

## BRINGING BACK THE SWANS



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**WATER AND RIVERS COMMISSION**

**BRINGING BACK THE SWANS:  
THE POTENTIAL TO ENCOURAGE MORE  
BLACK SWANS  
ONTO THE SWAN RIVER**

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## 1. INTRODUCTION

### 1.1 Background

Black Swans (*Cygnus atratus*) have considerable significance to Western Australia and in the history of Australian bird study. So much so that the eminent Western Australian zoologist Dr Dominic Serventy commented that Black Swans "...hold a premier place in the annals of Western Australia" (Serventy & Whittell, 1967).

Black Swans were one of the first Australian birds to be seen and described by Europeans with records in July 1635 from Shark Bay. Forty years later in January 1697, Willem de Vlamingh landed near Cottesloe and in the course of explorations four Black Swans were caught, two of which were taken alive to Batavia. This event led to the naming of the Swan River and later, when European settlement began, to the Swan River Colony (Serventy & Whittell, 1967).

Subsequently, the Black Swan became the emblem of the Colony and then of the State of Western Australia. Black Swans also feature on many colonial buildings such as on the clock tower of the Fremantle Town Hall and on lamp stands on the bridges next to the Perth Railway Station; on Coats of Arms such as that of the University of Western Australia; and as a brand name for a wide range of local products and businesses from beer to taxis. Black Swans also have special significance to the local Aboriginal community.

Despite the historical, cultural and symbolic significance of Black Swans in the Perth region, the birds have not fared well since European settlement on the river that is named after them. Much of the former habitat suitable for Black Swans on the river has been affected by development, particularly in the past century. Extensive shallow areas such as the foreshores at Perth and South Perth have been filled in and reclaimed, and fringing vegetation such as reed beds have been removed, thereby reducing shallow productive areas and adjacent freshwater wetlands, which are habitats favoured by swans as feeding and resting sites, and important components of nesting habitats.

Furthermore, the overall river ecosystem has changed through alterations to salinity as a result of dredging of the river mouth and modifications within the catchment area. This, together with pollution of the river by urban and industrial discharges, is likely to have affected the availability of food plants attractive to Black Swans.

The number of Black Swans frequenting the river has declined with this reduction in the availability of resources. The virtual absence of Black Swans on the Swan River today together with the importance of Black Swans in the cultural identity of Perth and Western Australia has generated interest in taking measures to attract a greater number of Black Swans to the Swan River on several occasions in the past decade. The Government of Western Australia, through the Water and Rivers Commission and the Swan River Trust, has commissioned the present study to investigate the feasibility of encouraging greater numbers of Black Swans on the Swans River system.



## 1.2 Purpose

The feasibility study to re-establish Black Swans on the Swan River was undertaken to gain a greater understanding of the scientific, financial, social and practical issues that would be involved in implementation of the idea.

The notion of “bringing back the Black Swans” has significant social and environmental merit:

- It would validate the use of the “Black Swan” as an icon of the social fabric of the Perth community. Having used the symbol of the Black Swan to present Perth to itself and the rest of the world, it is only reasonable that Perth people have a right and responsibility to ensure that the symbol is meaningful. There is a risk that, with complacency, there will be less and less physical presence of the swan to legitimise its use as a symbol.
- The Black Swan has value as a powerful and living icon that could be used to rally and promote environmental support, serving as a social reminder of the importance of environmental protection.
- Although an increased presence of Black Swans does not necessarily indicate a completely healthy waterway, it would serve as a conspicuous reminder and sign of the community’s efforts and ability to successfully manage the health of the river in the long term. As one of the largest conspicuous animal on the river, the Black Swan is an environmental indicator for both professional and lay people. The Black Swan could be viewed as a beacon of success, or failure, in joint government and community management of the river.
- The Black Swan, being a highly mobile animal, links the Swan to the wetlands of the Swan Coastal Plain and beyond to the inland rivers and lakes systems. Raising community awareness of Black Swans would also serve to remind the Perth community that it is part of a wider region, the health of which can be measured at its doorstep in the Swan estuary.
- Bringing back the Black Swans means bringing back the community of plants and animals that form and share their habitat. Re-creating habitat for the Black Swan will simultaneously create habitat for colonisation by a wide range of animals too small or secretive to be noticed by the general public. Seeing that the Swans are there, Perth people can be confident that many other elements of the Swan River’s flora and fauna are also present.
- The Black Swan is a tourism draw card. The Black Swan is the symbol of the original Swan River Settlement that forged Perth, and of ‘Swan Land’ — how people overseas first came to know of our region. The Black Swan is therefore a potent symbol that could continue to be used to attract visitors to a unique place, which through good environmental management will remain a good place to live and visit, for people as well as for Swans and their brethren.

### 1.3 Project Objectives

The overall objective of this study is to establish several permanent nesting and feeding sites for viable colonies of Black Swans on the Swan River. If this is not practical or feasible, the aim is to create a series of roosting precincts for Black Swans along the Swan River. Consideration of opportunities to encourage human appreciation of Black Swans, including possible interaction with the birds, was also an aim of the project.

Encouraging the return of larger numbers of Black Swans to river areas for the interest of the general public and visitors to the region also represents an initial step in restoring the values of the river as habitat for waterbirds in general and thus would have a beneficial impact on the ecology of the river.

### 1.4 Scope

The specific scope of the present study is to undertake a feasibility study to identify options, and research and assess the potential of re-establishing a greater presence of Black Swans on the Swan River.

The feasibility study involves the identification of areas on the Swan River where it may be possible to attract wild swans or to maintain local populations of introduced birds. This task requires a thorough understanding of the critical ecological requirements of Black Swans and an analysis of whether potential habitats provide these requirements or can be modified through engineering or other works (such as revegetation) or managed in some way to meet those requirements (for example through the provision of feeding stations). In the latter case, specification of potential works and management requirements need to be prepared to enable indicative costs to be determined. The need for and cost of any public access that may be required in order to facilitate viewing of the swans is to be identified, as are any changes in land use or regulatory requirements that may be necessary.

The broad aims of the study are to identify:

- Possible reasons for the present lack of Black Swans on the Swan River.
- Locations on the river that could be modified to create suitable habitat for Black Swans.
- The nature, extent and potential cost of the works required in creating such habitats.

This report provides a detailed analysis of:

- Information on the occurrence of swans on the Swan River.
- Critical habitat requirements of Black Swans.
- Suitability of sites within the river ecosystem for Black Swans.
- Site specific environmental, engineering and social factors.
- Considerations for implementation of suggested works.

## **1.5 Study Area**

The area of interest for the study includes the section of Swan River extending from Fremantle upstream to the confluence of the Swan and Helena Rivers in Guildford, and the lower Canning River upstream to the Shelley Bridge in Wilson, together with adjacent foreshore areas (Figure 1).

For the purposes of this study the term "Swan River" applies to the entire study area including the relevant section of the lower Canning River.



## **2. METHODOLOGY**

### **2.1 Overview**

A team of consultants including environmental scientists, wildlife ecologists and coastal engineers was involved in undertaking the project. The team comprised ATA Environmental (formerly Alan Tingay and Associates) including Dr Alan Tingay, Bamford Consulting Ecologists and MP Rogers & Associates.

The project involved several components that can be broadly separated into three main steps:

1. Research and Review – to determine the habitat requirements of Black Swans and identify any efforts to re-establish or introduce swans elsewhere.
2. Selection of Potential Sites - identify and evaluate locations that could potentially be suitable for encouraging greater numbers of Black Swans.
3. Nominate Selected Sites – recommend several preferred sites and prepare a concept plan and detailed development plan for each site.

Details of the methodology involved in completing the various components of the project are outlined in the following sections.

### **2.2 Literature Review & Research**

The biological and habitat requirements of Black Swans were identified through an analysis of the available literature, local expertise and consultation with key individuals and agencies. The information available was reviewed and collated to enable identification the primary habitat features that may entice Black Swans to use the sites for various daily or seasonal activities.

The review included gathering data from a variety of sources to determine the current status of Black Swans on the river. The review of data on Black Swans on the Swan River is based on information provided by Ron Johnstone of the WA Museum, records from Birds Australia's database of WA birds, from individual members of Birds Australia, and Bamford Consulting Ecologists' personal records of Black Swans on the river dating back to the late 1960s. These data include breeding observations as well as incidental sightings of birds.

The current and historical information relating to attempts at re-colonisation of Black Swan and other swan species were also sourced and reviewed as part of the study. The research included searching for literature pertaining to swans throughout Australia and other countries. The review was aimed at determining the likely success of implementing measures to re-establish or increase populations of Black Swans, and identify potential issues that may hinder attempts or determine any necessary management prescriptions.

### **2.3 Selection of Potential Sites**

An assessment of the habitat requirements of Black Swans based on available knowledge of their ecology and behaviour enabled the critical habitat features to be identified. This information, together with recent records of sites where swans are known to occur on the river, provided a basis to establish an initial list of potential sites at prominent locations on the Swan River for further assessment.

A review and site assessment of these preliminary sites was carried out. The site assessment involved visiting a range of sites known or suspected to be used by swans to categorise them with respect to what is known of the birds' habitat preferences. A standardised form was developed to record site assessments.

The categorisation was used as a basis for selecting sites with the greatest potential to be modified or enhanced to attract swans. Part of the categorisation process involved assessing sites from a human perspective, as one of the aims of the overall project is to make Black Swans accessible to people.

In identifying options at preferred locations, consideration was given to possible links with projects presently underway or likely to commence in the near future. This may enable projects to be undertaken concurrently or in association with each other to maximise the efficient use of resources and potentially minimise disturbances. Alternatively, the improvement and modification of existing drains flowing into the Swan River may be appropriate to achieve broader objectives.

Modifications of the potential sites to make them suitable habitat for Black Swans is expected to make them attractive sites for a range of other waterbirds. The potential for additional benefits to the riverine environment and wildlife was also an important element in selecting preferred sites.

### **2.4 Consultation**

It was recognised that successful completion of the study required consultation with local experts and key organisations and agencies to identify key issues and to obtain feedback on the proposals.

Consultation included obtaining views from government agencies such as Water & Rivers Commission, Swan River Trust, Department of Conservation and Land Management, Local Government Authorities and Perth Zoo and community based groups such as Birds Australia and Conservation Council. Selected experts and stakeholders were invited to attend a workshop at which the overview of the project, methodology of selecting suitable sites, preferred locations and preliminary concept plans were presented for discussion. Input and feedback were sought from the technical experts on the options presented.

Many local authorities have been working closely with the Swan River Trust (SRT) and the Water & Rivers Commission in trying to improve drainage into the river including the creation of detention and nutrient stripping basins. Close liaison with the local authorities throughout the project enabled the planned future works to be

identified and the options for habitat modification to link with other compatible works.

Close liaison with the Water & Rivers Commission ensured preliminary outcomes of the project were discussed throughout the project and enabled refinement of the project objectives and direction as necessary.

Outcomes of the workshop and general consultation with various agencies are reflected within the individual components and results of the project. The list of people that attended the workshop and a summary of the main issues arising from the technical workshop are provided in Appendix 1.

## **2.5 Development Plans**

Sites identified as having potential for swan habitat were evaluated in greater detail, and the list of preferred sites was rationalised following further on-site inspection and consultation with the Water & Rivers Commission. Initial concept plans for the habitat improvements and modifications at the preferred sites were then developed. The preliminary plans for development were subsequently refined and improved by referring to additional and more detailed information for the sites.

The detailed assessment involved obtaining more information on the sites from the various sources. Information such as hydrodynamic regime, water quality, bathymetry, topography, soil types, wind and wave patterns, drainage characteristics, relevant construction methods and costs was obtained to facilitate further development of the concept plans.

Following preparation of development plans for each of the potential sites, the construction and ongoing operational costs were estimated using current engineering and construction rates and other relevant price estimates for various components of the modifications.

A development schedule was also prepared to outline the priorities and ensure other key considerations and studies are undertaken and that an integrated and structured approach to the development of the recommended sites can be developed.

## **2.6 Implementation**

Various issues that may be relevant to the implementation of the development plans were identified and discussed. Issues included methods to attract swans to the modified habitat sites, approvals required in association with the project, management of potential land use conflicts, potential sources of funding and opportunities for community involvement.



### **3. BLACK SWANS ON THE SWAN RIVER**

#### **3.1 Distribution of Black Swans**

Black Swans occur in all States of Australia wherever there is suitable habitat. Some also occasionally stray to southern New Guinea (Blakers *et al.*, 1984). They do not occur naturally elsewhere but have been introduced into, and have become established, in New Zealand and they are acclimatized in parks and gardens in Europe, North America and Japan (Kikkawa & Yamashina, 1967) (Long, 1981).

In Western Australia, Black Swans are common in the South-west and Great Southern regions. They also occur in the Eastern and Northern Goldfields and the Pilbara and Mid-west when lakes in these areas contain water. They are scarce and casual visitors in much of the Kimberley and the eastern 'desert' regions (Johnstone & Storr, 1998).

During a survey of 253 wetlands on the Swan Coastal Plain in the Perth region between 1990 and 1992, the largest number of Black Swans recorded was 3406 in January 1992 (Storey *et al.*, 1993). The study found Black Swans to be common on Lake Monger, Thomsons Lake, Bibra Lake, Forrestdale Lake, Herdsman Lake, Lake Cooloongup and Lake Yangebup.

The largest numbers of nests and families recorded on Perth metropolitan wetlands were at Lake Monger, Forrestdale Lake, Bibra Lake, Big Carine Swamp, Lake Kogolup, Gibb Road Swamp and Herdsman Lake. It is probable that many of the families observed on Lake Monger were from nests on Herdsman Lake where there is an abundance of nesting habitat.

Black Swans are capable of long distance movements. It is generally believed that they are nomadic and move erratically and widely in response to rainfall or lack of rainfall and consequent increase or reduction respectively of habitat.

In the south-west of Western Australia, Black Swans appear to congregate in summer in near coastal wetlands such as those of the Swan Coastal Plain. Many then disperse inland during the winter nesting season provided that there has been sufficient rainfall to fill the inland lakes.

#### **3.2 Historical Occurrence on the Swan River**

As far as can be ascertained from anecdotal historical accounts and records of casual observations, Black Swans were never abundant on the Swan River and were more common in the shallows above Heirisson Island than in the Swan Estuary. They were more numerous and widespread, however, than they are today.

In 1938, specific information on waterbirds on the Swan River estuary, largely based on personal observations, was published (Serventy, 1938). In the late 1930s, Black Swans were found in undisturbed parts of the estuary at Frenchman's Bay, Lucky Bay and the lower Canning River, but were rare at Pelican Point. Ten years later, the loss of bird habitat on the river was noted including reclamation of large areas of foreshore at South Perth, Como, Crawley, Nedlands and Dalkeith (Serventy, 1948). Black

Swans could still be seen on the river during summer from the Causeway to beyond Maylands, at Lucky Bay and on the lower reaches of the Canning River.

### 3.3 Current Status on the Swan River

Today, Black Swans are a regular feature of the Swan River as far downstream as Lucky Bay, but only in small numbers. Over the past two years, single birds have been seen by members of Birds Australia at Matilda Bay, Milyu Nature Reserve and in Perth Water adjacent to the Narrows Interchange, while small groups of birds have been recorded at a number of other sites. A flock of up to 8 Black Swans spent much of summer 1998/99 in the Lucky Bay area, where they fed in Alfred Cove and roosted either on the edge of samphire in Alfred Cove or on sandbars in Lucky Bay, opposite Troy Park. Records indicate that Black Swans have consistently used Alfred Cove since at least 1979 in numbers similar to that occurring today, with up to 11 birds reported in summer/autumn 1999/2000. In the Canning River, up to 80 Swans have been recorded in late autumn in the Waterford area.

Black Swans are occasionally seen on the river upstream of Heirisson Island, and have been reported breeding on Ron Courtney Island between Ashfield and Redcliffe (WA Museum database). Black Swans in groups up to 50 birds have also recently been observed within the river foreshore, but not in the river itself, at Burswood. The WA Museum also has records of Swans breeding or attempting to breed on wetlands immediately adjacent to the Swan River near the Belmont Park Racecourse, the Maylands Peninsula, on the Ashfield Flats, at the Bayswater Bird Sanctuary and in the Ascot Fields area. There are also breeding records from the Guildford area and Swans occur in Black Adder Creek (in Viveash, just north of Midland). All these birds are largely dependent upon adjacent wetlands but occasionally venture onto the River.

One pair of Black Swans also breeds each year on wetlands at Sir James Mitchell and Clydesdale Parks in South Perth, and breeding has been recorded on the wetlands of the Narrows Interchange and on the lake in the gardens of Government House. These birds may occasionally venture onto the adjacent River, which could explain a recent observation of a single Black Swan seen from the Narrows Bridge.

It appears that Black Swans on the Swan River are mainly associated with adjacent wetlands, where they breed in small numbers. In addition, birds forage regularly at Lucky Bay and Waterford, but occasional birds are likely to visit almost any part of the river. This is encouraging, as it means that if the right habitat is made available, Black Swans are likely to find and utilise it.

The current status of Black Swans on the Swan River also gives an indication of the environmental features that are important for Swans. Safe roosting areas, access to freshwater and access to shallow, fairly sheltered water where the birds can graze on submerged aquatic plants seem to be important features. Observations on lakes around Perth also indicate that lawns are an important feature for Black Swans, and there are several lakes where the birds survive and breed almost entirely on a diet of grass, supplemented by bread. The abundance of Black Swans on some of these lakes also indicates that the birds are very tolerant of high levels of human activity.

### 3.4 Habitat Requirements

The main habitat features that have to be present for Black Swans to visit and remain in an area are discussed below. A thorough review of information pertaining to Black Swans behaviour and habitat requirements, which enabled the main characteristics to be identified, is presented in Appendix 2.

#### 3.4.1 Water Salinity

The salinity of a wetland is not a critical factor in determining its suitability as habitat for swans. Black Swans occur on fresh and saline lakes, swamps and rivers, on estuaries and occasionally at sea.

However, Black Swans need to drink relatively fresh water each day. Swans often fly from saline wetlands each day in the evening to a source of fresh water such as a freshwater wetland, a river, spring or farm dam.

According to standard definitions, Fresh Water is <500mg/L TSS and Marginal Water is 500-1500mg/L TSS (George *et al.*, 1996). The upper limit for human consumption is 250mS/m (~1375mg/L TSS) and for poultry is 470mS/m (~2585mg/L TSS).

Some of the most important sites for Black Swans around Perth are small freshwater lakes surrounded by reticulated lawns that provide food for the birds.

#### 3.4.2 Water Depth

The depth of water available is important to Black Swans. Black Swans forage extensively on submerged aquatic plants and the water depth needs to be suitable for reaching available food resources. Casual observations suggest the preferred water depth range for Black Swans is about 0.5m to 1.5m.

#### 3.4.3 Food

Black Swans feed exclusively on plants but may by accident ingest animals such as aquatic invertebrates. Swans graze on floating and submerged plants to a depth of about 1m. Swans also graze on plants on the margins and surrounds of wetlands including on cultivated lawn and algae and various rushes that grow in saline water.

A very wide variety of plants provide a food source including both native and weed species. This includes submerged plants such as Sea Wrack (*Halophila ovalis*), Pondweed (*Potamogeton crispus*, *P. ochreatus* and *P. pectinatus*), and introduced Water Couch-grass (*Paspalum distichum*), as well as other plants including young shoots of Bulrush (*Typha* spp.) (indigenous and introduced species), seeds of Tall Spike Rush (*Eleocharis sphacelata*) and sedges (Cyperaceae).

The availability of food is considered a main factor that determines the number of Black Swans on a wetland.



### 3.4.4 Nesting Sites

Important factors in nest site selection are water level, availability of suitable materials for nest construction, and proximity to feeding areas.

The water level is considered to be one of the most important elements of preferred nest sites of Black Swans. Studies have shown nests are constructed in a range of water depth from 300 to 965mm and it is suggested that water depth around a nest must be at least 300mm for Black Swans to initiate nesting. Black Swans generally breed during winter and spring, with a peak in the number of nests in late winter. An increase in the intensity of rainfall sufficient to create suitable nesting habitat and to increase the available food supply, is the initial factor that induces reproductive behaviour in Black Swans.

Black Swans tend to build nests to ensure the eggs are about 200mm or a little less above the water level. Swans are therefore most likely to breed in wetlands that will have a predictable winter rise and spring fall in water levels rather than tidal areas or positions that have fluctuating water levels in spring.

Black Swans will only nest at locations where suitable nesting materials can be found. Nest building continues throughout the incubation period and the nests require considerable quantities of vegetation even when old nest mounds are refurbished.

A variety of materials are used for nest construction. Materials such as reeds, samphire, aquatic plants, sticks and bark are collected mainly from the immediate vicinity of the nest. The bowl of the nest is lined with down feathers when incubation starts. Old nests are commonly refurbished by the addition of fresh nest building material at the start of the breeding season.

Black Swans nest in a wide variety of wetland habitats. Reed beds are probably the most common site for Black Swan nests in fresh water wetlands in the south-west of Western Australia, and samphire beds are the most common site in saline wetlands. Islands are often preferred as nest sites by Black Swans compared with swamp vegetation. The suitability of islands as nest sites is affected by size, the depth of surrounding water, proximity to feeding areas, surrounding visibility and topography.

The proximity of a source of fresh water to nesting areas is an important factor for nesting since cygnets require freshwater daily. There is limited information regarding the distance cygnets will travel to a freshwater source. Cygnets bred on saline wetlands however, must travel several hundreds of metres from the nest to freshwater soaks shortly after hatching. The conditions encountered during the journey to the freshwater source though, may limit the attractiveness of a particular site for breeding (ie. if windy and choppy conditions separate the potential nesting area and the freshwater source then the swans may not be inclined to breed at that location).

The density of nests appears to be determined by the availability of important ecological requirements such as food and suitable nest sites. Black Swans nest both in large colonies with many pairs of breeding birds, and as solitary pairs at some distance from the next nearest nest. Solitary pairs maintain a territory around the nest in the order of a hectare, but in colonies the distance between nests can be as little as 2.4m. It appears the density of Black Swan nests, given a suitable depth of water and

proximity to feeding areas, depends on the distribution of materials suitable for the construction of nests. Colonies are established where there is an abundance of materials or on islands where the space is limited. An adequate supply of food and the preferred depth of water, but limited nesting materials usually result in a single nest.

Artificial nests constructed from several old car tyres that are held in position with wooden stakes, filled with sand and topped with twigs, have been found to be utilised by Black Swans for nesting.

### **3.4.5 Wetland Area**

Black Swans need a relatively large area from which to take off as they have to run across water or land in order to get airborne. There is no specific length of water required for taking-off but a distance of at least 50m is considered adequate. The birds typically face into the wind during take-off.

In contrast, landing requires a length of water of only a few metres.

### **3.4.6 Other Wetland Features**

An area of open land adjacent to a wetland, or very shallow water, is an essential habitat requirement for Black Swans to enable daily preening. Preening is characteristically followed by a period of sleep, which usually takes place on land, and therefore safe habitat away from disturbance is required.

Wetland shorelines, island and sandbars need to enable easy access for the swans to and from the water for roosting and preening. Gradients need to be gentle enough to facilitate both adult swans and cygnets to enter and exit the water if nesting is to occur at a site. It is estimated that the slopes should be about 1 in 6 and preferably gentler, particularly where breeding occurs to ensure suitable access for cygnets.

The area around a wetland where swans are flying should be free of obstructions to avoid swans being injured or killed through collision with obstacles such as power lines.

## **3.5 Analysis of Requirements**

In summary, the critical features of ideal habitat for Black Swans are:

- A large area of water between 0.5m to 1m in depth.
- Abundant food in the form of aquatic plants.
- A continuous supply of fresh water for drinking.
- An area of land adjacent to the water that is large enough for swans to roost and preen, easily accessed from the water and secure from humans and dogs.

The availability of these features will determine the number of swans in an area and the length of time that they remain there. More swans are expected to be present

where a large area of water of preferred depth with food plants is available. If no fresh water or land for preening is available the swans will fly out to a source each day or may not use the habitat if an equivalent habitat that has all these features is available as an alternative. If the food resources are seasonal swans will be present only when there is sufficient supply.

All of the above habitat features should be provided at a given location on a continuous basis in order to attract Black Swans and encourage swans to be present throughout the year.

Other features that are desirable but not essential include:

- A sufficient length of water oriented toward the direction of prevailing winds to enable swans to take off and leave an area easily.
- A lack of obstacles such as powerlines in the vicinity of the habitat.
- Shelter from windy and rough conditions.
- Conditions and materials required for nesting.

Black Swans are expected to remain in an area that supports the important features but is not suitable for nesting as there is always a large number of non-breeding birds. Nesting habitat is therefore not essential but an additional attraction for an area especially if suitable habitat is limited in the region.

The important features of nesting habitat are:

- Materials suitable for nest construction.
- Water depth from 0.3m to 1m or on islands.
- Proximity to feeding habitat.

The quantity and area of suitable materials and depth of water will determine the number of nests that are constructed. Artificial nests may be used to create a nesting population if natural materials are not available or to supplement such materials. Reinforcement of the edges of steep shorelines around wetlands or on islands and sandbars should be provided to avoid significant shoreline erosion from regular access to the nest.

Nesting habitat in areas where there is a limited food supply may require the swans to fly to a food source each day and lead their cygnets to a food source once they hatch. There is a significant potential for cygnets to be killed or separated from their parents during this trip especially if the swans have to cross roads to reach the feeding area.

Table 1 provides a summary of all of the key habitat features and requirements for encouraging Black Swans to inhabit an area.

**TABLE 1**  
**CRITICAL HABITAT REQUIREMENTS**

Description	Preferred Conditions
Water Depth	0.5m to 1.5m preferred
Food	Reach to a depth of about 1m
Drinking Water	Need to drink relatively fresh water (<1500mg/L TSS, preferably <500mg/L TSS) each day. If no local source, swans typically fly off to a source each evening.
Flight	
→ Take Off	Facing into wind Distance of 50m adequate
→ Landing	Only a few metres required
	Area around a wetland where swans are flying into and out of should be free of obstruction eg. power lines.
Nesting	During winter and spring, with peak in late winter.
Nest Site Selection	
→ Water Level	Appears water depth around a nest must be at least 0.3m for swans to start nesting; water level needs to be relatively constant
→ Nest Location	Black Swans only nest at locations where suitable nesting materials can be found. Most nests located where density of reed spikes between 500 – 1500/m <sup>2</sup>
→ Nesting Material	<ul style="list-style-type: none"> <li>• Reed beds – freshwater wetlands</li> <li>• Samphire beds – saline wetlands</li> <li>• Artificial nests</li> </ul>

### 3.6 Previous Introduction Programs or Habitat Modification

A bibliography of the literature and sources consulted in reviewing information on any programs to re-introduce or establish populations of swans worldwide is provided in Appendix 3. A summary of the information reviewed and the success of the programs or difficulties encountered is provided below.

Populations of Trumpeter Swans (*Cygnus buccinator*), native to North America, have dramatically declined since settlement as a result of hunting and loss of habitat. The Trumpeter Swan is now restricted to few breeding grounds and habitat areas within its former range. Programs to re-introduce or re-establish populations of this now threatened and protected species have been undertaken and are continuing in Canada

and the United States of America (USA) in several regions including Minnesota, Iowa, Michigan, Ohio, Missouri and Wisconsin in the USA and Ontario in Canada.

Considerable information on the breeding and reintroduction programs for this species is available. The programs typically involve breeding swans, sometimes using eggs gathered from wild populations, and raising cygnets through the use of a decoy or non-native Mute Swans (*Cygnus olor*). Some programs include wing clipping prior to release at about 2 years of age as means of ensuring the birds remain in the habitat area and establish a connection or "imprint" with the site. The birds are released at selected sites, many of which are wetland areas that have been created through restoration work. The sites are selected based on quality of habitat available and viewing opportunities for the public. In Michigan, programs also involve the use of pinioned pairs and translocation of wild birds from the Pacific Coast.

The literature reviewed suggests efforts in reintroduce the Trumpeter Swans have been successful in terms of survival of released birds and establishment of breeding pairs. Monitoring of these programs includes population counts and breeding pair counts, which are generally reliant on observations by naturalists and the general public, using neck collars, wing tags, dyes or leg bands as markers, and satellite transmitters to learn about migration paths. Difficulties with the reintroduction programs tend to relate to establishing migratory traditions among populations and providing sufficient food resources, particularly during winter.

Introductions of the non-native Mute Swan to states such as Florida in USA have been undertaken typically for their ornamental value on ponds and lakes at hotels, golf courses and other public facilities. Introductions of this species do not appear to be difficult to achieve and the species tends to be more accustomed to people than other swan species. Mute Swans have also survived on the Avon River in Northam since being introduced over 100 years ago, although the habitat is marginal and the population is possibly in-bred and is declining.

Highly maintained lakes that are habitat for the Mute Swans in locations such as Florida often may not have sufficient food. The diet of the birds is supplemented with feed mix of cracked corn and laying poultry pellets or crumbles. This is delivered using an automatic dog feeder mounted on a pole in the water to avoid other wildlife accessing the food resource. The pellets are checked regularly to avoid mould growth that can sicken or kill the swans.

In terms of Black Swans, the introduction of this species into New Zealand provides an example of their adaptability and potential for population growth when suitable habitat is available. As far as is known, probably less than 100 Black Swans were introduced in the 1860s to New Zealand at various locations and usually in small groups. Shortly after their introduction, they began to appear at locations hundreds of kilometres from the release points, and in 1895 a population estimated at several thousand birds was established at the mouth of the Opawa River, near Marlborough (Long, 1981).

By 1922 they had spread to the Chatham Islands and by the 1930s they occurred throughout the country, especially on lakes and lagoons near the coast. The nesting population at Lake Ellesmere in the 1960s was estimated to be in the order of 5000 pairs, probably much larger than any nesting population at a single locality in



Australia, and the total population in New Zealand in 1972 was estimated to be about 200,000 birds.

No information regarding programs to reintroduce or increase populations of Black Swans in Australia was found during the research undertaken for this project. Advice from the New South Wales National Parks and Wildlife Service and the Australian Black Swan Co-ordinator for the international Swan Specialist Group suggests that if a suitable food source such as seagrass beds is provided, then there should be no major difficulty in re-establishing Black Swans (Richard Kingsford, pers. comm., 2000).

## 4. POTENTIAL HABITAT SITES ON THE SWAN RIVER

### 4.1 Site Assessment

Potential sites for Black Swans on the Swan River were assessed in terms of the birds' habitat preferences (Site Habitat Assessments). These assessments were then used as a basis for selecting sites with the greatest potential to attract swans. Part of the process involved assessing sites from a human perspective, as one of the aims of the overall project is to make Black Swans accessible to people.

The Site Habitat Assessments involved visiting as many sites as possible, including but not limited to sites that are used by swans. A standard assessment was conducted on each site using a form based on what is known of the habitat requirements of Black Swans (Appendix 4). The assessment was based on the habitat requirements as presented in Section 3.6 of this report. The main habitat features assessed were:

- Availability of water <1 m deep.
- Availability of fresh water.
- Availability of roosting sites.
- Presence of riparian habitats, such as rushes, along the shoreline for shelter and nesting.
- Presence of adjacent habitats such as freshwater wetlands and lawns.

The presence of suitable food plants could not easily be determined at each site but it was usually possible to obtain an indication of the extent of water of suitable depth for feeding. The area of water of this depth was determined from bathymetric maps of the Swan River.

The degree of shelter also was noted, as swans do not like exposed sites where the wind creates rough conditions. Sufficient area of open water for take-off and landing is not an issue on the Swan River.

Features of each site that were relevant to public access were also assessed. These were:

- Public access and tourism potential.
- Competing or conflicting uses.

For each site, observations were made with respect to access and facilities for people, especially tourists. It was considered that suitable sites would have reasonable access and have at least some existing facilities, such as carparks and existing parkland. Preferred sites would also be close to major transport routes and to areas already used by the public.

Competing or conflicting uses could compromise any effort to encourage Black Swans to utilise a site. It was therefore important to identify any such uses during the site assessment. Competing or conflicting uses included areas designated for water

sports, areas of very high usage by people where disturbance levels would be high and unmanageable, and areas of high conservation value. In such conservation areas, habitat modification to encourage Black Swans, and the development of facilities to cater for people observing the swans, could adversely affect the conservation values of the site. However, habitat modification to encourage swans also could favour other wildlife and this was considered to mitigate conflicting uses in some cases. Competing uses that could be compromised by an increase in usage of the site by people were also considered.

Current usage of the site by Black Swans was also considered as part of the site assessment. Usage was based on previous records and knowledge of the presence of Black Swans at each of the locations together with reports received as part of the preliminary consultation phase of the project.

To ensure objectivity of the assessment, each of the features was given a score between 1 and 5 at each site, although a score of 5 was rarely used as it implies that no improvement is possible. A score from 1 to 5 was also given for the number of Black Swans already known to use the site. The scoring system made it possible to give each site a rating.

Scores for each feature were assigned as indicated in Table 2, with intermediate scores assigned to sites with a moderate degree of the necessary attributes and/or limitations.

**TABLE 2  
SITE HABITAT ASSESSMENT SCORING SYSTEM**

<b>Site or Habitat Feature</b>	<b>Low Score</b>	<b>High Score</b>
Current use by swans	Swans never use or have been very rarely recorded at a site (1-2 seen every year or two over 1-2 days)	Swans are known to occur regularly in large numbers (50-100 present most of the time or seasonally)
Water Depth <1m	Little water of suitable depth and very exposed to prevailing winds	Large area of suitable depth and relatively protected
Fresh water	No fresh water and no obvious way to readily provide fresh water	Good supply of fresh water all year round
Roosting sites	No obvious roosting sites are available and sites could not be readily constructed.	Roosting sites are present.
Riparian habitats	Concrete retaining walls	Intact riparian zone of rushes and paperbarks
Adjacent habitats	Effectively no suitable habitat adjacent to a site and limited or no lawn	Freshwater wetlands within 100m and extensive lawn areas

Public access	Limited existing facilities, distant from major roads and public transport, limited public facilities nearby and a small area	Suitable existing facilities, near major roads and public transport, other desirable public facilities nearby and a large site
Competing uses	Many competing uses such as existing water sports, river traffic, major roads very close and high conservation value	Few or no competing uses

## 4.2 Site Ranking

Twenty-three sites were assessed and the results of this assessment are presented in Table 3. Descriptions of sites and details of their assessments are presented in Appendix 5. The location of each of the sites that were assessed is shown in Figure 1.

Nine of the sites assessed achieved scores in excess of 20 and these were considered to warrant further investigation. These same sites also scored the highest totals when considering only the habitat factors and disregarding public access and competing uses, although the order of these top ranking sites varied.

It is important to recognise that the assessment only gives an indication of how suitable certain selected sites are for Black Swans as they are now or with some modification, and that the scores are influenced by how accessible the sites are to people. All rating systems also are inherently biased by the weighting given to different factors. It would be quite possible to modify any site and to make it suitable for Black Swans, but at many locations this would require major works and disturbance that would be prohibitive in terms of cost and also probably socially unacceptable.

Sites in the lower reaches of the Swan River tended to rate highly for public access but poorly for available feeding areas, fringing vegetation and adjacent habitat. Competing uses were also considered to be significant at sites such as Point Walter, Nedlands Baths and Matilda Bay.

In contrast, sites surveyed in the upper reaches of the river tend to rate highly. This result was influenced by the occasional and even regular occurrence of Black Swans in such areas, but also because these sites have extensive riparian vegetation and adjacent wetlands. However, such adjacent wetlands may be of little relevance to the aim of re-establishing Black Swans on the river. The birds currently are using the wetlands, not the river, and where the river is narrow, water traffic may prevent swans from using it regularly. There may also be no suitable submerged aquatic plants in these upper sections of the river where annual variation in salinity and turbidity is likely to be considerable. The sites in the upper reaches also did not score well for public access.

Sites with the highest scores were: Lucky Bay (including Alfred Cove), the foreshore from the Narrows Bridge to Como Jetty (including Milyu), Sir James Mitchell Park in South Perth, Ascot Waters, Waterford on the Canning River, Burswood, Maylands

Yacht Club, Maylands and Ashfield Flats (Figure 1). In addition, the Swan River upstream of Heirisson Island, across to Burswood and Claise Brook, was noted as being an area that included several sites that individually were not rated highly, but which collectively could have some potential.

Some of the highest scoring sites scored well for different reasons. For example, Lucky Bay rated high because the site supports quality habitat for Black Swans and an array of other waterbirds, is regularly used by Black Swans, and has good public access and limited competing uses. Sir James Mitchell Park in South Perth has good access and exposure for the public and visitors, and supports suitable adjacent habitat. Waterford on the Canning River rates well because of the existing habitat provided on the river that is regularly used by Black Swans, but has limited access and viewing opportunities of the public.

#### **4.3 Potential for Habitat Modification**

Based on the knowledge of habitat and behaviour of Black Swans and the review of information relating to swans worldwide, together with the site assessments, it was considered the presence of Black Swans on the river could be increased through habitat modification of selected sites. Black Swans are likely to be attracted to any site that offers a food resource and site fidelity will be determined by the duration of that resource and the availability of other key factors such as fresh water for drinking and adjacent land for preening and resting.

Various prominent sections of the river were further assessed to determine the type of works that would be required to make them suitable for Black Swans, and to provide a preliminary indication as to the practicality and benefits of habitat modifications at each of the sites. The sites were selected because they scored highly during the site assessment and are places that attract large numbers of people for passive recreation. These sites were Sir James Mitchell Park, the Narrows to Como jetty (Freeway Foreshore) and Alfred Cove/Lucky Bay.

Information on the preliminary feasibility assessments is provided in Appendix 6. The assessment indicated that necessary modifications to create habitat for Black Swans along the river were expected to be achievable, but also showed that these three high scoring sites varied when consideration was given to the works required and ability to achieve the objectives of the project. The assessment further indicated that creation of swan habitat at locations along the river would enhance their recreational value and provide benefits to other wildlife and Perth's environment.

#### **4.4 Selection of Potential Sites**

The top nine scoring sites from the site assessments were selected for further consideration in terms of habitat modification. The location of these nine sites is shown in Figure 1. Refinement of this list and selection of preferred sites for the preparation of the concept plans and detailed development plans involved further assessment primarily of engineering requirements, together with consideration of geographic distribution of sites, the type of habitat provided by each site (ie. feeding,



loafing, breeding areas) and the potential for providing several sites in close proximity as a key habitat location for Black Swans.

Several of the sites identified by the site habitat assessments for further consideration were inspected on 24 March 2000. A site not assessed during the habitat assessments but which was identified through liaison with local authorities at McCallum Park in Victoria Park was also inspected. The site is to be redeveloped to create a wetland for stormwater management.

The purpose of the site inspections was to identify whether sites were suitable for habitat modification to encourage usage by Black Swans and to identify the types of works that may be required to accomplish this objective. Representatives of the study team, including officers from the Water and Rivers Commission, carried out the inspections.

Proposed works to improve waterbird habitats at the other highly rated sites including Heirisson Island, Burswood, and Maylands were discussed, although these sites were not visited during the site inspections. During refinement of the list of potential sites and selection of several preferred sites, these sites were not viewed as the best opportunities to achieve the project objectives. The river tends to be narrow near these sites with higher flows and deeper water that are not necessarily most suitable for creating swan habitat. There is a need to maintain access for boats upstream, and together with the high conservation values at Maylands, this suggests these sites are not as suitable as others. Furthermore, the western end of Heirisson Island is exposed to wind and wave action and was noted to lack a fresh water source.

Preliminary engineering assessment also suggested that sites located upstream of Ascot Waters were likely to be less suitable for encouraging swans onto the river than sites downstream. Sites upstream have a narrow river channel resulting in less favourable flow rates and water depth at these locations for Black Swans, and limited opportunities for modification due to the need to ensure access for boats is maintained.

Several sites were identified as part of the consultation process and technical workshop (see Appendix 1). Many of the sites noted by attendees at the workshop were considered during the project team's systematic site evaluation and were not identified as the preferred sites to meet the project objectives. Other sites identified may offer additional opportunities for modification and provision of habitat for Black Swans. These sites, however, were not considered likely to provide the opportunities to meet the project objectives that the sites identified during the site and engineering assessments offered.

The sites assessed as being most suitable for habitat enhancement to encourage usage by Black Swans and identified for more detailed consideration following the site inspections were:

- Attadale Reserve (Lucky Bay/Alfred Cove).
- Clontarf Bay, Waterford.
- Como Foreshore (The Narrows to Como Jetty).
- Sir James Mitchell Park, South Perth.
- Ascot Waters.

**TABLE 3  
RESULTS OF THE SITE ASSESSMENT FOR THEIR POTENTIAL AS HABITAT FOR BLACK SWANS.**

Site	Habitat Requirements							Social Factors		Sub-total Rating	Total rating
	Presence of Swans	Depth	Fresh Water	Roosting	Riparian Vegetation	Adjacent Habitat	Public Access	Competing Uses			
Gilbert Fraser Reserve	1	1	3	2	1	2	4	2	10	16	
Rocky Bay	1	2	3	3	1	2	4	3	12	19	
Pt Roe/Chidley Pt	1	2	3	2	1	1	3	3	10	16	
Freshwater Bay	1	3	3	3	1	2	4	2	13	19	
Point Walter	1	3	3	4	1	2	4	2	14	20	
Pt Resolution/Jutland Pde	1	1	3	2	1	2	3	3	10	16	
Attadale Foreshore	1	3	3	3	2	2	4	2	14	20	
<b>Lucky Bay (Alfred Cove)</b>	3	4	4	5	4	2	4	4	22	30	
Nedlands Baths	1	3	3	3	2	2	4	1	14	19	
Pelican Point	1	2	4	3	3	3	2	2	16	20	
Matilda Bay	1	2	3	3	1	2	4	1	12	17	
<b>The Narrows/Como Jetty</b>	2	4	3	4	3	1	4	3	17	24	
The Narrows/Barrack St	2	2	3	2	1	2	4	2	12	18	
<b>Sir James Mitchell Park</b>	2	4	4	4	1	4	4	4	19	27	
Heinsson Island	1	2	3	3	1	4	4	2	14	20	
<b>Burswood</b>	2	2	4	3	3	4	2	2	18	22	
Claise Brook	1	2	3	2	2	2	3	2	12	17	
<b>Maylands Yacht Club</b>	2	2	4	3	4	4	2	2	19	23	
<b>Maylands Peninsula</b>	2	2	3	3	4	3	3	2	17	22	
<b>Ascot Waters</b>	2	1	4	4	4	4	4	2	19	25	
<b>Ashfield Flats</b>	3	1	4	4	4	3	3	2	19	24	
Bull Creek	1	2	3	2	4	2	3	3	14	20	
<b>Waterford</b>	4	3	4	3	4	4	1	2	22	25	

Note: Each site is assigned a score between 1 (Low) and 5 (High) for each feature and a Total Rating out of 40.

## **5. CONCEPT PLANS**

### **5.1 Background Information**

The development of concept plans for each of the five selected potential sites required assessment of the following:

- Hydrodynamic regime, including tidal and flood levels, and water quality and salinity.
- Bathymetry and topography.
- Wind and waves.
- Drainage characteristics and fresh/ brackish water sources.
- Relevant construction methods and costs.

Information was obtained from the sources listed to assist in the assessment of engineering issues relating to each of the sites:

- Swan and Canning River Hydrographic Surveys - Department of Transport.
- Swan and Canning River Flood Levels - Water and Rivers Commission.
- Orthophotomaps - Department of Land Administration.
- Stormwater Drainage Plans and Studies, Town Planning Scheme Information and other background information - Local Government Authorities.

Meetings and other discussions were also held with officers of the Local Government Authorities where sites were located to determine other details relating to the past history and future plans for these sites.

Many of the sites identified have been used in the past as landfills for the disposal of putrescible and/or inert waste. Details of the type, amount and extent of waste disposed of at each site is generally poor. Similarly, survey control between the various sources of background information was in some instances poor.

### **5.2 Engineering Assessment**

In addition to the critical habitat requirements for Black Swans (see Section 3.6) engineering factors were used as a general guide in assessing other aspects of the sites inspected. A standard assessment form was used to assist identification of the features of each of the sites assessed (Appendix 7). The features considered include:

- Water Depth
- Earthworks required
- Edge Details

- Vehicle Access
- Pedestrian/ Bicycle Access
- Parking - Vehicles/ Buses
- Infrastructure
- Power/ Water/ Sewer
- Fencing
- Lighting
- Signage Opportunities
- Toilets
- Viewing Areas
- Access to carry out Works
- Access for Maintenance Program
- Constraints
- Benefits

### **5.3 Options for Habitat Modification**

Various broad options for modifying potential and selected sites to improve habitat for Black Swans were reviewed as part of this study. These comprise:

- Creation of permanent islands.
- Provision of floating islands or pontoons.
- Creation of embayments within the river.
- Construction of wetlands.
- Enhancement of existing wetlands.
- Generic improvements to existing features.

Some of the key aspects and considerations of each of these options are presented in the following sections.

#### **5.3.1 Permanent Islands**

Permanent islands could be created within the river using surplus dredged material or construction and demolition waste. Offshore construction and maintenance costs are generally more expensive than that for works that could be carried out adjacent to the foreshore largely due to accessibility for the necessary works. To be cost effective compared with other options, the creation of islands should be carried out as part of another complementary project.

Wave and tide action needs to be considered and protection from highly variable water levels provided if breeding on the island was to be encouraged. This could be achieved through the appropriate design of the island. A supply of freshwater on the island would be desirable for breeding.

The island design would need to consider potential erosion during peak flows and wave action. Conditions in terms of exposure to strong flows and wave action at a location will affect the stability and the need for, and extent of, specific protection measures to minimise potential erosion.

### 5.3.2 Floating Islands

The concept of using floating pontoons to provide roosting and nesting areas was also examined. In the Swan River at virtually all sites, the wave generated by winds over the water would have wavelengths in the range of 5m to 20m. Such waves would cause a small (less than about 30m x 30m) pontoon to pitch and roll in a similar fashion to dinghies and small boats. These conditions would be unpleasant for swans to roost and probably prohibit nesting.

In order to achieve the desired calm conditions for roosting and nesting, a larger pontoon would be necessary. It has been estimated that a minimum practical size would be about 30m by 30m for a stable pontoon. Such a pontoon together with the mooring/anchoring system would cost in the order of \$1 million. The pontoon could be constructed of steel, aluminium, fibreglass or plastic. The mooring/anchoring system could be elastic cords, steel rope or chain secured to concrete or steel anchor blocks or grouted anchors; or steel, concrete or timber piles attached to the pontoon. Regardless of which materials are used, there would be the need for ongoing maintenance of the pontoon and the mooring/anchoring system.

The wave conditions in the various freshwater lakes at the sites would be much more favourable for the use of a small pontoon for roosting and nesting. The smallest practical pontoon would be about 5m by 3m to permit a sloping beach for entry to the water. Such a pontoon together with the required mooring/anchoring system is estimated to cost about \$20,000. Again, regardless of which materials are used, in the longer term there will be the need for maintenance of the pontoon and the mooring/anchoring system. A comparable island formed by sand fill would cost about \$7,000 and is unlikely to require significant maintenance.

Given the capital and maintenance costs of floating pontoons, they are not the preferred method of creating roosting and nesting areas. Conventional reclamation appears a more natural and cost effective means of creating the desired roosting and nesting areas.

### 5.3.3 Embayments

Construction of rubble walls within the river to provide sheltered embayments would enable shallows and feeding areas for the swans to be established in the river itself. The walls provide the necessary protection from the elements such as wind and waves that may deter swans from occurring on the river, and create a sheltered area potentially suitable for the establishment of a food source that further encourages swans to utilise the area and increase their presence on the river.

Factors that should be considered include whether there is sufficient area for an embayment without affecting other major uses of this section of river, and if the necessary protection from the currents, wind and waves can be achieved. Linkage to the river from the embayment and access from the foreshore may require modification to the edge of the river and creation of a beach area. Suitable access for equipment for the construction and ongoing maintenance of the embayment wall will be required or higher costs are likely to be incurred.



The availability and amount of material for construction of the embayment walls and creating shallows may affect the feasibility of this option. Creation of an embayment is generally more feasible in terms of cost where shallows are present and the height of the wall required is minimal to reduce the amount of fill and construction material. Construction of the embayment should aim to maximise the sheltered area created with the minimum length of wall to reduce costs.

Dredge spoil and construction and demolition material may be suitable and the construction of an embayment may be linked with other works in the area such as channel maintenance dredging. Geotechnical investigations may be necessary to confirm suitability of the substrate and requirement for geotextiles.

A source of freshwater may need to be made available nearby in order to allow the swans to breed at the site and inhabit the site year round.

#### **5.3.4 Constructed Wetlands**

Creation of wetlands within the river foreshore area is considered another feasible option to encourage swans to inhabit an area. Habitat suitable for swans can be readily created adjacent to the river to provide the essential requirements including fresh water, food resources and nesting materials. This option does not create habitat within the river itself but swans would venture onto the river when conditions were suitable or during certain activities that have no particular requirements, such as loafing.

Creation of wetlands requires the foreshore adjacent to the river to be of sufficient area (minimum of about 1ha) and suitable for excavation and modification. In many instances foreshore areas along the Swan River have historically been used as landfill sites and geotechnical investigations may be required to confirm suitability. The material that may have been disposed of within landfill areas may imply significant costs associated with clean-up or detrimental environmental impacts. Creation of wetlands as habitat for Black Swans may be complementary with other purposes such as foreshore restoration and stormwater drainage, or conflict with current usage and plans for the site.

Flooding potential, tidal information and depth to groundwater requires assessment to ensure the wetland water levels are maintained and water will remain relatively fresh unless an alternative freshwater supply is available at the site. A source of freshwater may be necessary to maintain or control water levels within a desirable range in the wetland.

Suitable access to the site for equipment to undertake the earthworks and modifications for construction and maintenance will be necessary or increased costs may be incurred.

#### **5.3.5 Enhanced Wetlands**

Existing wetlands within foreshore areas along the river could be improved to provide better habitat specifically for Black Swans and other waterbirds. Modifications may be made to created or degraded wetlands to provide the necessary essential habitat

characteristics for the swans that may be lacking at a particular site. The present function and purpose of the existing wetlands may restrict the potential for modifications to be implemented at a site.

The extent of the modifications depends on the features of the existing wetland, and the desired outcome in terms of the type and extent of habitat necessary. Works may be restricted by the size of the area, geotechnical properties of the soil and existing infrastructure. Modifications may consist of enlarging the wetland, reshaping the wetland, creating small islands, increasing the area of optimum depth for swans and planting vegetation.

Water depth and seasonal water level variability are important consideration in determining the modifications and potential suitability of the site as swan habitat. The area of open water, available for planting for food and nest material, or creation of islands or mounds and the degree of exposure may limit opportunities and ultimately the effectiveness of the site as habitat for swans.

### **5.3.6 Generic Improvements**

Generic improvements to habitat include relatively minor alterations to features already in place to provide the critical habitat characteristic(s) presently lacking or insufficient, such as any of the following:

- Planting fringing or aquatic vegetation to supplement food supplies and nesting materials.
- Modifying banks to facilitate entry and exit from the water.
- Providing greater protection or shelter from environmental conditions such as planting trees as a wind break.
- Reducing the level of disturbance through controlling access and activities to encourage roosting and nesting.
- Provision of fresh water throughout the year.
- Maintaining or controlling water levels.
- Constructing and providing artificial nests.

### **5.4 Concept Plans**

The five selected potential sites were subjected to a more detailed assessment to identify the most appropriate works that may be required at these locations to accomplish the project objectives.

Following the more detailed assessment of these sites, the Como Foreshore location was eliminated from further consideration for the purposes of this study as this area would require significant engineering works due to its exposed location in order to

provide suitable habitat for Black Swans. It was assessed that the benefits of these works for Black Swans would be outweighed by possible negative impacts on the habitats of other waterbirds that use this area.

For the remaining sites, a number of different types of work were proposed. These included:

- Enhancement of existing wetlands.
- Construction of wetlands (in conjunction with stormwater works)
- Creation of embayments within the river (rubble wall protection)

Creation of permanent islands and floating pontoons were not proposed in the preliminary concept plans for the selected sites primarily due to the costs associated with these features. It was considered that the habitats at the selected sites could be suitably modified to enhance habitat for Black Swans using less expensive options.

Preliminary concept plans, which illustrated the different types of work proposed, were prepared for the four recommended sites comprising:

- Attadale Reserve, Attadale
- Clontarf Bay, Waterford
- Sir James Mitchell Park, South Perth
- Ascot Waters

The general location of these recommended sites is shown in Figure 1 and photographs of each of the sites are provided in Plates 1 to 4.

The concept plans were presented at the technical workshop for comments prior to preparation of detailed plans for each of the sites. The preliminary concept plans as presented at the workshop are provided in Appendix 8.

The key points of the works proposed at each site are outlined in the following sections.

#### **5.4.1 Attadale Reserve, Attadale**

- Create food source and breeding sites through establishment of freshwater wetlands on the foreshore.
- Freshwater wetlands to be perched above river tidal level.
- Complements City of Melville Stormwater Drainage Strategy.
- Catchment Treatment Prescription proposed involves creation of:
  - 9,500m<sup>2</sup> wetlands
  - 30% macrophytes
  - 70% open water
  - average depth 0.8m
- Possibly old landfill area (thought to be inert waste).

#### **5.4.2 Clontarf Bay, Waterford**

- Existing wetlands offer opportunities for improving swan breeding habitats.
- Existing freshwater wetlands - 8.1ha (approx.).
- Improvements required to creek linking wetlands to river.
- Land is zoned for development R20 - High land value.
- Foreshore area has been used for landfill (thought to be inert waste).
- Preliminary planning assessment to determine site development constraints.

#### **5.4.3 Sir James Mitchell Park, South Perth**

- Existing freshwater lakes already created on foreshore reserve.
- Lakes established in area of old landfill (possibly putrescible).
- Lakes used as balancing pond for reticulation of foreshore reserves.
- Lake water quality issues (stormwater and groundwater inflows).
- Create breeding habitats in lakes by establishing a number of small islands.
- Establish food source in contained embayment in river.
- Removal of section of river wall.
- Beach for swans to access river.
- Possible use of shallows adjacent to embayment for roosting /loafing.
- Highly visible site with well established facilities:
  - Vehicle/ Pedestrian/ Bicycle access
  - Parking
  - Toilets

Another option considered at the Sir James Mitchell Park site was to link the existing lakes to the river via a stepped ramp with the foreshore cycle path raised over the top. The stepped ramp was to provide direct access for the Black Swans from the existing lakes to the river.

The issues of poor water quality in the existing lakes and the reluctance of Black Swans to move under structures were assessed at the time as being sufficiently negative to eliminate this option from further consideration as part of this study.

#### 5.4.4 Ascot Waters

- Create freshwater wetlands within embayment in river to establish food source and opportunities for roosting /loafing.
- Ongoing improvements in relation to stormwater quality issues and main drains. These improvements to the stormwater system are described in detail in Section 6.2.4.
- Central Belmont Main Drain entry point to river relocated.
- Access freshwater from weir on Central Belmont Main Drain.
- Links to proposals by City of Belmont on redevelopment of Bristile Park and Adachi-Ku Park and by Main Roads WA for upgrading of Great Eastern Highway to Perth airport.
- Corporate funding (Bristile) to Bristile Park redevelopment.
- These proposals will establish public facilities in this area:
  - Vehicle/ Pedestrian/ Bicycle access
  - Parking
  - Toilets

Great Eastern Highway, which is to be widened and realigned in the area adjacent to Adachi-Ku and Bristile Parks, in part forms a natural barrier to the use of this area.

This negative aspect is more than compensated for by proposals for development of the foreshore area which will establish vehicle, bicycle and pedestrian access, carparking and public toilets.

The proposal to establish swan habitat in this area by constructing an embayment in the river complements the foreshore development proposals of the City of Belmont.



## 6. DETAILED DEVELOPMENT PLANS

### 6.1 Establishment of Habitats

This project initially looked at the habitat features currently existing at each location. Each location is unique although several common elements are evident. An assessment has then been made of how additional elements may be added at each location to provide further opportunities for breeding, feeding, and roosting/loafing to encourage Black Swans to remain in these areas.

The following criteria were assessed in the development of initial concept plans for each site:

- hydrodynamic regime, including tidal and flood levels, and water quality and salinity;
- bathymetry and topography;
- wind and waves;
- drainage characteristics and fresh/ brackish water sources; and
- relevant construction methods and costs.

The preparation of detailed development plans for each site has required a more detailed assessment of the following:

- Tidal levels
- Flood Levels
- Wind Protection
- Waves

Tidal levels were considered to ensure that all wetlands are to be constructed above tidal levels to prevent saline water entering the freshwater wetlands. We have therefore adopted the principle that all freshwater wetlands should be perched above the Highest Astronomical Tide (HAT) level. This level is about +0.5m AHD.

Flood levels were similarly considered to provide a level of protection from inundation of the freshwater wetlands. Flooding of the wetlands may occur during certain flood flow conditions but river water quality at that time would be largely fresh to brackish (although possibly turbid). Vegetation to be established in the wetland must be able to tolerate these variable conditions.

Swans naturally build their nests so that the eggs are about 200mm above the water level. Therefore, they do not breed in tidal waters or where water levels are likely to fluctuate during spring. They are most likely to breed in adjacent wetlands that will have a predictable winter rise and spring fall in water levels.

Habitats for Black Swans must provide protection from the prevailing winds and from waves created on more open sections of the Swan and Canning Rivers if swans are to

be encouraged to use the site regularly. Islands within the freshwater wetlands are to be oriented to provide protection from wave and current action. Within open water sections of the rivers, rubble mound structures are to be provided to provide protection from wave action created by wind set-up and wave run-up.

In most cases, Black Swans will feed on terrestrial vegetation such as Kikuyu that is already present at the selected locations. Establishing fringing vegetation such as sedges around wetlands such as the wetlands at Sir James Mitchell Park will provide additional food. Creation or enhancement of food sources within the river at the selected locations will further encourage Black Swans to occur on the river.

Information regarding the plants suitable as a food source for Black Swans is contained in Section 3.4.3 and Appendix 2 (Section 2.3). An assessment of the species listed as suitable for Black Swans and the conditions required for establishment and growth will need to be made prior to species selection and implementation. Each of the selected sites will provide different conditions and the food source will have to be selected to survive in the given habitat. Elements may be incorporated into the design to ensure conditions provided as a result of habitat modification are favourable for establishing a food source whether reliant on a single species or a range of plants.

In particular, Black Swans are known to graze on the seagrass *Halophila ovalis*, which is patchily distributed within the Swan River estuary (Hillman *et al.*, 1995). This species however, does not occur in Perth Water adjacent to the city or extend far upstream in the Canning River. It is not known whether salinity or the availability of light and turbidity limits its distribution. Seagrass biomass changes due to seasonal influences and this species is known to re-colonise when favourable conditions return.

Specific conditions, particularly in terms of salinity and turbidity, may require investigation and comparison with sites where *Halophila ovalis* is known to occur to determine the potential for establishing this species at the selected sites for Black Swans. It is possible that a current lack of *Halophila ovalis* indicates the conditions are not suitable. Provision of more sheltered conditions such as the creation of embayments could however, improve conditions for growth of *Halophila ovalis*. Translocating seagrasses to the locations where it presently does not occur may need to be trialed to evaluate the feasibility of this option.

It is noted that research on constructed wetlands has mainly been carried out from the viewpoint of improvements to urban stormwater quality without consideration of their potential benefit to waterbird habitats. The information and design guidelines for constructed wetlands (BMP R3) in the Water & Rivers Commission's "Manual for Managing Urban Stormwater Quality in Western Australia" (1998) has been used in the preparation of detailed development plans for the selected sites. The Waters and Rivers Commission's "Wetlands as Waterbird Habitat" (WN5) (2000) was also consulted for information relating to habitat requirements.

The implementation stages of this project would provide opportunities for further research to complement the above reference documents and to prepare detailed guidelines for incorporation into other projects.

## 6.2 Detailed Development Plans

Detailed development plans have been prepared for Attadale Reserve, Sir James Mitchell Park and Ascot Waters to provide more prescriptive design features and habitat modifications. Development of the site at Clontarf Bay in Waterford is also considered in greater detail, however due to uncertainties in terms of the potential for this site to be modified for the benefit of Black Swans a detailed plan has not been prepared.

Detailed plans and cross sections for each of the sites are attached as Figures 2 to 4. The scope of works proposed at each site and the cost estimates follow. A breakdown of the cost estimates for each site is presented in Appendix 9. The cost estimates presented are indicative and will need to be refined following more specific and detailed site investigations and planning.

### 6.2.1 Attadale Reserve, Attadale

Black Swans currently use the adjacent Lucky Bay area, mainly in late summer when they feed on the seagrasses and roost on sandbars. It is proposed to enhance the Black Swans habitat by establishing a constructed wetland to encourage Black Swans to stay at the site and breed there.

It is proposed that constructed wetlands be established on the foreshore reserve at Attadale. This would be located near the intersection of Haig Road and Burke Drive. The site is screened by a stand of native trees from existing houses (Figure 2). The site is adjacent to a dog exercise area, however management of this issue at this location is presently being resolved with the Department of Conservation and Land Management and the local authority.

The wetlands are proposed to be established in conjunction with stormwater drainage improvements for the catchment that were identified in the City of Melville Stormwater Management Strategy (Kinhill, 1997). The constructed wetlands would not require any changes to the location of stormwater drainage discharge to the Swan River.

This location was previously used for disposal of waste, although it is believed that only inert waste was disposed of in this location. Previous drainage works in the area by the City of Melville support this belief. It is recommended that a geotechnical investigation of the area be carried out to determine the type and extent of waste disposed in this area.

The detailed design of the wetlands should meet the preliminary design requirements identified in the Stormwater Drainage Strategy. The Catchment Treatment Prescription proposed involves creation of:

- 9,500m<sup>2</sup> wetlands
- 30% macrophytes
- 70% open water
- average depth 0.8m

In addition, the detailed design of the wetlands would incorporate the critical habitat requirements for Black Swans (see Section 3.5).

The detailed development plan and cross-section for this site are shown on Figure 2.

The wetlands would be perched above the Highest Astronomical Tide (HAT) level of +0.5m AHD to prevent saline ocean water entering the area. Subject to water quality issues and the time of year, freshwater may either be obtained directly from the existing stormwater drains discharging from Haig Road or from bores which are used to reticulate the adjacent foreshore reserve. An existing stormwater pumping station located opposite Haig Road may be suitable for supplying freshwater to the wetlands.

Flooding of the wetlands may occur during certain flood flow conditions but river water quality at that time would be largely fresh to brackish (although possibly turbid) and vegetation in the wetland must be able to tolerate these conditions. The approximate 100 year Flood Level at Attadale Reserve is +1.10 m AHD.

Fencing may need to be provided during the establishment of the wetlands to act as a barrier to humans and general disturbance. The area presently experiences a relatively high usage for exercise, passive activities and dog exercising. Controlled access during implementation may therefore be necessary to encourage users to find alternative routes or nearby locations to enable plant establishment and limit these types of activities at the site in the future. Landscaped mounds will be created to demarcate and separate recreation areas and habitat areas at this site.

The estimated cost of this work is \$310,000. Details of the cost estimates are provided in Appendix 9.

### **6.2.2 Clontarf Bay, Waterford**

Clontarf Bay in Waterford on the Canning River is a sheltered cove with adjacent freshwater wetlands. The site attracts up to 60 Black Swans in autumn with smaller numbers for much of the year. Black Swans feed in the river and have attempted to breed there. Although the site has a low public profile, the potential exists to enhance the adjacent freshwater wetlands to increase the number of Black Swans at the site and to provide further opportunities for breeding.

The existing wetlands are approximately 8.1ha in area and are connected by a small creek to the river. These wetlands are in private ownership and are zoned for future development under the City of South Perth Town Planning Scheme.

In conjunction with the owners of the site, it is recommended that a site development constraints plan be prepared that delineates the areas that may be available for future development of this site for housing. This plan should also address the retention of the wetlands and consider works that could be undertaken to enhance breeding opportunities for Black Swans and to provide a link via the existing creek to the Canning River.

The foreshore area is believed to have been used in the past as an inert landfill disposal site. The type and extent of the waste deposited needs to be determined. It is

therefore recommended that a geotechnical investigation of the area be carried out to determine the type and extent of waste disposed in this area.

National Heritage Trust funding has previously been obtained for a foreshore revegetation project in this area.

No detailed development plan has been prepared for this site due to the land being in private ownership and existing zoning. Based on the concept plan (see Appendix 8) and the nature of the works required for habitat modification at this site, an indicative cost of between \$300,000 and \$400,000 is estimated to implement the suggested measures. This indicative cost is based on creating a similar size wetland to that proposed at Attadale Reserve (approximately 9500m<sup>2</sup>), and the need to screen and dispose of unsuitable inert waste. The upper cost should also enable some modification to the existing wetland and creek line on site to improve habitats, particularly for breeding.

### **6.2.3 Sir James Mitchell Park, South Perth**

Sir James Mitchell Park is a very high profile site located alongside Perth Water. Black Swans occur there now and breed there in small numbers in freshwater wetlands that have been established on the foreshore.

The foreshore area was used in the past as a landfill (putrescible) disposal site.

The City of South Perth has advised that there are poor water quality issues relating to these lakes and that algal blooms are evident at some times of the year. These issues reduce the options to link these lakes directly to the Swan River.

Habitat improvements at this site are therefore proposed in two areas. These are:

- Stage 1 – create islands in existing lakes.
- Stage 2 – create an embayment in the river.

It is proposed to establish further breeding sites in the existing freshwater wetlands by constructing a number of small islands. Due to the territorial nature of Black Swans when breeding, it is preferable to provide a number of small islands oriented to provide protection from the prevailing winds than it is to provide larger islands.

The density of swan nests is variable and is discussed in detail in Section 3.4.4 and Appendix 2 Section 2.8.3 (iii). Solitary pairs maintain a territory around the nest in the order of a hectare, but in colonies the distance between nests can be as little as 2.4m. Several breeding pairs per hectare should be achievable if the wetlands are complex with lots of small islands. Ensuring there is abundant food resource, area of preferred water depth and nest building materials is likely to increase the potential for breeding at the site and the number of nests built.

The number of islands shown in the lakes on the development plan for Sir James Mitchell Park is not a maximum but an estimate of what may be acceptable given that these lakes have other functions such as landscape amenity, and in order to provide sufficient open water for swans to take off.

The detailed development plan and cross-section for this site is shown on Figure 3.

It is further proposed to provide other enhancements to this location by constructing a freshwater wetland in a rubble wall protected embayment linked to the adjacent river. This will provide other opportunities for feeding, roosting and providing for Black Swans access directly to the river. The river in this location is quite shallow and there are few, if any, conflicts with other uses.

It is proposed that this embayment would involve removal of a section of the existing river wall and would provide a kikuyu grassed slope down into the embayment. The embayment would be perched above the Highest Astronomical Tide (HAT) level of +0.5m AHD. Subject to water quality issues and the time of year, freshwater may either be obtained directly from the existing lakes or from bores. The embayment would be linked to the river by a sloping sandy beach facing to the east. The embayment should not require any maintenance dredging. The shallows adjacent to this embayment could be enhanced with placement of selected maintenance dredging material from other areas to provide more extensive shallows for roosting and loafing.

Flooding of the wetlands may occur during certain flood flow conditions but river water quality at that time would be largely fresh to brackish (although possibly turbid) and vegetation in the wetland must be able to tolerate these conditions. The approximate 100 year Flood Level at Sir James Mitchell Park is +1.25m AHD.

The outer face of the embayment would be protected from wave and flood currents by small limestone armour. Plants could be grown to cover the rubble mound wall. The rubble mound wall would displace some of the substrate at construction and some settlement may occur. This would be addressed at detailed design with appropriate use of geotextiles prior to placement of limestone rocks for the wall construction.

No barrier fencing is proposed at this site. The rubble mound wall can be designed to limit access along the top of the wall from the adjoining foreshore. The open water zone in the wetlands would act as a barrier to humans and animals such as foxes, cats and dogs.

The estimated cost of this work is \$800,000. Details of the cost estimates are provided in Appendix 9.

The reclamation of river areas greater than 1 hectare may require approval by an Act of Parliament. The area of wetlands shown is greater than 1 hectare but this concept size may be reduced if needed to overcome constraints regarding approvals.

#### **6.2.4 Ascot Waters**

Ascot Waters has a moderately high public profile and existing use by Black Swans, but much of the usage by Black Swans is in adjacent wetlands and narrow branches of the river, rather than the river itself.

Habitat enhancement in this area would be provided to encourage Black Swans and draw them out onto the river.



Major redevelopment of the adjacent recreation reserve between the Swan River and Great Eastern Highway is proposed by the City of Belmont who have prepared Concept Plans for the redevelopment of Adachi-Ku Park and Bristle Park. A copy of this concept plan is included as Figure 4. Habitat enhancement works in this area would be linked to these plans.

The detail development plan and cross-section for this site is shown on Figure 4.

It is proposed to construct a freshwater wetland in an embayment protected by the rubble wall and linked to the adjacent river so that the birds will move onto the river on a regular basis. The embayment would be perched above the Highest Astronomical Tide (HAT) level of +0.5m AHD. Freshwater would be obtained from an existing weir located on the Central Belmont Main Drain.

Flooding of the wetlands may occur during certain flood flow conditions but river water quality at that time would be largely fresh to brackish (although possibly turbid) and vegetation in the wetland must be able to tolerate these conditions. The approximate 100 year Flood Level at Ascot Waters is +3.60 m AHD.

The outer face of the embayment would be protected from wave and flood currents by small limestone armour.

Plants could be grown to cover the rubble mound wall. The rubble mound wall would displace some of the substrate at construction and some settlement may occur. This should be addressed at detailed design with appropriate use of geotextiles prior to placement of limestone rocks for the wall construction.

Allowance has been made in the cost estimate for Ascot Waters to construct a concrete weir structure or beach to provide access for the swans to the river. A beach area similar to that proposed for Sir James Mitchell Park is preferred if it can be integrated with the proposed development of Adachi Ku and Bristle Parks.

No barrier fencing is proposed at this site. The rubble mound wall can be designed to limit access along the top of the wall from the adjoining foreshore. The open water zone in the wetlands would act as a barrier to humans and animals such as foxes, cats and dogs.

Over recent years significant upstream works have been carried out to improve stormwater quality discharging to the Swan River from the Central Belmont and South Belmont Main Drains. These have included diversion of the Mathieson Road Drain out of the Central Belmont Main Drain through a series of lakes in Ascot Race course to the river. The Central Belmont Main Drain has also been diverted through lakes and its discharge point to the Swan River relocated. Works associated with the discharge of the Belmont South Main Drain to the river at Adachi-Ku Park has also recently been completed.

Base survey data for this area were obtained from a number of sources which do not adequately represent construction or adjusted cadastral boundaries in this area. It is therefore recommended that a composite survey plan be prepared for this area to incorporate all relevant survey information.

The estimated cost of this work is \$600,000. Details of the cost estimates are provided in Appendix 9.

### 6.2.5 Other Sites

Other sites that have been identified as offering opportunities for habitat enhancement include:

- Tompkins Park, Alfred Cove,
- McCallum Park, Victoria Park,
- Others - generic improvements to improve waterbird habitats:
  - Heirisson Island
  - Burswood
  - Maylands

Tompkins Park and McCallum Park offer opportunities similar to Attadale Reserve in that the respective local governments are considering the establishment of constructed wetlands as urban stormwater quality improvement initiatives. The constructed wetlands are proposed as part of broader stormwater quality improvement programs. These involve significant upstream catchment initiatives for improving the quality of stormwater discharged to the Swan River.

The Tompkins Park site was identified in the City of Melville Stormwater Management Strategy (Kinchill, 1997). The Catchment Treatment Prescription proposed involves creation of:

- 15,000m<sup>2</sup> wetlands
- 30% macrophytes
- 70% open water
- average depth 0.8m

Other works proposed for this catchment include the construction of a Gross Pollutant Trap or Deflective Separator and an upstream Infiltration Basin.

The Town of Victoria Park is considering the McCallum Park site as part of a comprehensive review of Stormwater Disposal Options for the Local Authority. This study has not yet been commissioned however it is anticipated that this will be carried out in the 2000/2001 financial year. These works are expected to involve constructed wetlands at the McCallum Park site.

A number of freshwater lakes already exist at Heirisson Island, Burswood and Maylands. Habitat enhancements for Black Swans and other waterbirds could be provided at these locations by the introduction of more small islands to offer further breeding opportunities.

No detailed cost estimates have been prepared for these additional sites. However, based on works being similar to that proposed at other sites, the following order of costs could be expected:

- Tompkins Park – similar order of cost as Attadale Reserve and Clontarf of \$300,000 to \$400,000.
- McCallum Park – scope of works proposed by Town of Victoria Park is not known however may be similar to Attadale Reserve and Tompkins Park.

Generic improvements elsewhere will be site specific. The order of cost may be in the range of \$50,000 to \$100,000 per site.

In addition, the City of Perth has recently advised that it is proposed to construct two artificial wetlands at Ozone Reserve adjacent to the Causeway 'roundabout' and Point Fraser along the edge of the Swan River between Plain Street and the Causeway. An irrigation lake proposed at Ozone Reserve will store high quality water and will include an island that may be suitable for the nesting of swans. The second proposal will include constructed wetlands for stormwater management that will be landscaped and could provide habitat for bird life, including swans.

### **6.3 Development Schedule**

Each of the priority sites identified above has a number of site specific issues that impact on their implementation. Some of these, such as Attadale Reserve and Ascot Waters, are associated with co-ordination with existing Local Authority planning for the sites. Private ownership and the current zoning of the site for urban development affect other sites, such as Clontarf Bay. These issues require resolution before a specific implementation schedule can be prepared.

The preparation of a detailed implementation schedule should include the following:

1. Survey - a composite survey plan be prepared for each site to incorporate all relevant survey information and site constraints.
2. Geotechnical investigations - a geotechnical investigation of the Attadale Reserve and Clontarf Bay sites be carried out to determine the type and extent of waste disposed in these areas prior to any ground disturbing activities. Geotechnical investigations are also to be carried out at the Sir James Mitchell Park and Ascot Waters sites to determine subsurface conditions for the embayments proposed.
3. Determine site specific issues which may effect implementation in conjunction with other stakeholders including relevant Local Authorities.

4. It is recommended that sites be developed according to the following Priorities:
- Sir James Mitchell Park - Stage 1 Modify existing lakes  
- Stage 2 Create embayment in river
  - Attadale Reserve
  - Ascot Waters
  - Clontarf Bay

However it is recommended more than one site be developed to ensure several suitable sites throughout the Swan River.

5. A more detailed plan would need to be prepared for each of the sites prior to construction. The plan would include specific details such as materials, bank slopes, aquatic and dryland vegetation for planting, and other habitat improvement measures for wildlife.

#### **6.4 Maintenance**

Ongoing maintenance of the modifications outlined at the recommended sites will be required in order to ensure proper function and public safety. A maintenance plan for each site and the various components of the suggested modifications should be prepared prior to implementation.

Overall responsibility for implementing and funding ongoing operational and maintenance requirements is expected to be an issue that will need resolution with relevant stakeholders and local authorities. The local authorities may be the most appropriate to co-ordinate regular land based maintenance works such as mowing, litter removal and weed control. Responsibility for maintaining and refurbishing rubble walls is expected to rest with the Water & Rivers Commission or Swan River Trust. The involvement of volunteers or community groups in certain aspects of the ongoing maintenance of the sites and habitat features may enable costs to be reduced.

It has been assumed that as the selected habitat sites are intended to be high profile, attracting significant numbers of visitors, the operating and maintenance schedule will similarly be to a high standard. A detailed maintenance schedule and costings have not been prepared, however an order of likely costs has been suggested.

There will be a need to regularly inspect and maintain the constructed wetlands. Examples of maintenance activities that should be conducted during these inspections include checking inlet and outlet structures, cleaning of surfaces where solids and floatable substances have accumulated to the extent that they may block flows, removing nuisance species and maintaining the appearance and general status of the vegetation and wildlife populations, and removal of sediment accumulations.

Considerations for maintaining created or modified wetlands include:

- A higher level of maintenance will be required during implementation phases.

- Removal of sediment and litter from traps and specifically designed areas on a regular basis.
- Weed control measures.
- Vegetation monitoring and refurbishment particularly during establishment.
- Any remedial works to the wetland or associated infrastructure as required.

A typical total annual operating and maintenance cost for each site upon completion of the implementation phase would be roughly \$20,000.

Maintenance on the rubble mound breakwaters is usually associated with impacts caused during major storm events. It is therefore difficult to determine the extent of works on an annual basis and associated indicative cost for maintenance. The maintenance work of the breakwaters would typically involve a cost of about 1% per annum of the capital cost, plus allowance for mobilisation and access. For Sir James Mitchell Park the estimated maintenance cost is in the order of \$25,000 every 5 years. At Ascot Waters a maintenance cost of \$22,000 every 5 years should be allowed.

Monitoring is viewed as an essential component of the project to assess that the proposed and implemented modifications are functioning as intended and that no unforeseen issues or difficulties arise. It is envisaged that responsibilities for monitoring and maintenance would be a matter for negotiation between the Water and Rivers Commission and the local authorities or other relevant agencies. A coordinated approach to the monitoring by Water and Rivers Commission or other agreed nominated authority or agency would be appropriate. Implementation of many of the tasks could be undertaken by the Shire or community groups with funding from various sources.

## **7. IMPLEMENTATION**

### **7.1 Attracting Black Swans**

Black Swans are currently present on the Swan River but in low numbers. This is most probably a consequence of limited habitat being available along the river systems and availability of numerous wetlands in the Perth area that offer key habitat requirements. Literature and available information regarding behaviour and movement of Black Swan suggests that if suitable habitat is available the area will be utilised by swans. It is therefore expected that Black Swans together with other wildlife will colonise or frequent modified habitat areas naturally without any requirement to initiate measures to specifically introduce birds to the sites.

There is some indication however, that swans may return to areas they are familiar with or return to the same location to breed in successive years. Increases in the number of swans on the Swan River following implementation of measures such as those outlined in this report for the preferred sites may be progressive over several years or seasons as the swans become familiar with the modified habitats and a "connection" with these sites is established.

The attraction of swans and other wildlife to the sites should occur naturally without interference, and this is the preferred method in which to increase the occurrence of swans on the Swan River. Several options have been suggested however, to actively enhance the populations of Black Swans should this be considered necessary.

The presence of Black Swans at a particular site is considered likely to encourage other swans to also use the area. A feasible option to enhance populations of Black Swans at modified habitat areas may be to release swans and possibly other birds that have been in care following abandonment while young or injury and subsequent recuperation. Alternatively, Black Swans bred at wildlife centres or Perth Zoo could be introduced to the habitat areas, although there does not appear to be any requirement for specific breeding or introduction programs. Birds released at the sites may disperse to alternative habitat upon release, or they may remain in the area and inhabit the site regularly or return on a seasonal or periodic basis. Options such as pinioning birds to the sites are not considered desirable or warranted.

It may be appropriate to provide an artificial food source such as pellets for an initial period at certain locations to increase the population of wildlife utilising the site at a faster rate. This may be useful at least in the short term to enable aquatic plants and natural food sources to continue to establish without impacts of overgrazing. Additional sources of food however, are not expected to be required particularly in locations where there are large areas of lawn nearby. Should supplementary sources of food such as pellets be necessary, automatic feeders specifically designed to enable swans access to feed and not other wildlife, similar to those used with success overseas, may be applicable for this project.



## 7.2 Land Use Conflicts

Identification of potential sites included criteria relating to existing land uses that may not be compatible with the establishment of wildlife habitat. The preferred sites therefore have been selected on the basis of having limited competing land use issues or the conflicting uses are considered to be readily manageable.

Modification of the habitat areas will require continual management to ensure land use conflicts that may interfere with the site providing suitable habitat for the wildlife do not arise during implementation phases or at a later date. Potential disturbances in the foreshore area include dog exercising, visual amenity, human access and active and passive recreational pursuits including cycling, jogging and golf practice. Within the river, boat use, water skiing and jet skis are typical activities that would greatly reduce the habitat potential of any site.

There is potential for changes to designated areas of use to occur in the future that could severely restrict the attractiveness of a site to wildlife. Changes may include modification to speed restrictions, additional boat launching areas, extension of water skiing and jet skiing areas, changes in location of dog exercising areas and possibly redevelopment or adjoining urban or other land and associated demand for views and improved access. Consultation with the agencies such as the Department of Transport and Fisheries Western Australia may be required.

Changes within upstream catchments that drain into the habitat areas or adjacent river could significantly impact on the habitat value of the modified areas. The drainage system and catchment areas will need to be managed by the Water Corporation and the local authorities together with other approving and advisory agencies to ensure changes within the catchment to not compromise the habitat areas.

It may be appropriate to enter into an agreement or Memorandum of Understanding between the relevant agencies that have some jurisdiction or management responsibility of the river and foreshore area. This will enable a co-ordinated approach to managing and maintaining the wildlife habitat values at the selected sites.

It is further recommended that the foreshore areas and adjoining sections of the river be officially reserved for conservation purposes and wildlife habitat. The appropriate section of the river and foreshore could be designated specifically as a "Wildlife Sanctuary" or "Conservation Area" by the responsible agency and management objectives established for its protection from disturbance and other impacts. This reservation or zoning would need to be reflected in relevant planning documents and strategies, and supported by agencies such as CALM, Ministry for Planning, Swan River Trust and the local authorities. Management strategies should ensure planning of adjacent areas does not conflict with the objectives of the modified habitat areas. Restrictions on potential changes in land use in adjacent areas should be established to ensure long term protection of habitat areas.

Preparation of published management plans for the habitat sites will facilitate awareness of the values and importance of these areas throughout the community and effective integrated management.

### **7.3 Approvals**

The creation of habitat attractive to Black Swans and other wildlife should not require any special permits in relation to the swans. The sites will be utilised by wildlife in manner consistent with other existing natural or artificial habitats. Should specific breeding or introduction programs be implemented to enhance numbers of swans at the habitat areas consideration may be given to marking these birds to assess the effectiveness of the introductions. In this instance it is expected that formal approval from the Department of Conservation & Land Management would be necessary. Any banding would need to be done as a formal project with the Australian Bird and Bat Banding Scheme.

Interaction with people such as hand feeding the swans presents a multitude of issues including the domestication of wildlife and increased susceptibility of the swans and other birds to potential acts of cruelty and injury. Random, indiscriminate interaction between the public with wildlife should be discouraged. Any feeding of the swans, should this be a key aspect of the project, should be co-ordinated and supervised. Specific times should be selected and personnel or volunteers appointed to undertake feeding for the benefit of public interaction and appreciation. Feeding should be conducted under the direction of the Department of Conservation and Land Management. The feed used during this activity should be specifically designed for Black Swans or waterbirds.

Appropriate approvals in terms of general aspects of the environment such as water quality, existing vegetation, dredging and use of fill and disturbance of land fill sites will be required from relevant agencies to ensure impacts on the environment as a result of the modifications are acceptable. Agencies from which approval may be required include Department of Environmental Protection/Environmental Protection Authority, Swan River Trust, Department of Transport, Local Government Authority, Department of Conservation and Land Management, and Ministry for Planning/Western Australian Planning Commission. An Act of Parliament may be required to approve structures or reclamation and/or dredging affect an area of the river greater than 1ha.

### **7.4 Monitoring**

The success of any habitat modifications to attract greater numbers of Black Swans onto the Swan River should be determined through monitoring. Monitoring should also consider the increase, or otherwise, in numbers of other wildlife at the modified sites. Prior to the commencement of the works to improve habitat for Black Swans criteria should be established to enable evaluation of the success of the habitat modifications carried out at each site.

Regular and seasonal monitoring should involve an assessment of habitat utilisation by wildlife and recording evidence of breeding at each of the sites. The number of swans actually using the river and activities such as feeding, preening or roosting being undertaken should be noted. Monitoring should also determine if any deaths or injuries of swans or other wildlife have occurred and the likely cause of the injuries. Incidents, such as dog attacks, general disturbance and road deaths, which suggest

possible land use conflicts or the need for stricter management and control should be identified.

Criteria to evaluate the success of the project should be based on the current usage by swans (and other wildlife) of each of the sites to be modified, and the frequency and numbers of swans (and other wildlife) visiting or inhabiting the site after works have been completed over several years. Existing information could be compiled by the relevant local authorities, interest or community groups, and Birds Australia. However, it may be necessary for routine and coordinated monitoring of each of the sites to be undertaken to ensure standardisation of the monitoring and results obtained.

Habitat usage monitoring should commence preferably at least 12 months prior to works being carried out to establish baseline information and continue using the same frequency and methodology to enable comparisons with baseline data. It may be appropriate to encourage groups such as Birds Australia to undertake the monitoring and submit regular reports, although the monitoring methodology should be established with advice from relevant consultants and/or authorities.

The creation or re-establishment of wetland areas within the river foreshore will necessitate management of wetland features and water quality. Routine monitoring of water quality parameters such as nutrients and algae together with visual inspections of the wetland are recommended and may be incorporated into the maintenance schedule for the site. The occurrence and health of fringing vegetation and aquatic plants should be noted together with signs of erosion, stagnant water or disturbance. Protection of planted sedges and submerged plants may be required during establishment to ensure losses from grazing pressures are minimised.

It is not considered necessary to band or otherwise mark birds released at or found to be using the river and habitat areas. Black Swans tend to disperse on a seasonal basis and in response to their requirements for resources. The tendency for individual swans or groups to remain in a specific area or return regularly is highly dependent on the availability of appropriate resources and is therefore largely opportunistic.

It is recommended that management plans be prepared for each of the habitat areas that specifically identify monitoring requirements and responsibilities for maintenance. Requirements for regular periodic review of the monitoring information and management measures together with possible contingency measures or additional actions should be prescribed in the plan. Much of the monitoring and components of the maintenance of the habitat such as additional vegetation planting and weeding could be achieved through the involvement of community based groups such as Birds Australia, "Friends" groups and schools.

## **7.5 Other Potential Sites**

Throughout the course of the project several sites were identified or suggested as potentially suitable sites by several local authorities and those who attended the technical workshop. Many of these sites are linked with proposed works to create or modify wetland areas in close proximity to the river.

While these sites may not rate as highly in terms of habitat potential and access for public appreciation as other sites, they present further opportunities to include design features that are conducive to encouraging Black Swans and other wildlife to be present. Increased numbers of swans at a variety of locations within the river foreshore areas is expected to encourage more swans to venture onto the river.

It is expected that projects and works will be proposed in the future that also offer possibilities for increasing and improving habitats for Black Swans and other wildlife at locations along the river. The key habitat requirements and considerations taken into account as part of the evaluation and selection of sites for this study could be applied for other projects or work that area being undertaken. The critical habitat requirements identified as part of this study should be used as a guide for wetland or foreshore modification works to be carried at any location adjacent to the river to maximise the habitat available for Black Swans and opportunities to encourage increased numbers of swans onto the river.

The critical habitat requirements, relevant assessment forms and additional information that should be considered as an initial evaluation of the potential for a site to be modified as habitat for Black Swans is presented in Appendix 10.

Opportunities for providing habitat features for Black Swans and other wildlife should take advantage of any future proposals for works within the foreshore. Preparation of detailed guidelines on the requirements of Black Swans and other wildlife for dissemination throughout the community will maximise potential development of compatible habitat areas at numerous locations along the river. Artificial wetlands are often created for the purpose of stormwater management and the guidelines presently available to assist the creation of wetlands generally deal solely with this issue rather than also focussing on design features for wildlife habitat.

## **7.6 Funding Opportunities**

Assistance with the costs of environmental projects, such as the implementation of management measures and the ongoing maintenance of the habitat areas, is available by incorporation into existing works programs, from corporate sponsorship and through a number of State and Commonwealth programs.

Co-ordination of the proposed works with other schemes such as foreshore regeneration and stormwater management may assist in reducing actual costs associated with creating improved habitat for Black Swans. The development plans for the preferred sites considered the issue of implementation and where possible the proposed works have been linked with other proposed works such as improvements to stormwater management.

The applicability of the sources of funding will depend on the authority or organisation that has responsibility for implementing measures and maintaining the area. In many instances apart from corporate sponsorship it may be necessary to form partnerships with, or encourage, local authorities or community groups to co-ordinate the implementation and maintenance of the habitat areas in order to access funds available for environmental projects.

Funding opportunities available for local governments to assist with major works and ongoing maintenance and monitoring are described in the current 'Directory of Financial Assistance'. This document should be consulted to identify and investigate potential sources of funding for works associated with implementation of habitat modification and ongoing maintenance.

Some of the funding sources that may be applicable to projects designed to increase numbers of Black Swans on the river through habitat modification are outlined below.

- Natural Heritage Trust - Commonwealth Government's Natural Heritage Trust (NHT) including National Rivercare Initiative, (incorporating Fishcare, Waterwatch and National Wetlands Programs), Natural Vegetation Initiative, National Landcare Program, National Weeds Program.
- Gordon Reid Foundation for Conservation - major grants are available for strategic projects that planting of local tree and understorey species and controlling weeds.
- Living Cities Program – a Federal Government initiative administered by Environment Australia that includes various components such as the Urban Stormwater Initiative for improvements to stormwater systems.
- Community Conservation Grants - provides funding for community groups and individuals to undertake conservation projects such as implementation of environmental management plans and other conservation projects.
- Labour Market Programs and Volunteer Groups - can assist with supplying labour for conservation, rehabilitation and revegetation projects.
- Corporate Sponsorship - by companies wishing to be associated with environmental projects is a possible avenue through which to obtain assistance for implementing modifications, ongoing monitoring and maintenance, and assistance with community involvement and public awareness initiatives.

## **7.7 Community Involvement**

Community enthusiasm and involvement are recognised as key elements in the successful implementation of the project at a local level. Success of habitat modifications will depend largely on the establishment of partnerships between relevant authorities such as the Water & Rivers Commission, Swan River Trust, Department of Conservation & Land Management and Local Governments and possibly including prominent conservation groups and wildlife care providers. Partnerships may assist in providing support, encouraging and promoting the establishment and ongoing maintenance of areas.

Local community appreciation and support for the implementation of measures to improve habitat for Black Swans and other wildlife will assist fulfilment of the objectives of the project. The Water & Rivers Commission together with the local authority and other relevant organisations should develop programs aimed at ensuring



community awareness of and involvement in the project and the specific areas to be modified. Providing the community with information and opportunities to be involved can encourage a sense of ownership and greater community involvement in ongoing management.

Opportunities for encouraging community involvement and enhancing public awareness and appreciation include:

- Identifying tasks or roles that could involve input and assistance such as vegetation planting, habitat usage and water quality monitoring or supervising feeding opportunities (should these be encouraged as part of the project).
- Encouraging participation of schools and institutions and sense of ownership of the habitat area with involvement in plant propagation, revegetation and monitoring.
- Forming of an advisory committee to ensure ongoing community support and commitment of agencies to the project.
- Encouraging and supporting "Friends" groups/community projects associated with the habitat sites or areas complimentary to these sites.
- Informing the local community of the project, events and monitoring results through media coverage and community newsletters, and about the river and the local flora and fauna.
- Providing information relating to the wildlife occurring at the site, disturbing activities and impacts, and the river system to the community using signage and pamphlets.
- Utilising modified areas as the focus of demonstrating the theoretical and practical aspects wetland management, foreshore regeneration and native flora and fauna.
- Providing expert advice and guidance to school groups during theoretical and practical exercises.
- Establishing and co-ordinating community monitoring programs that could readily involve participation and contribution from schools and institutions.



## 8. CONCLUSION

The present study has considered the potential for modifications to be made to the Swan River foreshore area at several locations in order to encourage a greater presence of Black Swans on the river system.

The review and research undertaken of the behaviour and biology of Black Swans, and knowledge of projects to increase numbers of other species of swans, indicates that provided the critical habitat requirements are supplied, the swans should readily utilise the modified sites. Swans presently occur in the river at certain locations and times of the year although in low numbers. The number of swans and duration of their stay will depend on the extent of suitable habitat and provision of all essential habitat requirements and features required for all phases of their lifecycle.

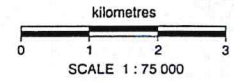
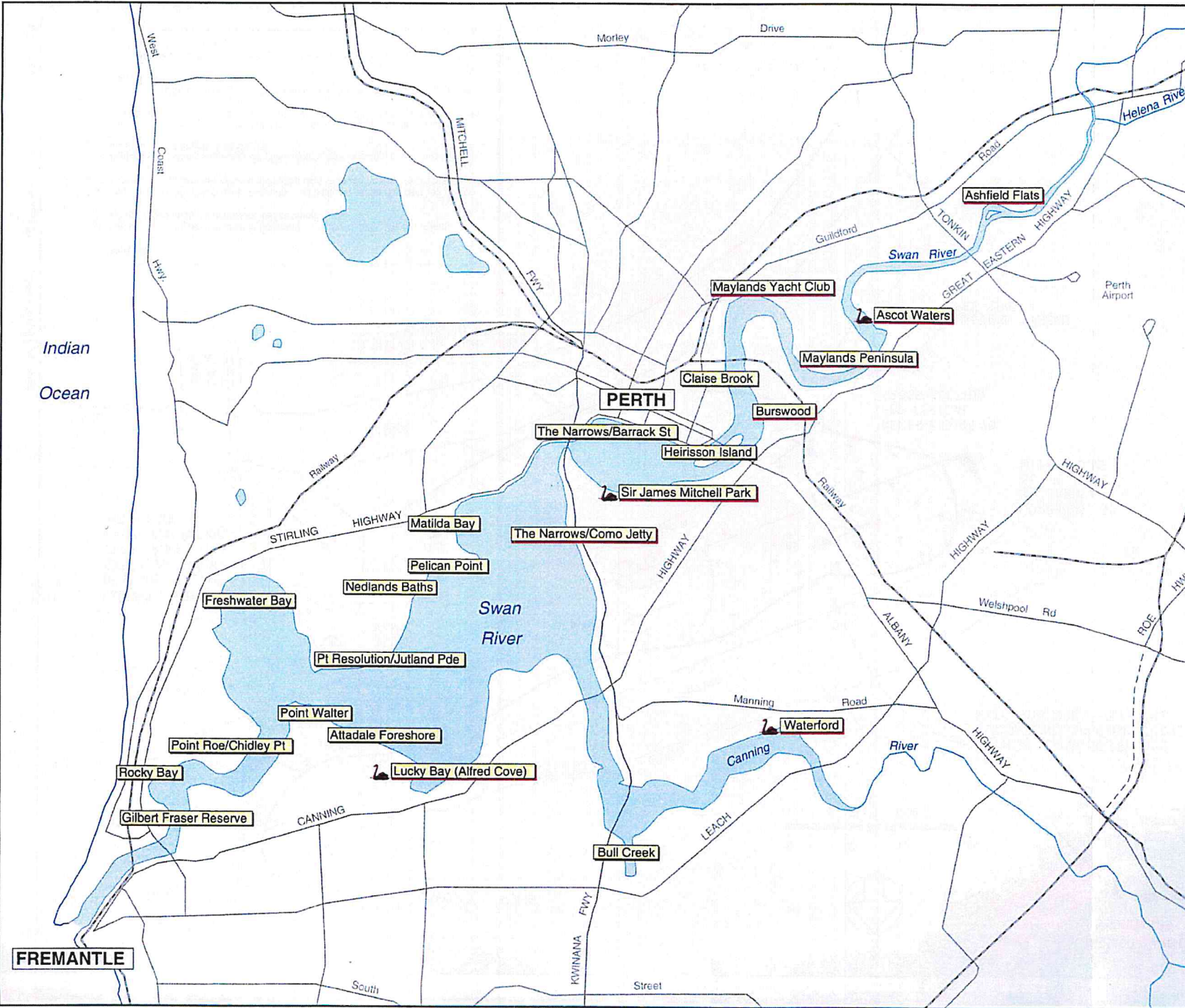
The study suggests suitable habitat can be created at numerous sites along the river, although several prominent locations offer better opportunities than others. Enhancement of habitat will involve considerable capital works but will provide additional benefits such as provision of habitat for a range of fauna, restore some area of foreshore to more natural conditions and potentially reduce nutrient and pollutant inputs to the river.

It is suggested that consideration be given to modifying more than one of the recommended sites so that a network of sites suitable for Black Swans (and other waterbirds) is established along the Swan River.

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## **FIGURES**



**LEGEND**

- Name of Site Assessed Site
- Potential Site
- Recommended Site

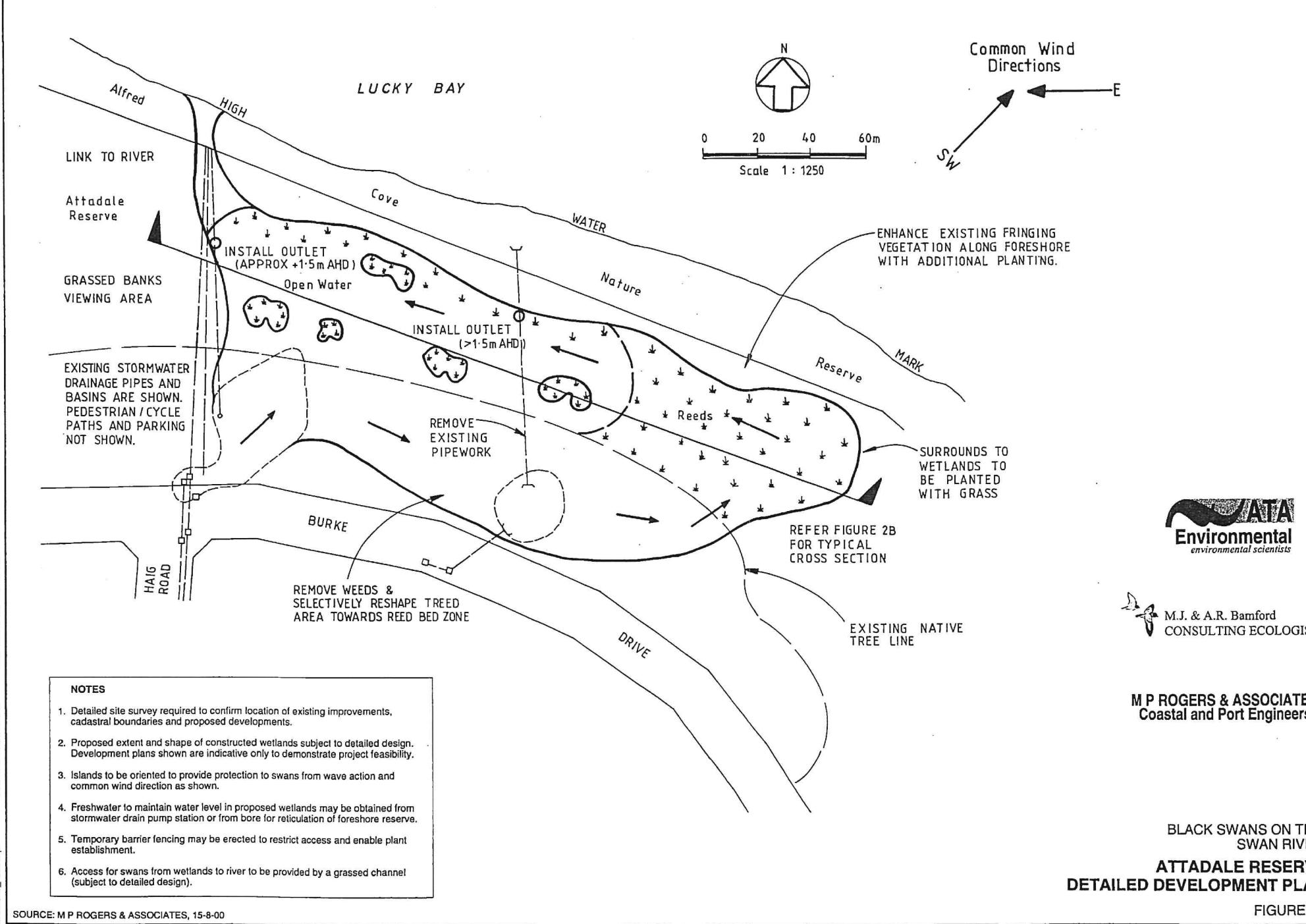


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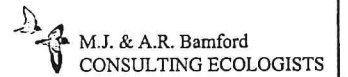
BLACK SWANS ON THE  
SWAN RIVER  
**LOCATION OF ASSESSED  
& RECOMMENDED SITES**

FIGURE 1



**NOTES**

1. Detailed site survey required to confirm location of existing improvements, cadastral boundaries and proposed developments.
2. Proposed extent and shape of constructed wetlands subject to detailed design. Development plans shown are indicative only to demonstrate project feasibility.
3. Islands to be oriented to provide protection to swans from wave action and common wind direction as shown.
4. Freshwater to maintain water level in proposed wetlands may be obtained from stormwater drain pump station or from bore for reticulation of foreshore reserve.
5. Temporary barrier fencing may be erected to restrict access and enable plant establishment.
6. Access for swans from wetlands to river to be provided by a grassed channel (subject to detailed design).

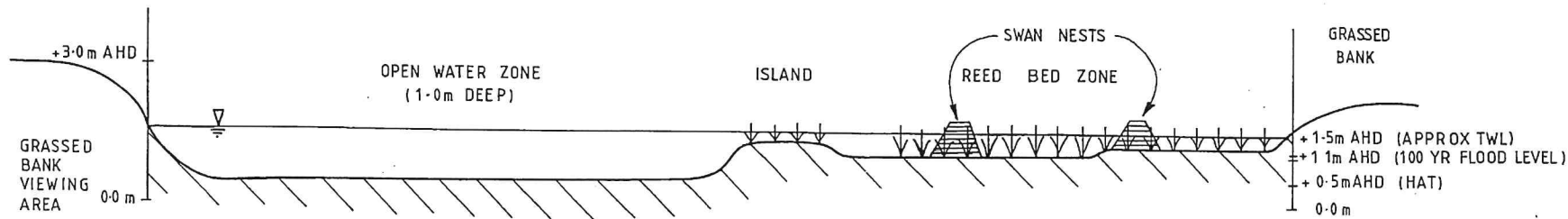


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BLACK SWANS ON THE SWAN RIVER  
**ATTADALE RESERVE**  
**DETAILED DEVELOPMENT PLAN**

FIGURE 2A

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**TYPICAL CROSS SECTION**

Scale Horiz. 1:1000  
Vert. 1:100



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BLACK SWANS ON THE  
SWAN RIVER  
**ATTADALE RESERVE**  
**TYPICAL CROSS SECTION**

FIGURE 2B

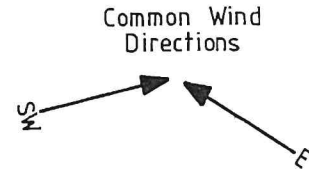
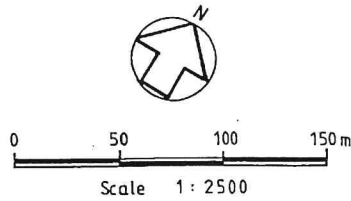
- NOTES**
1. HAT (Highest Astronomical Tide) Level is +0.5m AHD.
  2. 100 Year Flood Level is +1.10m AHD

SOURCE: M P ROGERS & ASSOCIATES, 15-8-00

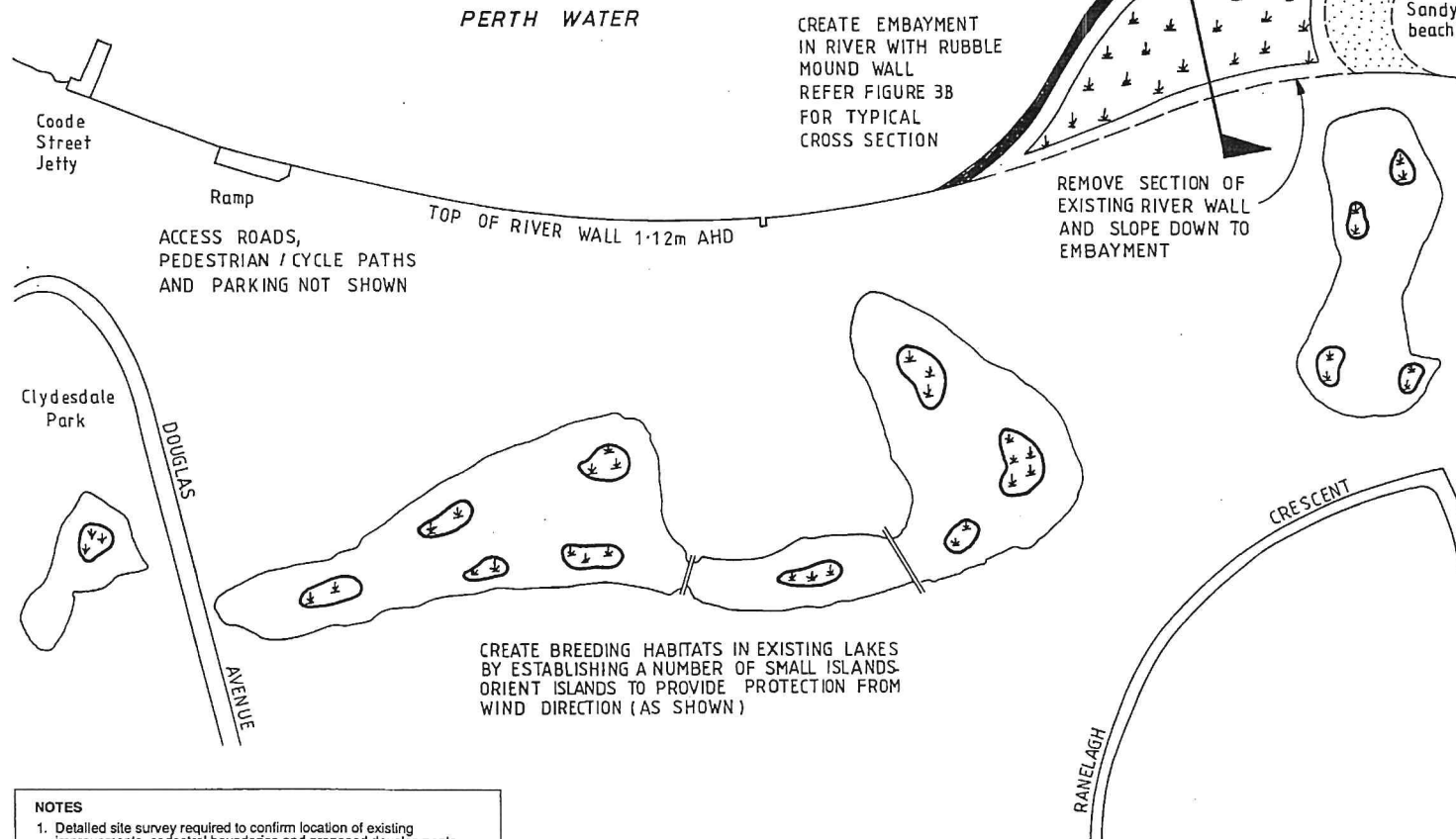
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POSSIBLE USE OF SHALLOWS  
ADJACENT TO EMBAYMENT  
FOR ROOSTING / LOAFING



- NOTES**
1. Detailed site survey required to confirm location of existing improvements, cadastral boundaries and proposed developments.
  2. Proposed extent and shape of constructed wetlands subject to detailed design. Development plans shown are indicative only to demonstrate project feasibility.
  3. Spoil from maintenance dredging may be used to create additional shallows in river adjacent to wetlands embayment for swans roosting / loafing.
  4. Rubble mound wall provides protection to swans from wave action and common wind direction as shown.
  5. Freshwater to maintain water level in proposed wetlands may be obtained from existing lakes or from bore for reticulation of foreshore reserve.



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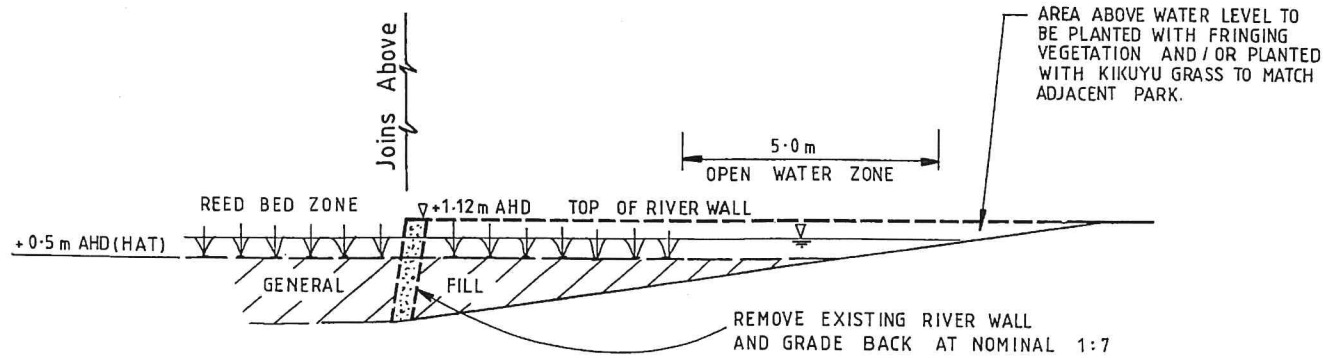
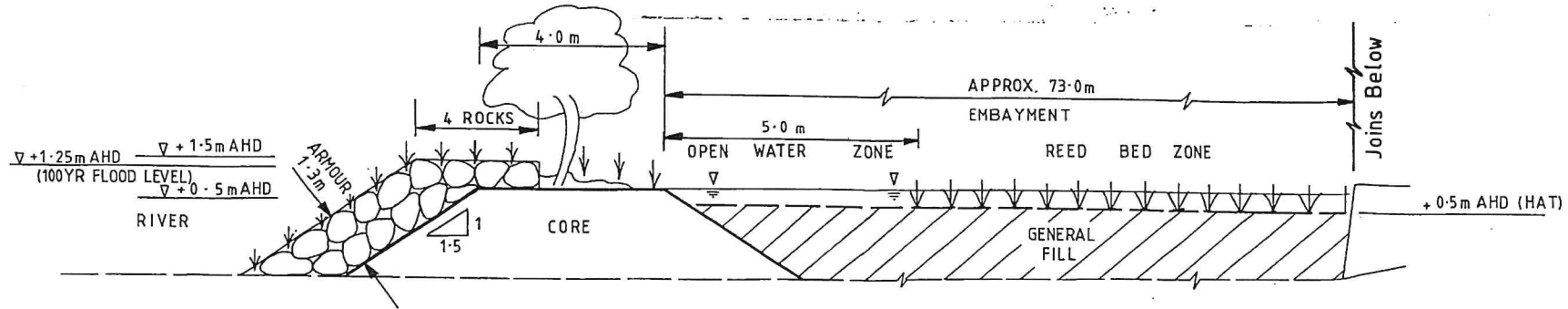
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BLACK SWANS ON THE  
SWAN RIVER  
**SIR JAMES MITCHELL PARK**  
**DETAILED DEVELOPMENT PLAN**

FIGURE 3A

9917720\_63F3A1P1 DRAWN: GUM/TE 24-8-00 CHECKED: KG 24-8-00

SOURCE: M P ROGERS & ASSOCIATES, 15-8-00



- NOTES**
- Rubble mound to consist of:  
Armour - 2 layers 0.5 tonne limestone (S.G. 1.9 t/m<sup>3</sup>), D50 (Nominal) = 0.64m.
  - Open water zone in wetlands acts as barrier to humans and such animals as foxes, cats and dogs.
  - Outer (riverside) face of rubble mound wall to be planted.
  - Existing river wall where removed may be suitable to be used as general fill embayment.
  - HAT (Highest Astronomical Tide) Level is +0.5m AHD.
  - 100 Year Flood Level is +1.25m AHD.
  - Access for swans from wetlands to river to be provided by a beach (Subject to detailed design).

**TYPICAL CROSS SECTION**

SCALE H. 1 : 100  
V. 1 : 100

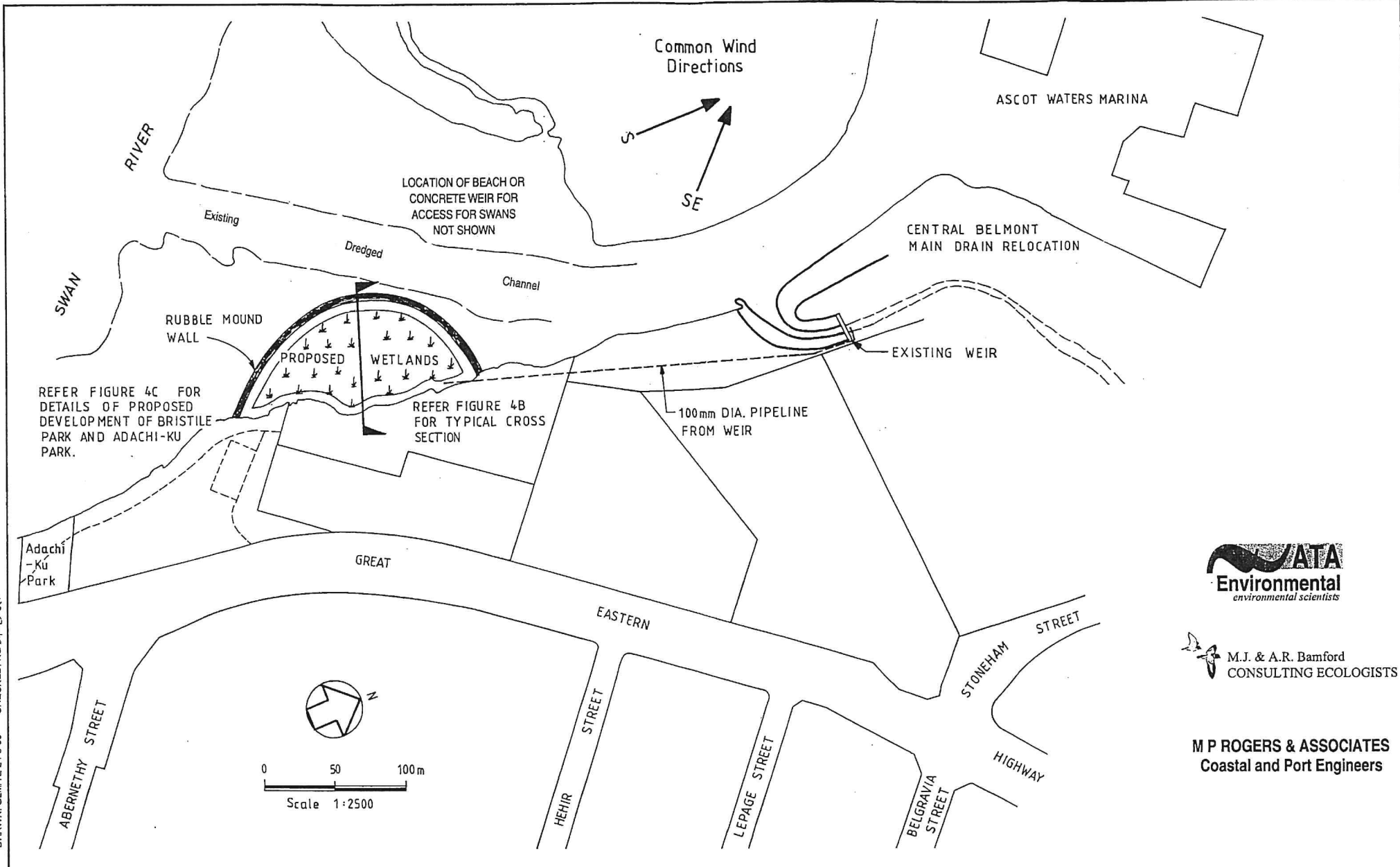


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BLACK SWANS ON THE  
SWAN RIVER  
**SIR JAMES MITCHELL PARK**  
**TYPICAL CROSS SECTION**

FIGURE 3B



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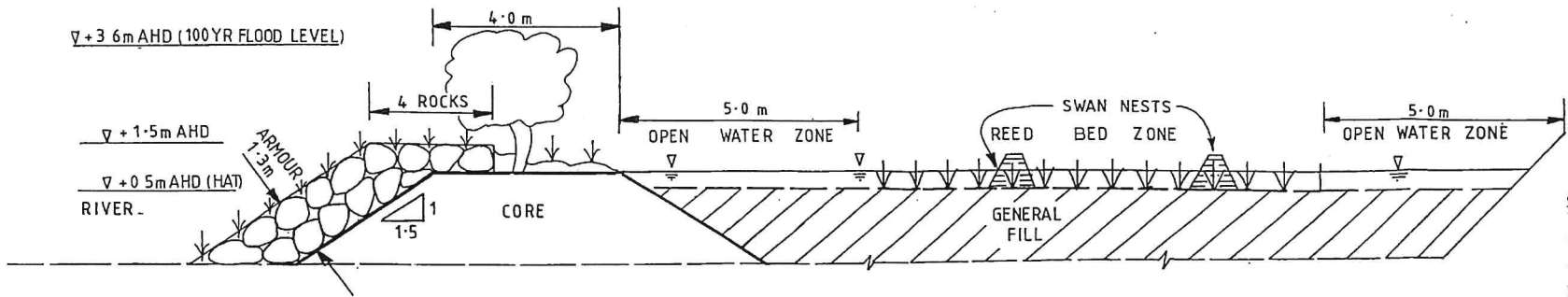
BLACK SWANS ON THE SWAN RIVER  
**ASCOT WATERS  
DETAILED DEVELOPMENT PLAN**

FIGURE 4A

- NOTES**
1. Detailed site survey required to confirm location of existing improvements, cadastral boundaries and proposed developments.
  2. Proposed extent and shape of constructed wetlands subject to detailed design. Development plans shown are indicative only to demonstrate project feasibility.
  3. Spoil from maintenance dredging may be used to create additional shallows in river adjacent to wetlands embayment for swans roosting/loafing.
  4. Rubble mound wall provides protection to swans from wave action and common wind direction as shown.
  5. Freshwater to maintain water level in proposed wetlands may be obtained from existing weir located on central Belmont Main Drain (as shown) or from bore for reticulation of Adachi-ku and Bristle Parks.

SOURCE: M P ROGERS & ASSOCIATES, 15-8-00

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 DRAWN: GUM/TE 24-9-00  
 CHECKED: KG 24-9-00



SLOPE TO SHORE TO BE GRADED GENTLY (~1:6) AND FRINGING VEGETATION PLANTED TO MATCH LANDSCAPING PROPOSALS FOR ADACHI-KU AND BRISTLE PARKS.

TYPICAL CROSS SECTION

SCALE H 1:100  
V 1:100



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BLACK SWANS ON THE SWAN RIVER

ASCOT WATERS  
TYPICAL CROSS SECTION

FIGURE 4B

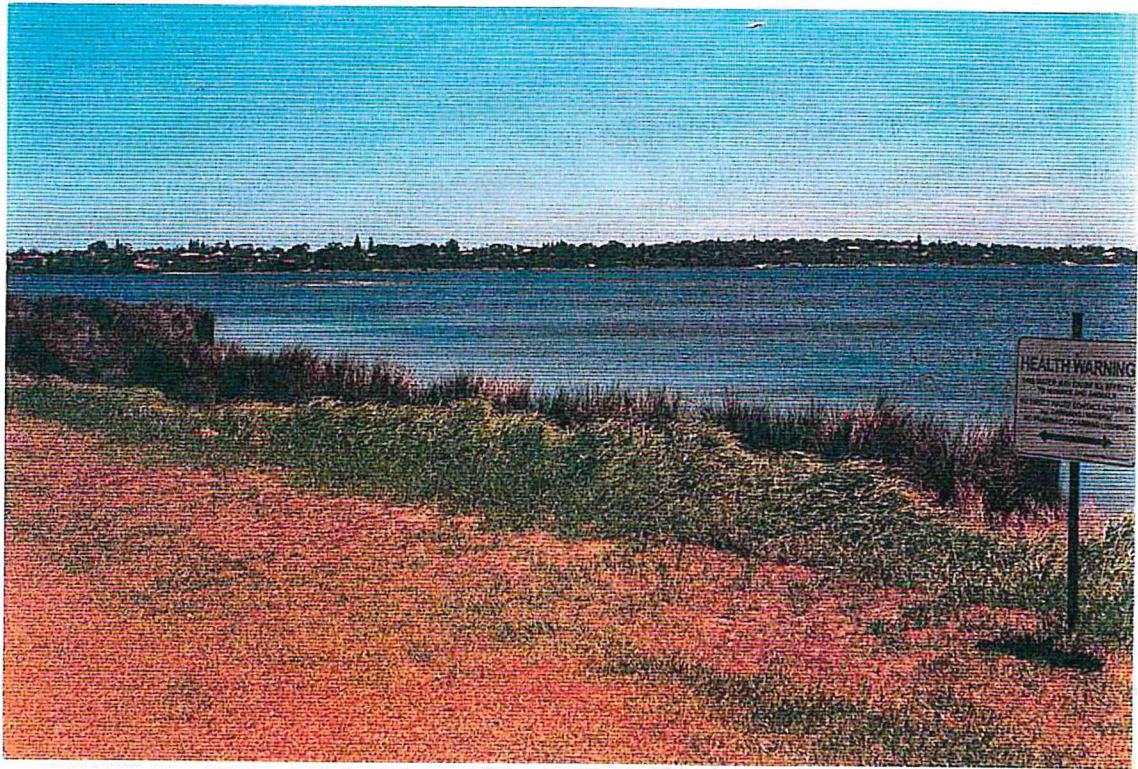
- NOTES
1. Rubble mound wall to consist of:  
Armour - 2 layers 0.5 tonne limestone (S.G. 1.9 1/m<sup>3</sup>), D50 (Nominal) = 0.64m.
  2. Open water zone in wetlands acts as barrier to humans and such animals as foxes, cats and dogs.
  3. Outer (riverside) face of rubble mound wall to be planted to complement fringing vegetation proposed for Adachi-ku and Bristle Parks.
  4. HAT (Highest Astronomical Tide) Level is +0.5m AHD.
  5. 100 Year Flood Level is +3.60m AHD.
  6. Access for swans from wetlands to river to be provided by a beach or concrete weir structure ( to be finalised as part of detailed design & to integrate with Adachi-ku & Bristle parks ).

SOURCE: M P ROGERS & ASSOCIATES, 15-9-00

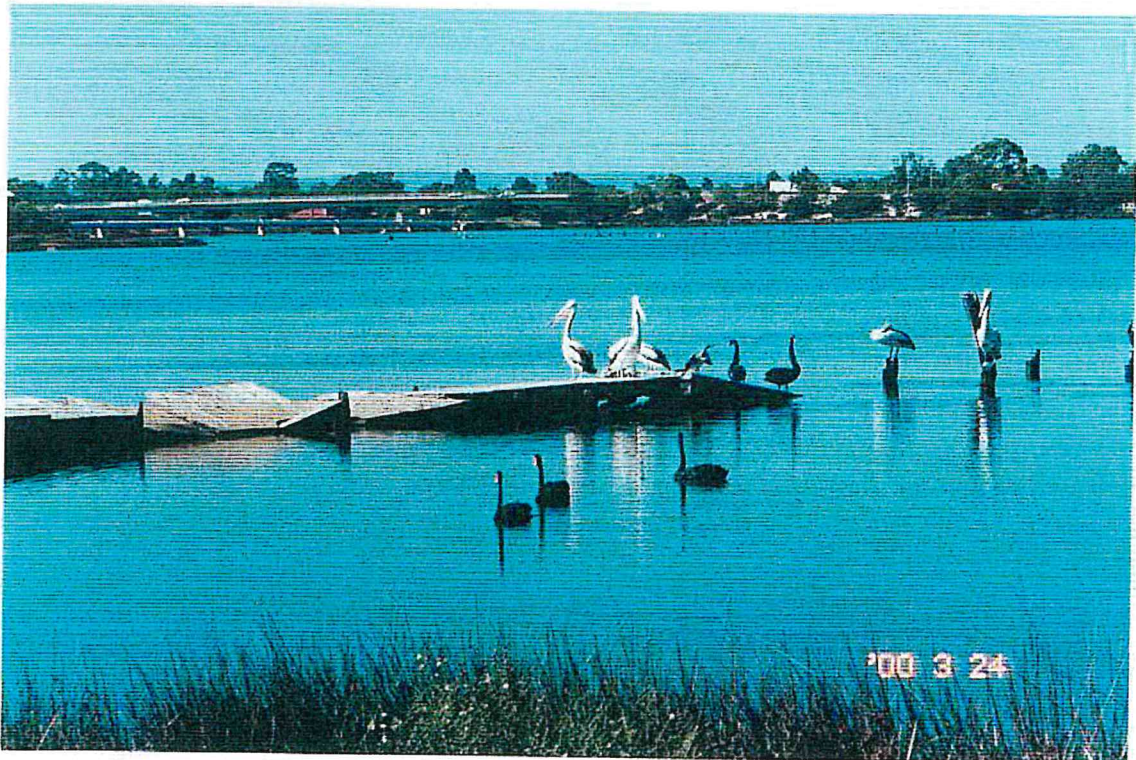
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## **PLATES**





**PLATE 1** Attadale Reserve, Attadale at Lucky Bay/Alfred Cove – The river at this site includes large areas of shallow water, sandbars and limited fringing vegetation. The adjacent land includes expansive grassed areas with small pockets or stands of remnant vegetation.

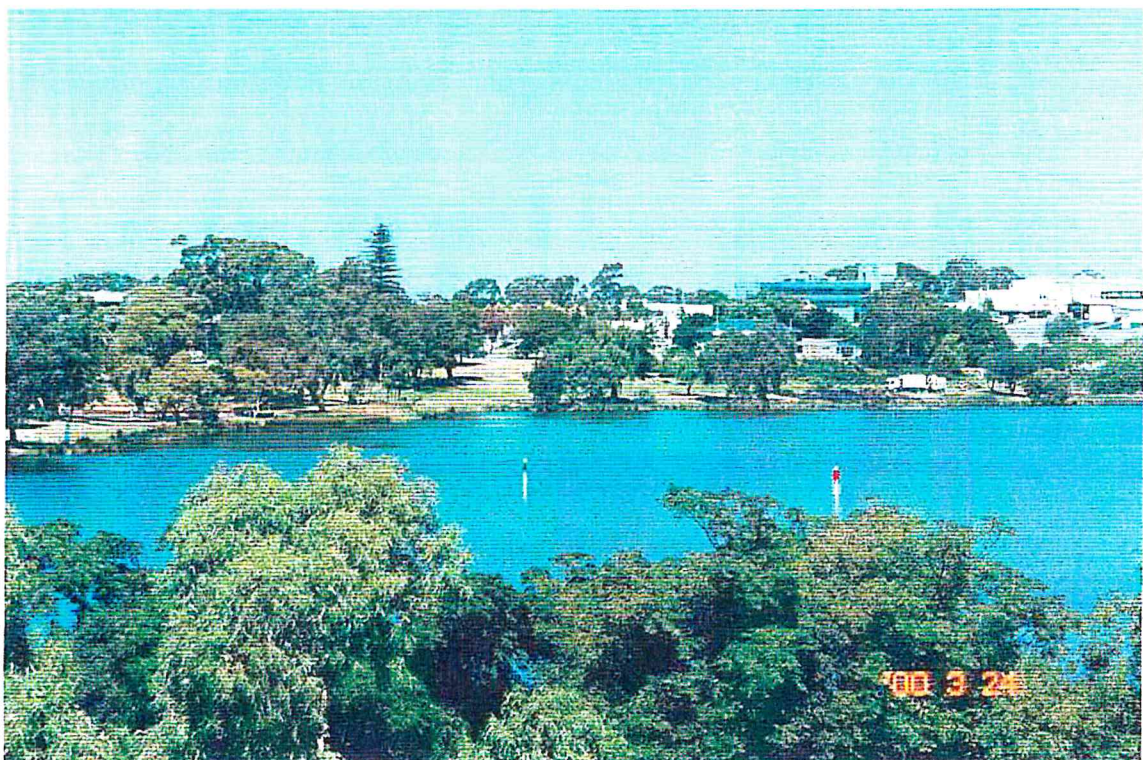


**PLATE 2** Clontarf Bay, Waterford on the Canning River – This location includes a sheltered, shallow bay on the Canning River that provides habitat for Black Swans for at least part of the year. The adjoining land has been used as an inert landfill and includes a protected wetland area.





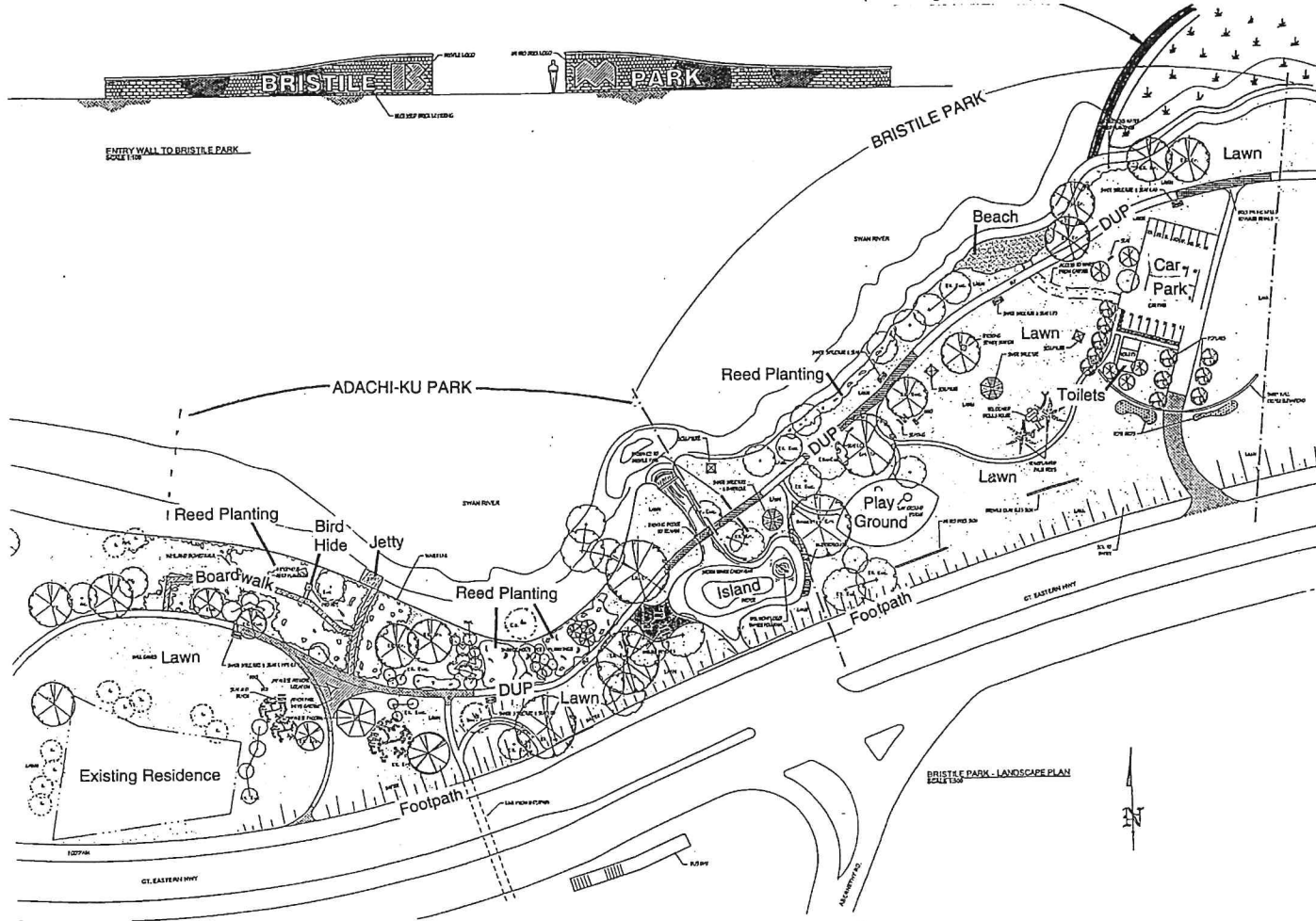
**PLATE 3** Sir James Mitchell Park, South Perth - The existing wetlands are surrounded by extensive grassed areas that support Black Swans but are limited in terms of habitat value. The adjacent river at this location is separated from the wetlands by a retaining wall that limits accessibility to the Swan River for Black Swans.



**PLATE 4** Ascot Waters – The river at this location is broader and more sheltered than most upstream sections and offers better habitat potential for Black Swans.



APPROXIMATE LOCATION OF  
PROPOSED RUBBLE MOUND WALL  
( Refer to Fig. 4A for details )



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**NOTE**

Draft Landscape Plan for Bristile Park and Adachi-Ku Park provided to M P Rogers & Associates by the City of Belmont ( Drawing No. 99L-234-2-06 ).

BLACK SWANS ON THE  
SWAN RIVER

**ASCOT WATERS - PROPOSED  
BRISTILE & ADACHI-KU PARKS**

FIGURE 4C

DRAWN: GLM/TE 24-8-00 CHECKED: KG 24-8-00

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