act 1942*; *Bush Fires Act 1954*; and *Emergency Services Levy Act 2002* (FESA, 2003). The structure of FESA is shown in Figure 7.7.

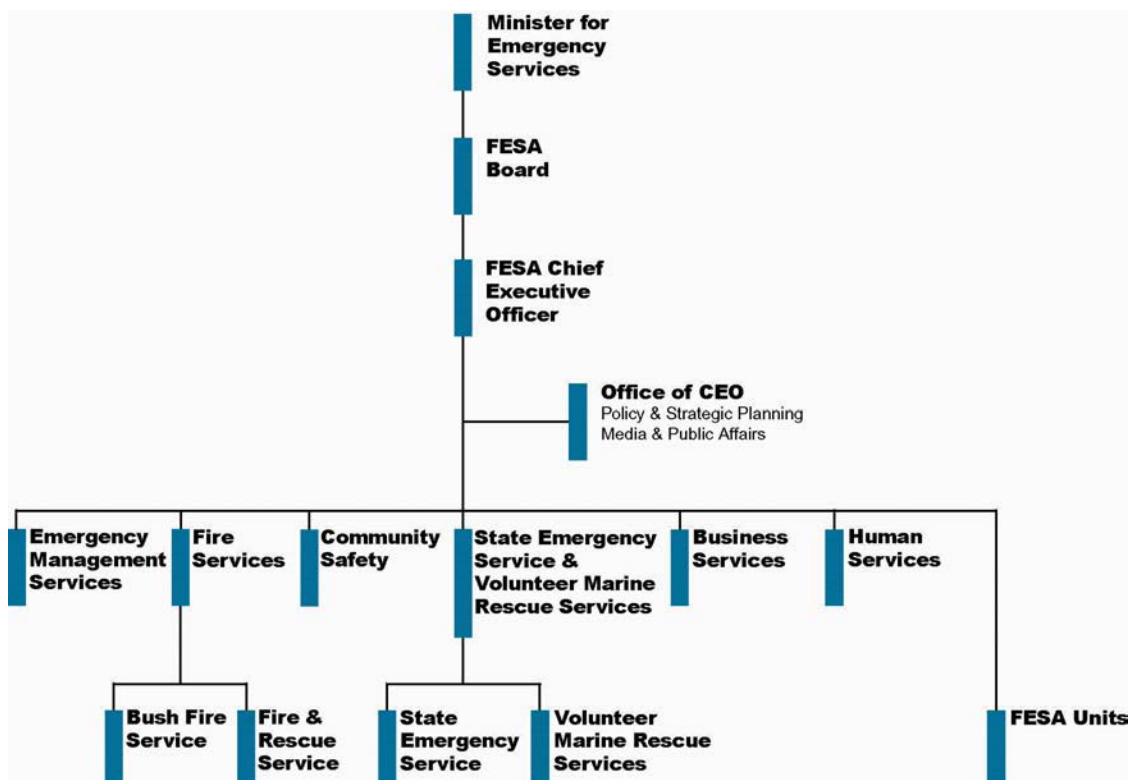


Figure 7.7 Structure of Fire and Emergency Services (FESA, 2003)

Fire suppression can only be effective if fires are detected quickly and fire fighters can respond and access the fire and contain it before it becomes uncontrollable. The nearest fire stations are:

Canning Vale Fire Station  
13 Catalano Street CANNING VALE

Kensington Fire Station  
21 George Street KENSINGTON

Welshpool Fire Station  
380 Welshpool Road WELSHPOOL WA

The approximate locations of nearby fire hydrants are shown in Map 5.

### ***Post-fire Recovery and Incident Analysis***

Bushland is in a highly sensitive condition following fire. The soil is left bare and sensitive to erosive processes, such as vehicle and foot movements, heavy summer rain and wind.

Following a fire within the Bull Creek Wetlands, an initial assessment should be undertaken of the potential for further encroachment of vehicle parking or movement into bare ground. Access control measures should also be implemented as soon as possible after the fire. Access to any burnt areas should be limited to management purposes only for the first six to twelve months.

Following fire, weed species have an opportunity to increase in density and abundance. Weed control measures will need to be implemented if a fire occurs. The post-fire environment is susceptible to further damage, and weed control works should be undertaken at a time that will give the bushland the greatest chance of successful regeneration. Implementation of weed control in the post-fire environment should follow the strategy outlined in Section 6.2.

Fire fighting operations have the potential to cause mechanical damage through trampling of vegetation, water erosion and small scale clearing. This cannot be entirely avoided, though should be minimised where possible through appropriate training within the fire-fighting authorities. Trained bush regenerators be used to repair damage of this nature.

Post-fire incident analysis is an important facet of fire management which enables fire fighters and fire control authorities to review procedures, strategies and tactics and revise them in light of experience. It is crucial that accurate records be kept to facilitate future fire and bushland management. A database should be set up where details of all fires in the City of Melville are recorded. Maps of the fire extent should also be entered into the City's GIS databases.

### 7.6.4 Monitoring

All fires that occur within the study area should be recorded. Information that should be compiled includes the date, time, cause of ignition, intensity and extent of the fire, fire control methods used and damage caused by the fire. This information can be used for long-term fire management for minimising the number of fires, educating the public the significance of the issue and examining the impact upon the flora and fauna.

Weeds in areas that have been burnt should be monitored to determine whether there are opportunities for control before weeds re-establish at the site. This would generally involve spraying with a grass selective herbicide such as Fusilade after the first flush of growth after the fire before it has had a chance to set seed.

Seed germination and resprouting in vegetation should be monitored for a year following fire. Although recovery should be adequate if grazing and weed control measures are implemented, additional direct seeding and tubestock replanting may need to be considered if germination success is low.

Fuel monitoring programmes are recommended under the City of Melville Bushfire Management Strategy.

### 7.6.5 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
6.1	Implement relevant recommendations of the City of Melville Bushfire Management Strategy in the Bull Creek Wetlands.	High	2004	2009	CoM, FESA, Local fire brigades	N/A
6.2	Undertake fuel reduction activities through the control of grassy weeds and Bracken ( <i>Pteridium esculentum</i> ) according to the guidelines in this management plan.	High	2004	2009	CoM	\$3,000 / annum
6.3	Undertake community education in the form of interpretive signage and / or pamphlet drops at the onset of summer.	Medium	2004	2009	CoM	\$500 <sup>17</sup>
6.4	Establish a database of bushfires in the City of Melville linked to the city's GIS.	High	2004	2005	CoM	N/A.

<sup>17</sup> This cost refers to the pamphlet drops only. Interpretive signage costs are included in Section 7.8.

## 7.7 Plant Pathogen Management

### 7.7.1 Objectives

The objectives for disease management within the study area are to:

- prevent the introduction of disease into the study area, or if disease becomes established then prevent further spread of disease; and
- monitor the vegetation of the area for the presence of fungal disease such as *Phytophthora*, *Armillaria* and other plant pathogens.

### 7.7.2 Background

#### ***Dieback (Phytophthora cinnamomi)***

There are 15 *Phytophthora* species in Western Australia. *Phytophthora* are soil-borne water moulds that kill a wide selection of plant species of the south west of Western Australia. As *Phytophthora* is a parasite, it requires a living host on which to feed and extracts its food by a mass of thread-like mycelium, which forms the body of the organism and eventually kills its host by girdling the base of the stem, destroying the roots and depriving the plant access to nutrients and water.

The most significant *Phytophthora* species is *Phytophthora cinnamomi*. Its life cycle requires moist, non-alkaline conditions that favour survival, sporulation and dispersal. Human activity is perhaps the biggest factor contributing to the spread of the disease. Infected soil can be moved around the forest on vehicles or bikes, footwear, animal movements, road construction and earth moving equipment.

A survey for *Phytophthora cinnamomi* was undertaken for Bull Creek Park, Reg Bourke Park, Richard Lewis Park and Bateman Park by Hart, Simpson & Associates (2002). The conclusions from this survey were:

1. The study area is largely uninterpretable due to the high level of disturbance, loss of vegetation, recent fires and lack of susceptible species;
2. *Phytophthora cinnamomi* was isolated from one dead *Banksia attenuata* tree;
3. The extent of the *Phytophthora cinnamomi* infestation could **not** be mapped due to issues of interpretation listed above but it was **not** assumed that all the higher areas are infected. Some of the vegetation in better condition indicate that dieback is not present throughout the site;
4. *Phytophthora drechsleri*, which is common in disturbed areas and has little impact upon native vegetation was isolated numerous times from flowing water within the site.
5. *Phytophthora cinnamomi* was not isolated from the running water but from the timing of the survey, after heavy rains may have reduced the probability of detection. It was assumed that *Phytophthora cinnamomi* is present in all the low lying areas of

the study area. The presence of dieback is having little impact upon the vegetation in these areas as susceptible trees have already been eliminated.

### **Honey Fungus (*Armillaria luteobubalina*)**

*Armillaria luteobubalina* (Honey Fungus), is a toadstool-producing parasitic fungus lives off both live and dead hosts and is native to Western Australia. It commonly occurs in the south-west of the state and unlike *Phytophthora cinnamomi* is not restricted by soil or landform types. It occurs in woodlands, forests, scrublands and parks on a wide variety of eucalypts and other plants such as Acacia, Agonis, Banksia, Bossiaea, Grevillea, Hakea, Trymalium and Xanthorrhoea. In some circumstances it can act as a virulent parasite that kills hosts including Tuarts. (Bougher and Syne, 1998)

*Armillaria luteobubalina* appears as a golden yellow fruiting body at the base of tree stumps around June or July. The infection is caused by the aerial dispersion of spores, or through mycelium in root systems. Infection entry points for the spores may be provided by wounds caused by fire, broken limbs and insect damage.

There is no evidence of *Armillaria* being present in the study area.

### **Aerial Canker**

Aerial Cankers are diseases caused by a group of largely air-dispersed fungi (including *Cryptodiaporthe melanocraespida* and *Zythiostroma* and *Diplodena* species) that affect the State's flora in the south-west. Occurrence of the disease is dependant on a combination of a susceptible host, infective pathogen, infection site (e.g. pre-existing wounds) and favourable environmental conditions. Under suitable conditions the disease can cause the death of plants within 2 years. (RIRDC, 2003).

Aerial canker kills twigs in the lower crown and causes lesions called cankers in the bark of the main stem and roots. Severe cankers can cause death in parts of the plants above the canker. The fungus usually enters the plant through an existing wound (insect attack or wind damage). Healthy trees not subject to stress are unlikely to be severely affected. There is no large scale control method for Aerial Canker but on an individual tree scale control is largely through the removal of infected limbs. They can be controlled using clean secateurs and Carbendazin™ (RIRDC, 2003).

There is currently no evidence of aerial canker in the Bull Creek Wetlands. If aerial canker is observed within the bushland the above methods should be used to treat the affected vegetation.

### **7.7.3 Strategy**

As there is no practical large scale cure for dieback, prevention of infection is the primary means of defence. Once dieback has been established within the study area, the protection of individual plants from dieback can be achieved using phosphite which is injected or sprayed onto individual trees. This method is a non-toxic way of preventing the disease attacking the plant and can help the plant recover. However, the treatment only lasts for 3 to 5 years it is relatively expensive due to the intensive labour requirements of injecting each tree, and can only be effectively used on small or isolated occurrences of dieback.

Standard horticultural hygiene procedures will minimise the introduction and spread of infected material. These procedures include destroying infected material, minimising vehicle access through reserves, ensuring vehicles and tools are free of soil and plant material when they come onsite, and ensuring materials brought onsite such as greenstock, soil and mulch are disease free).

Planting highly susceptible species should be minimised in dieback infected areas as these plants have the potential for high attrition rates due to the *Phytophthora*. Highly susceptible species as listed by CALM (1999b), that occur onsite include:

- *Adenanthos cygnorum*;
- *Adenanthos obovatus*;
- *Allocasuarina fraseriana*;
- *Banksia attenuata*;
- *Banksia ilicifolia*;
- *Banksia menziesii*;
- *Dasypogon bromeliifolius*;
- *Eucalyptus marginata*;
- *Hibbertia hypericoides*;
- *Macrozamia riedlei*;
- *Patersonia occidentalis*;
- *Stirlingia latifolia*; and
- *Xanthorrhoea preissii*.

There are no known methods for controlling Aerial Canker or *Armillaria luteobalbina*. The best defence against these species is to reduce disturbances within the park that could stress plants, such as frequent fire and alterations to hydrologic regime.

Standard hygiene protocols should be used to reduce the spread of diseases into and through bushland reserves in the City of Melville. These should be embodied in a policy separate, to but consistent with, the Management Plans of individual reserves to ensure that inconsistencies between reserves do not arise over time as procedures are updated and modified.

The hygiene protocols should:

- restrict unnecessary vehicle access through reserves;
- restrict the movement of soil in infected areas (through the grading of firebreaks);
- establish a system for documenting infestations and their control;
- recognise different levels of risk based on factors such as soil type (given that *Phytophthora* does not express in highly alkaline soils); and
- establish systems to ensure diseased material such as seedlings, mulch and soil are not brought into reserves.

In addition the following should be adhered to:

1. Minimise operations involving movement of soil, such as firebreak and track construction and maintenance, to a minimum, and carry out these operations under strict dieback hygiene practices.

2. Ensure that any soil or plant material used for bushland restoration should be certified as *Phytophthora*-free.
3. Ensure that nurseries commissioned to grow plants for revegetation works are accredited dieback-free nurseries.

#### 7.7.4 Monitoring

The death of susceptible species can be used as an indication that *Phytophthora* is present (CALM, 1999b). Key indicator species that occur at the site include:

- *Adenanthos cygnorum*;
- *Adenanthos obovatus*;
- *Allocasuarina fraseriana*;
- *Banksia attenuata*;
- *Banksia ilicifolia*;
- *Banksia menziesii*;
- *Dasypogon bromeliifolius*;
- *Eucalyptus marginata*;
- *Hibbertia hypericoides*;
- *Macrozamia riedlei*;
- *Patersonia occidentalis*;
- *Stirlingia latifolia*; and
- *Xanthorrhoea preissii*.

The presence of these species indicates that the entire study area may not have been infected by *Phytophthora*. Deaths of groups of these plants should be monitored as potential indicators of the spread of *Phytophthora* within the study area.

#### 7.7.5 Recommendations

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
7.1	Maintain hygiene protocols for Council operations within bushland	High	2005	2006	CoM	N/A
7.2	Monitor bushland for signs of plant pathogens and map occurrences.	Medium	2004	2009	CoM	\$1,000

## 7.8 Recreation and Infrastructure Management

### 7.8.1 Objectives

The objectives for maintaining, rationalising or upgrading access within the reserves are:

- Providing access for the public's use of the reserves;
- Providing access for Council works programs; and
- Providing a sense of common identity between all the reserves within the study area.

### 7.8.2 Background

The visions identified during public for the Bull Creek Wetlands included:

- a raised profile amongst residents in the immediate vicinity;
- the identity of the Bull Creek Wetlands is based on it being an integrated biological system rather than a series of nearby reserves; and
- a pathway providing a bushland experience in the urban environment.

Existing infrastructure is shown in Map 5.

#### ***Paths***

There are already paths within the Bull Creek Wetlands, but no sense of continuity in the path network due to the fragmentation of the reserves in the system by roads and development, the inconsistent use of materials for paths and bridges, and the lack of unifying signage. The bridge linking Bateman Park with Thomas Middleton Park to the north was burnt down in 2002 and has not been rebuilt. Examples of the different styles of bridges is shown in Plate 7.5.



***Plate 7.5 Different Bridge Styles in the Bull Creek Wetlands***

## **Signage**

There is little regulatory signage within the study area. Currently signage consists of the following:

1. Interpretive information shelter at Bull Creek Park. This has graffiti on it.
2. Entry statements for all reserves in the Bull Creek wetlands consisting of the name of the reserve. These signs are uniform in style and appearance.
3. Various rehabilitation works signs – notably in Bateman Park along the leach highway (partially hidden by vegetation) and at Richard Lewis park by the Lions Club.
4. Regulatory signage on shared-use pathways in Bateman Park.

Some of the signage in the study area has fallen into disrepair. There is graffiti on some signs, signs with no writing on them whatsoever (at Richard Lewis Park), and the panels in the information shelter have been broken.

The 'Melville Historical Heritage Trail' sign at the boundary of Bateman Park on Pulo Road is not associated with any formal path or further indication as to where it should lead. At present this sign provides little guidance to persons visiting the park. It needs to be removed, amended to provide additional information, or have a formal path constructed next to it.

Signs at present also do not reinforce a sense of common identity between all the reserves within the study area:

- Signs in Reg Bourke and Richard Lewis Parks make no reference to the Bull Creek Wetlands;
- there are no signs at Location 03827; and
- there is little interpretation of linkages between the reserves.

## **Fencing**

Currently fencing in the study area has been erected separating Reg Bourke Park and Bull Creek Park with All Saints College Oval. This consists of a tall chain link fence, which while unattractive is functional to protect school assets. Bollards have also been established at Bull Creek Reserve along Karel Avenue, Brockman Avenue, Debries Place and Mossman Crescent / Forster Court.

Fencing is not necessary in most areas of the Bull Creek Reserve. The built up nature of the surrounding area means that unauthorised access by vehicles is rare. Although there is some anecdotal evidence that vehicles are entering the bushland within Rossmoyne Senior High School off Karel Avenue.

### 7.8.3 Strategy

#### **Paths**

While there is an existing path network within the Bull Creek Wetlands, these do not contribute to a sense of cohesion or continuity between the reserves in the Bull Creek Wetlands as:

- there is no indication of the extent of this network on any signs;
- parts of the network have been aligned along Leach Highway, and therefore the bushland experience desired by the public is not fulfilled;
- there is no uniformity in materials within the site (which varies from concrete and bitumen to limestone);
- bridges are not uniform in style; and
- the bridge linking Bateman Park to Thomas Middleton Park has not been rebuilt since it burnt down in 2002.

The need to protect infrastructure such as bridges from fire is discussed in Section 7.6.3.

The existing network of paths (shown in Map 5) can be unified through the following actions:

- placing informative signage and maps that show the site and path network in the context of the Bull Creek Wetlands;
- gradually upgrading paths to a uniform surface. This should ideally be bitumen or concrete to include a wide variety of recreational uses (i.e. walking, cycling, wheelchair access);
- where possible ensuring uniformity in all public infrastructure along the path network including seats; and
- closing the sand tracks indicated in Map 5.

The priority for track upgrades are the limestone tracks in Bull Creek Park.

#### **Signage**

An appropriate level of signage in the Bull Creek Wetlands can help unify the wetlands, guide and regulate activities. Signage can be divided into:

1. Regulatory
2. Interpretive
3. Advisory

Regulatory signage is currently limited to cycleway signage. Additional regulatory signage should relate to the requirement for dogs to be leashed at all times.

Interpretive signage is important to reinforce the identity of Bull Creek Wetlands. Interpretive signage can cover the following topics:

1. The Aboriginal and European history of Bull Creek. This is important in light of the publicity surrounding the return of Yagan's head to the Aboriginal community.
2. The natural history of the area, including insights as to what the area was like before European settlement.

3. General information on the function of wetlands and how rehabilitation is improving the function and aesthetic values of the wetlands.
4. Guidelines for appropriate recreational use of the wetlands. Do's (enjoy nature, take photographs, respect the bush, respect other recreational users, be careful, keep dogs on leashes) and don'ts (stray off paths, pick wildflowers). Make sure the do's outnumber the don'ts.
5. How the Bull Creek Wetlands, although separate reserves are linked and can be regarded as a single ecosystem.

Potential locations for additional interpretive signage are:

- *Fair - Good* condition vegetation at southern end of Bull Creek Park;
- near bridge at 'elbow' of Bull Creek Park; and
- *Fair to Good* condition vegetation at Richard Lewis Park near Lions Club rehabilitation.

Advisory signage provides information to enhance the use of the Wetlands. This includes entry statements, directional signs and maps. The following Advisory signage should be incorporated in the Bull Creek Wetlands:

1. Entry statements featuring reserve names should have the subheading added: *.. "Part of the Bull Creek Wetlands"*. This modification can be carried out to existing entry statement signs that are uniform.
2. Maps showing of the path network in the Bull Creek Wetlands. These should be positioned in a visible but unobtrusive manner. To cut costs and reduce 'sign crowding' these can be incorporated into the interpretive signage.

## **Other infrastructure**

### **Seats**

Seats should be uniform and consistent and placed at appropriate intervals with high comfort and visual amenity. They should be placed in shady areas, with good natural views away from isolated areas which are likely to be vandalised.

At this stage few areas present themselves that meet the above criteria. However ongoing revegetation works in the area will improve the visual amenity and shade options for seating towards the end of the life of the management plan.

### **Bins**

It is not recommended to provide bins as the study area does not include picnic and barbecue areas. Bins require emptying, are frequently vandalised and can actually increase the incidence of littering. CALM has recently adopted a policy of not providing bins in natural areas and this has actually reduced litter problems in many areas.

### **Playgrounds**

There is currently one playground near the southern part of Bull Creek Park. This appears sufficient as there is little parking and is likely to be only used by surrounding residents. There are no other areas where the installation of a playground is appropriate.

### **Picnic / barbecue areas**

Picnic and barbecue areas should be limited to grassy recreational areas. The only location that suggests itself in this respect is the small park at the southern end of Bull Creek Park. This area would be enhanced by the addition of a picnic area. A barbecue is likely to be underused in this location.

### **7.8.4 Monitoring**

There is no need for intensive monitoring of recreational use or infrastructure. Monitoring visitation levels within the study area should be undertaken as part of strategic studies undertaken by the City of Melville and infrastructure should be monitored as part of the general maintenance of Council assets.

### **7.8.5 Recommendations**

<b>No.</b>	<b>Recommendation</b>	<b>Priority</b>	<b>Start Year</b>	<b>End Year</b>	<b>Responsibility</b>	<b>Cost</b>
8.1	The bridge linking Bateman Park to Thomas Middleton Park should be rebuilt and linked into a Dual Use Path on the Spinaway Crescent side of the creek;	Medium	2007	2008	CoM	\$45,000
8.2	Upgrade limestone tracks to Bitumen in Bull Creek Reserve	Low	2009	2009	CoM	\$36,000 <sup>18</sup>
8.4	Rationalise existing signs and erect interpretive signage in strategic locations outlined in text	Medium	2005	2005	CoM / Rossmoyne / All Saints	\$1,500 <sup>19</sup>
8.5	repair existing interpretive shelter at south end of Bull Creek Park	High	2004	2004	CoM	\$250
8.6	Install subheading sign to reserve entry statements	High	2004	2004	CoM	\$2,000 <sup>20</sup>
8.7	Install map advisory signage near entry points to the Wetlands	Medium	2006	2006	CoM	\$1,500
8.8	Install seats near interpretive signage locations	Low	2009	2009	CoM	\$3,000 <sup>21</sup>
8.9	Install picnic table at small park on southern end of Bull Creek Park	Low	2008	2008	CoM	\$1,000

<sup>18</sup> 740 m of path @ \$120 / m

<sup>19</sup> 3 signs @ \$500 each

<sup>20</sup> 4 signs @ \$500 each

<sup>21</sup> 3 seats @ \$1,000 each

## 8.0 Implementation Plan and Costs

### Bull Creek Wetlands Management Plan 2004 - 2009

#### 8.1 Recommendations

There are 41 recommendations in this report. These are collated in the summary at the beginning of this document. Timeframe, responsibility and costs associated with each recommendation have been included to guide implementation of the recommendations. Recommendations are associated with specific actions. Procedural management (such as fire response) has been detailed in the text of the Management Plan.

#### 8.2 Timeframe

The timeframe for this Management Plan is 5 years. It is intended that all recommendations will be implemented during this timeframe. Some recommendations relate to ongoing projects (such as weed control) and therefore completion dates are not appropriate, but the priority assigned to each recommendation can be used for guidance in their implementation.

#### 8.3 Funding Requirements

##### 8.3.1 Introduction

The City of Melville has an Environmental Programs Manager, an Environmental Officer and two Bushland Maintainers. At present the City of Melville spends approximately \$700 per hectare per annum on bushland management (Stansfield, 2004).

Cost estimates for recommendations requiring specific one-off funding are costed under capital funding. Other recommendations are dealt with in the recurrent funding section below. Some of the recommendations made do not require specific funding as they refer to the formalisation, review or continuation of current practices.

##### 8.3.2 Cost Estimates for Capital Works

Approximate costs for implementing the capital works recommended in this plan, including installation where appropriate, are given in Table 8.1.

Table 8.1 Capital Work Expenditure

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
1.1	Continue monitoring water quality parameters, using standardised measurements and noting significant findings.	High	2004	on	CoM / consultant	\$2,000 / annum
1.3	Investigate significant aberrations in water quality parameters, if and when they occur, through further sampling	High	2004	2004	CoM / consultant	\$3,000 - \$5,000
1.4	Continue to investigate and implement streamlining options for stormwater drainage within the study area	High	2004	2009	CoM / Community Groups / SRT / Water Corp / DoE	\$10,000 / annum
1.5	Investigate the feasibility of bank reshaping and realignment of the drainage line originating from Richard Lewis Park where it runs through Bateman Park	Low	2008	2009	CoM / Water Corp / SRT / DoE	\$2,000
2.2	Remove inappropriate amenity plantings according to invasiveness and replace with local native amenity plants	Medium	2005	2006	CoM	\$2,000
2.3	Undertake monitoring to determine the effectiveness of rehabilitation strategies using Bushland Condition Mapping	Medium	2009	2009	CoM / consultant	\$2,000
2.4	Establish monitoring quadrats to determine the effectiveness of rehabilitation strategies.	Medium	2004	2004	CoM / community groups / consultant	\$1,000
2.5	Assess rehabilitation success using monitoring quadrats	Medium	2008	2009	CoM / community groups / consultant	\$2,000
2.5	Undertake a targeted flora search for <i>Caladenia huegelii</i> and if found focus weed control efforts in its habitat.	Low	2008	2008	CoM	\$1,500
3.4	Remove Geraldton Wax from the eastern end of Rossmoyne High School	Medium	2007	2007	CoM, Rossmoyne High School	\$1,000
3.5	Investigate the replacement of the exotic trees on the outside of the fence on the northern boundary of the All Saints' Oval with local species and/or the construction of path linking Bull Creek Park to Reg Bourke Reserve along this alignment	Low	2009	2009	CoM, Community Groups and schools	\$2,000

No.	Recommendation	Priority	Start Year	End Year	Responsibility	Cost
5.2	Erect signage at strategic path intersections to notify the public that dogs must be on leads and keep to pathways	Medium	2005	2005	CoM	\$2,000 <sup>22</sup>
5.3	Undertake public awareness campaign to encourage local residents to keep their cats indoors at night.	Low	2006	2008	CoM	\$500
5.4	Investigate and implement control, if feasible, of Speckled Mosquito Fish.	High	2005	2005	CoM, Murdoch Uni	\$2,000
5.5	Monitor Speckled Mosquito Fish population.	High	2006	2009	CoM, Murdoch Uni	\$3,000
5.6	Continue to liaise with Murdoch University with regards to the presence of <i>Petalura hesperia</i>	Medium	2005	2009	CoM, Murdoch Uni	\$3,000
6.3	Undertake community education in the form of interpretive signage and / or pamphlet drops at the onset of summer.	Medium	2004	2009	CoM	\$500 <sup>23</sup>
7.2	Monitor bushland for signs of plant pathogens and map occurrences.	Medium	2004	2009	CoM	\$1,000
8.1	The bridge linking Bateman Park to Thomas Middleton Park should be rebuilt and linked into a Dual Use Path on the Spinaway Crescent side of the creek;	Medium	2007	2008	CoM	\$45,000
8.2	Upgrade limestone tracks to Bitumen in Bull Creek Reserve	Medium	2006	2009	CoM	\$58,800 <sup>24</sup>
8.4	Rationalise existing signs and erect interpretive signage in strategic locations outlined in text	Medium	2005	2005	CoM / Rossmoyne / All Saints	\$1,500 <sup>25</sup>
8.5	Repair existing interpretive shelter at south end of Bull Creek Park	High	2004	2004	CoM	\$250
8.6	Install subheading sign to reserve entry statements	High	2004	2004	CoM	\$2,000 <sup>26</sup>
8.7	Install map advisory signage near entry points to the Wetlands	Medium	2006	2006	CoM	\$1,500
8.8	Install seats near interpretive signage locations	Low	2009	2009	CoM	\$3,000 <sup>27</sup>
8.9	Install picnic table at small park on southern end of Bull Creek Park	Low	2008	2008	CoM	\$1,000

The cost estimate for the capital works recommended in the Management Plan total \$203 550. These costs are only approximate as they can vary considerably, depending on how much work is completed by Council Staff and the details of design and materials. The cost of upgrading signage will depend on decisions such as whether aluminium or plastic backing is used, whether single or multiple colours are used, whether the signs are single or double-sided, and the complexity of the sign layout (which will determine the graphic design costs).

<sup>22</sup> calculated at \$250 / sign

<sup>23</sup> Cost of pamphlet drops only. Interpretive sign costs are included in 8.4, 8.5, 8.7, 8.8.

<sup>24</sup> 740 m of path @ \$120 / m

<sup>25</sup> 3 signs @ \$500 each

<sup>26</sup> 4 signs @ \$500 each

<sup>27</sup> 3 seats @ \$1,000 each

### 8.3.3 Cost Estimates for Restoring Bushland to Very Good Condition

Approximate costs for maintaining very good condition and improving poorer condition urban bushland to very good over a 5 year period are given in Table 8.2.

**Table 8.2 Cost of professional rehabilitation per square metre**

Condition	Very Good to Excellent	Fair to Good	Poor	Very Poor
Establishment	\$0.02*	\$0.02*	\$5.00	\$6.00
After 1st Year	\$0.02	\$0.25	\$2.00	\$3.00
After 2nd Year	\$0.02	\$0.05	\$1.00	\$1.20
After 3rd Year	\$0.02	\$0.02	\$0.50	\$0.50
Years thereafter	\$0.02	\$0.02	\$0.02	\$0.02

\*There is no establishment phase for either *Very Good-Excellent* or *Fair-Good* condition bushland. However a maintenance cost has been included in the first year (establishment phase) of the table so that the total costs calculated reflect the management of all sites over a five year period.

These indicative estimates are based on the full commercial costs of maintaining or restoring bushland in an urban setting to very good condition. They vary from \$200 to \$60 000 per hectare per annum. The City of Melville spends \$700 per hectare per annum on bushland management (Stansfield, 2004). These figures appear to be in consistent but should not be directly compared without reference to the bushland condition across all the sites it manages and the objectives and implementation timeframes for all these sites.

The costs given above are indicative and the actual costs of maintaining good condition bushland will vary depending upon circumstances such as the size of the area, accessibility (e.g. steep slopes and dense vegetation), and adjacency to degraded areas. Maintaining larger bushland remnants is less expensive than maintaining small or fragmented remnants, which most urban bushland is, but the cost of establishment and maintenance of the very poor sites would be less variable, given that most of the cost is absorbed by seedlings. It is assumed that seedlings will cost approximately \$1.50 each and that 2-3 seedlings will be planted per square metre in poor to very poor sites. This is an indicative cost of purchasing and planting seedlings. The cost of seedlings will vary depending upon the species selected and the quantity ordered. Planting costs will also vary depending upon how accessible the site, how well the site is prepared (in terms of weeding and ripping etc), and whether labour is provided by volunteers or whether it is paid for. Additional costs at sites can also include any earthworks (such as ripping), tree guards (18-30c each), bamboo stakes (9-15c each), weed mats (35-45c). The cost of these items will depend upon the type and quantity.

These estimates reflect the cost of maintaining or restoring bushland to very good condition. The cost of restoration is higher than maintenance because costs such as seedlings do not have to be borne. It should be noted that even though the cost of maintaining very good bushland is approximately \$0.02/m<sup>2</sup>, the maintenance costs will be greater in poorer quality bushland as the weeds are in higher abundance and increase their extent more rapidly. This should be taken into account when considering if the overall goal of a site should be maintenance rather than restoration.

Costs could be reduced significantly with the use of staff and volunteer labour, particularly in maintenance of higher quality bushland where a greater proportion of costs are labour.

The recurrent costs for managing the bushland at the Bull Creek Wetlands, based on the above data, are shown in Table 8.3.

**Table 8.3 Total Cost of Professional Rehabilitation per Category**

<b>Condition</b>	<b>V. Good to Excellent 1.945 ha</b>	<b>Fair to Good 5.246 ha</b>	<b>Poor 3.829 ha</b>	<b>Very Poor 8.8464 ha</b>	<b>Total ha</b>
Establishment	\$389.00	\$1,049.20	\$191,450.00	\$530,760.00	\$723,648.20
After 1st Year	\$389.00	\$13,115.00	\$76,580.00	\$265,380.00	\$355,464.00
After 2nd Year	\$389.00	\$2,623.00	\$38,290.00	\$106,152.00	\$147,454.00
After 3rd Year	\$389.00	\$1,049.20	\$19,145.00	\$44,230.00	\$64,813.20
Years thereafter	\$389.00	\$1,049.20	\$765.80	\$1,769.20	\$3,973.20
<b>Total of above</b>	<b>\$1,945.00</b>	<b>\$18,885.60</b>	<b>\$326,230.80</b>	<b>\$948,291.20</b>	<b>\$1,295,352.60</b>

The above cost estimate is based on targeting all areas within a five-year timeframe. The costs could be spread over a greater number of years, for example by staggering the years of establishment between sites within or between the reserves. These typical costs also do not factor in optimising opportunities (such as increasing weed mapping and weed control after fires).

Whilst a useful exercise to gauge the full costs of restoring the Bull Creek Wetlands, funds of this magnitude for bushland management of the Bull Creek Wetlands likely to be beyond the resources of the City of Melville within the time frame of this management plan. Therefore the scope of recommendations for rehabilitation within the study area is based on the assumption that in the order of \$14 000<sup>28</sup> per annum is available for normal rehabilitation activities in the Bull Creek Wetlands.

<sup>28</sup> This is based on \$700 per hectare per annum average expenditure on revegetation within the City of Melville.

### 8.3.4 Cost Estimates for Establishing Seedlings on Degraded Slopes

There is approximately 0.19 ha of degraded slopes on the north-eastern boundary of Bull Creek Park, adjacent to Karel Avenue. This area has been included in the *Very Poor* condition bushland in the above costing estimates but additional management may be needed to avoid short term slope destabilisation in this area where there are few native plants and the risk of soil slippage is high.

An organic fibremulch such as Jutemat® needs to be considered for temporary stabilisation of fragile or unstable slopes and suppress weeds. Holes need to be cut into the material so that native plants or large rocks are not covered, and so seedlings can be planted. The costs associated with such works are shown in Table 8.4.

**Table 8.4 Costs for Plant Establishment on Steep Degraded Slopes**

Item	Unit Cost	Quantity	Total Cost
Weed Control (prior to Juting slopes)	\$0.13 / m <sup>2</sup>	1 900 m <sup>2</sup>	\$247
Jute mat – 500 gsm	\$3.00 / m <sup>2</sup>	1 900 m <sup>2</sup>	\$5,700
300 mm Pins for Jute	\$15.00 / 50 pins	7 600 pins (@ 4 / m <sup>2</sup> )	\$2,280
Laying Jute	\$1.50 / m <sup>2</sup>	1 900 m <sup>2</sup>	\$2,850
Seedlings (tubestock)	\$1.50 / seedling	7 600 (@ 4 / m <sup>2</sup> )	\$11,400
Cutting Holes in Jute & Planting Seedlings	\$1.50 / seedling	7 600 (@ 4 / m <sup>2</sup> )	\$11,400
Weed Control (each year after planting)	\$0.13 / m <sup>2</sup>	1 900 m <sup>2</sup>	\$247
<b>Total</b>	<b>\$17.96 / m<sup>2</sup></b>	<b>1 900 m<sup>2</sup></b>	<b>\$34,124</b>

The cost of approximately \$18 / m<sup>2</sup> for slopes contrasts dramatically to the estimate for easily assessable areas of \$6 / m<sup>2</sup> and reflect the need for soil stabilisation. This equates to \$22,800 in excess of the cost estimate provided in the preceding subsection.

## 8.4 Current external funding Sources

There are a number of external sources of funding in the form of grants and employment and training programmes, which are described below.

Funds can also be sought from the major stakeholders including local businesses, large corporations, government departments and non-profit organisations.

### 8.4.1 Envirofund

The Australian Government Envirofund is the local action component of the Australian Government's \$2.7 billion Natural Heritage Trust. It helps communities undertake local projects aimed at conserving biodiversity and promoting sustainable resource use. The Australian Government Envirofund enables community groups and individuals to apply for grants of up to \$30 000 to carry out on-ground and other actions to target local problems. Application Forms and Guides can be obtained from the Natural Heritage Trust information line on 1800 065 823 or by emailing [ciu@deh.gov.au](mailto:ciu@deh.gov.au).

Cleaning up rivers & waterways around Australia Bundaberg Rum has joined forces with Landcare Australia to launch the Bundaberg Rum Bush Fund, a new environmental initiative to help your community improve rivers and waterways across Australia. Working in partnership with Landcare, the Bundaberg Rum Bush Fund will see more than \$150,000 in community grants available to environment groups around Australia tackling water quality projects.

### 8.4.2 Bundaberg Rum Bush Fund

Landcare and other community groups, tackling water quality projects, are invited to apply for a Bundaberg Rum Bush Fund grant (between \$1 000 - \$5 000). Landcare Australia and Bundaberg Rum will assess proposals, based on environmental and community merits, and allocate grants twice yearly.

Grant applications must address water quality issues within the local area. This may be within a river, lake, stream, creek, or as part of the wider catchment.

Applications will be assessed against the following criteria and the overall aims of the Fund:

- The expected environmental benefits of the project;
- What your local water issues are and how severe they are (i.e. why help is needed for your area);
- Your plan to use appropriate on-ground works to work on those problems (where do you get advice from on those problems and what you have proposed);
- How your project links into wider community plans;
- Potential for the project to develop the group's skills and their ability to contribute the environmental restoration in the future; and
- Your plan's feasibility and technical soundness.

Applications can be obtained from [www.landcareaustralia.com.au](http://www.landcareaustralia.com.au).

### **8.4.3 Mitre 10 Junior Landcare Grants Program**

This program provides funds for schools and youth groups across Australia wishing to participate in environmental projects.

Through the Mitre 10 Junior Landcare Grants Program, any school or organisation that would like to involve their students in landcare projects, in conjunction with local landcare groups, can apply for grants to assist them with the cost of their projects. The program targets major issues relevant to our natural environment including:

- Energy
- Waste/Recycling
- Air
- Biodiversity
- Water
- Land

In addition to on-ground rehabilitation or restoration works, projects may also include conservation of natural resources, environmental monitoring programs, waste minimisation, using school grounds as learning centres or undertaking an environmental field trip.

Most project applications will be expected to have a value of around \$500 and will be more likely to be successful if the projects:

- involve the school community or broader local community;
- have determined educational outcomes with an environmental focus;
- link with a community landcare entity;
- are well planned and documented; and
- are student-oriented and allow maximum student involvement.

Applications can be obtained from [www.landcareaustralia.com.au](http://www.landcareaustralia.com.au).

### **8.4.4 Lotterywest**

Lotterywest's Gordon Reid Foundation for Conservation provides funding to help community groups conserve natural habitats and biodiversity. Only local government authorities and non-profit community groups can apply for this type of funding.

Grants are available to support community organisations to conserve the State's natural habitats and diversity. Examples of projects that may be considered are:

- Revegetation activities and the protection of remnant vegetation;
- Flora and fauna surveys;
- Management plans for reserves;
- Public education projects such as the production of brochures etc; and
- Research projects which will assist in the conservation of Western Australia's biodiversity.

Grants must be a minimum of \$1000, and non-incorporated organisations can apply for up to \$5000 whilst incorporated organisations can apply for grants in excess of \$5000.

Applications can be obtained from [www.lottery.wa.gov.au](http://www.lottery.wa.gov.au).

#### **8.4.5 Greening Australia, Western Australia Inc.**

Greening WA Inc works with the community to protect and restore native vegetation at a greater rate than the rate of decline. Greening WA is particularly concerned with restoring degraded farmland, neglected wetlands and natural bushland. Greening WA is a member of the national Greening Australia federation. It is resourced through the Federal Government's Bushcare program, the Western Australian government, corporate sponsors and members. Greening WA is involved with administering a number of programs for revegetation and protection of remnant vegetation, such as the National Corridors of Green Program. Greening Australia also provides plants, seeds and materials to school groups in the metropolitan area called 'Grow us a Home'.

#### **8.4.6 Corporate Sponsorship**

There are a number of bushland management activities currently funded (either jointly or wholly) by corporate parties, such as Alinta Gas, Western Power, Alcoa, Woodside, insurance companies and banks. This avenue for funds for implementing works should be explored more fully. Western Power has a substation adjacent to (and powerlines through) the study area, and therefore may be amenable to funding in the Bull Creek Wetland.