

Lake Claremont Management Plan 2010

(Updates 1998 Lake Claremont Policy)



Prepared by the North Metro Conservation Group for the Town of Claremont

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PART ONE: SUMMARY OF RECOMMENDATIONS

Table 1: Summary of Recommendations

2007 RECOMMENDATION		1998 RECOMMENDATION	
SURROUNDING LAND USE			
Groundwater Management			
1	The Town of Claremont should employ a suitable consultant to investigate and report on the nature and extent of groundwater flow and contamination from the refuse disposal site.	1	The Town of Claremont should employ a suitable consultant to investigate and report on the nature and extent of ground water flow and contamination from the refuse disposal site.
2	Council should consult with the Department of Environment and Conservation to develop a suitable ground water management strategy in the light of potential saltwater intrusion.	2	Council should consult with the Waters and Rivers Commission to develop a suitable ground water management strategy in the light of potential salt water intrusion.
Nutrient and Irrigation Management			
3	Ensure that fertiliser and irrigation use is minimised on lands surrounding Lake Claremont. Seek appropriate professional advice on the minimal quantities of fertiliser and irrigation necessary to maintain parks and ovals in an acceptable condition. Research turf species suited to low fertiliser and irrigation. Specifically:	3	The Town of Claremont should seek appropriate professional advice on the minimum quantities of fertiliser and irrigation necessary to maintain the golf course, parks and ovals in an acceptable condition.
(i)	That the Town of Claremont prepare a nutrient and irrigation management plan for Cresswell Oval and Stirling Road Park. These plans need to ensure that fertiliser and irrigation use is minimised.	5	That the Town of Claremont prepare a nutrient and irrigation plan for Cresswell Oval and Stirling Road park.
(ii)	If the Lake Claremont Golf Course is to remain as a golf course or contain parkland, then a nutrient and irrigation management plan should be prepared to ensure that fertiliser and irrigation use is minimised in this area.	4	The lessee of the golf course be required to prepare a nutrient and irrigation management plan for endorsement by Council. This plan needs to ensure that fertiliser and irrigation use is minimised. Once in place, the plan should be regularly audited by Council as part of its lease compliance procedures.
(iii)	That Scotch College prepare a nutrient and irrigation management plan for the school grounds, in particular the ovals. Once in place, the plan should be regularly audited by Council.		
4	There should be no additional direct discharge of surface water into the lake via any new drainage network.	7	There should be no additional direct discharge of surface water into the lake via any new drainage network.
5	The Town of Claremont should ensure that all future developments within the Lake Claremont catchment area retain all stormwater on site.	8	The Town of Claremont should ensure that all future developments within the Lake Claremont catchment area retain all stormwater on site.
6	The Town of Claremont should investigate the construction of vegetated wetlands or other appropriate nutrient and sediment stripping devices on the relevant drain(s) which empty into Lake Claremont, using the results of the water quality monitoring to identify priority sites.	9	The Town of Claremont should construct vegetated wetlands or other appropriate nutrient and sediment stripping devices on each drain which empties into Lake Claremont.
		6	That Scotch College be requested to permit Council to construct vegetated wetlands on each required drain crossing its land.
Conservation and Recreation Zoning			
7	Establish clear delineation of Lake Claremont into conservation and recreation zones to achieve the following outcomes:		
(i)	Both upland and wetland communities are represented in the conservation area.		
(ii)	Restricted public access within the conservation area with no access to open water.		
(iii)	Provision of appropriate infrastructure in the conservation area to address path erosion issues. (i.e. boardwalk construction, semi-permeable path materials, moving the lake path and fence west with agreement from Scotch College).		
(iv)	The conservation area is a "Dogs on Leash" only zone		
(v)	The recreation area is restricted to areas of existing turf around the perimeter of the reserve.		
(vi)	Any existing exotic species (i.e. Fig trees) are confined to the recreation area. If Fig trees are removed it should be through a staged process in conjunction with replacement with appropriate native species.		

(vii)	Provision of appropriate infrastructure within the recreation area (i.e. picnic areas, cycle paths, dog exercise areas). Provision of modern picnic facilities in suitable locations in John and Jean Mulder Park and Stirling Road Park.	11	That modern appropriate picnic facilities be provided in suitable locations in John Mulder Park and Stirling Road Park.
(viii)	Review the provision of additional car parking facilities and signage to facilitate access from public transport.		
8	That the north west area of the reserve below the former drive-in theatre site be reserved as a conservation and wildlife observation zone. The only public facilities to be provided in this area should be an unobtrusive path.	12	That the north west area of the reserve below the former drive in theatre site be reserved as a conservation and wildlife observation zone. The only public facilities to be provided in this area should be an unobtrusive path.

Lakeway Drive-in Site

9	Prior to the former Lakeway Drive-in site being developed, the Town of Claremont make a stated requirement on the Certificate of Title (s) ensure;	13	Prior to the former Lakeway Drive-in site being developed, the Town of Claremont by means of a caveat on the Certificate of Title (s) ensure;
(i)	That the existing topography of the land is generally retained, that is, the land falls to the north west and all storm water is disposed of in a suitably designed sump located in the north west corner of the site.	a	That the existing topography of the land is generally retained, that is, the land falls to the north west and all storm water is disposed off in a suitably designed sump located in the north west corner of the site.
(ii)	Retention of the existing vegetation where possible. In particular ensure no felling of trees for views.	b	Retention of the existing vegetation where possible.
		c	Restricting the height of all buildings on the site to a maximum of 6.6 metres as per Clause 40 (2) of the Town of Claremont Town Planning Scheme # 3.
(iii)	Impose a fencing requirement to restrict access through the regenerating bushland.	d	Impose a fencing requirement to restrict access through the regenerating bushland.
(iv)	Preferential use of local and Western Australian plant species in the landscaping of the Lakeway Drive-in site. The use of environmental or potential environmental weed species and deciduous trees is avoided.		
10	That council in conjunction with the developer undertake an environmental education program for residents including the following:	14	That Council undertake a program to educate residents living in the vicinity of the Lake Claremont reserve of the consequences of excessive fertiliser and water use and the dumping of garden waste in the reserve. That Council ensure that appropriate dense vegetation is provided on the southern and eastern embankments
(i)	The consequences of excessive water and fertiliser use		
(ii)	The impact of dumping garden waste in the reserve		
(iii)	Appropriate local and Western Australian plant species for use in gardens and landscaping		
(iv)	Information on environmental weeds and their impact on natural areas		
11	That Council ensure that appropriate dense vegetation is provided on the southern and eastern embankments of the Drive-in site to prevent erosion and provide a buffer to the development.		

Lake Claremont Golf Course

12	To be completed following recommendations from the Golf Course Stakeholder Reference Group.	15	Council should permit access on the golf course of persons, other than those playing golf, in accordance with a local law.
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WATER QUALITY AND QUANTITY

13	That the Town of Claremont should institute a water quality monitoring program to measure both the lake health and nutrient inputs. Samples of water should be taken regularly (e.g. monthly, bimonthly or quarterly) to provide an ongoing record of nutrient concentrations and to identify hotspots. Monitoring should include sites located within drains to identify nutrients and contaminants entering from surrounding land uses (i.e. stormwater drains, refuse site). Sampling should also occur within Lake Claremont itself to monitor its health over time.	16	The Town of Claremont should institute a monitoring program to measure the effectiveness of the policy in reducing nutrients in the lake. Samples of the water should be taken monthly to provide an ongoing record of the nutrient concentrations in the lake and water levels.
14	Council should implement a range of strategies to improve water quality in Lake Claremont. Council should continue to seek professional advice on means to improve water quality in the lake.	17	Council should seek a range of professional advice on means to improve water quality in the lake.
15	Retain the lake's natural water fluctuations (i.e. Lake Claremont to be managed as a seasonal wetland). The use of bore water to maintain water levels in the lake should not be considered (except under exceptional circumstances and not until the sources of significant water recharge of the lake has been investigated).	19	That the use of bore water to maintain water levels in the lake all year around not be considered except under exceptional circumstances and not until the sources of significant water recharge of the lake has been investigated.

ACID SULPHATE SOILS			
16	Conduct an Acid Sulphate Soils / Potential Acid Sulphate Soils assessment to ground-truth the current risk maps produced by the Department of Environment, as Lake Claremont falls in an area at "high risk of acid sulphate soils or potential acid sulphate soils". This should be completed before any earthworks or disturbance occurs in or around the lake.		
FAUNA			
17	That the management of the lake be compatible with the conservation of flora and fauna, in particular, to maintain or enhance its value as a water bird refuge.	20	That the management of the lake be compatible with the conservation of flora and fauna, in particular, to maintain or enhance its value as a water bird refuge.
18	That the lake continue to be managed as a shallow drying wetland since this increases productivity and variety of bird habitat.	21	That the lake continue to be managed as a shallow drying wetland since this increases productivity and variety of bird habitat.
19	That non-vegetated areas of open water (which may be subject to seasonal drying) are retained to provide habitat for fauna.		
20	That the vegetation (and drainage) rehabilitation programs should be designed to minimise nuisance insects and improve the lake habitat for water birds, terrestrial birds and any remaining terrestrial and aquatic fauna (i.e. tortoises). This involves staged weed removal coupled with adequate revegetation to provide protection for fauna from predators.	23	That the vegetation and drainage rehabilitation programs should be designed to minimise nuisance insects and improve the lake habitat for water birds, terrestrial birds and any remaining terrestrial fauna.
21	That users of the reserve be discouraged from allowing pets to run free in the vicinity of the lake. Signs should be erected with a warning that offenders will be issued an infringement notice. The reason for the restriction should also be shown on the signs and conveyed by a public education program.	24	That users of the reserve be discouraged from allowing pets to run free in the vicinity of the lake. Signs should be erected with a warning that offenders will be issued an infringement notice. The reason for the restriction should also be shown on the signs and conveyed by a public education programme.
22	That there be ongoing monitoring of mosquito and midge larvae at the relevant time of the year to ensure densities remain below the threshold where they become a nuisance to residents. Provide residents with information on mosquitoes and midges and ways to reduce their breeding.	26	That a program be introduced to monitor mosquito and midge larvae at the relevant time of the year. Pesticide should only be a last resort as a control mechanism and only low toxicity chemicals should be applied with strict controls on application.
23	Monitor feral animals (in particular foxes) and implement control programs as required.		
		22	The depth of the water between the islands and the bank could be increased to provide a refuge from predators.
		25	Any domestic/feral ducks should be removed from the lake. There should be appropriate signs advising of the problems of interbreeding of domestic and Pacific Black ducks and the feeding of waterfowl and tortoises.
VEGETATION			
24	That the Town of Claremont implement policies to protect and maintain the local indigenous plant gene pool and the natural seed source in the reserve where possible.	29	That the Town of Claremont implement policies to protect and maintain the local indigenous plant gene pool and the natural seed source in the reserve.
25	That the drowned paperback stumps in the lake be retained to provide roosting opportunities for water birds in the vicinity.	30	That the drowned paperbark stumps in the lake be retained to provide roosting opportunities for water birds in the vicinity.
26	That the Town of Claremont implement and regularly review a strategic rehabilitation program with specialist advice that will achieve the following objectives:	31	That the Town of Claremont continue a vegetation rehabilitation program with specialist advice that will achieve the following objectives:
(i)	Prioritised, staged removal of exotic terrestrial plant species around the lake, particularly weeds including Japanese Pepper, Figs, Giant Reed, Weeping and Chilean Willows and grasses including Couch, Buffalo and Kikuyu.	27	That a program be continued by the Town of Claremont to remove exotic terrestrial plant species around the lake and within the north western portion of the reserve generally, particularly weeds such as bamboo, watsonia and the castor oil trees.
(ii)	Prioritised, staged removal of exotic terrestrial plant species within the north west portion of the reserve, particularly weeds such as Perennial Veldt Grass, Geraldton Carnation Weed, Castor Oil, Blackberry Nightshade, Lupins, <i>Chasmanthe</i> .	27	That a program be continued by the Town of Claremont to remove exotic terrestrial plant species around the lake and within the north western portion of the reserve generally, particularly weeds such as bamboo, watsonia and the castor oil trees.
(iii)	Staged removal of the Bulrush within Lake Claremont in conjunction with the establishment of indigenous emergent aquatic vegetation to replace it.	28	That the Town of Claremont control bulrush in areas where it has spread recently.
(iv)	Revegetate the lake edges to create a 10 metre buffer of fringing wetland vegetation.	31i	Regrade the lake edges to create suitable conditions for the survival of a 10 metres buffer of fringing wetland vegetation.
(v)	Revegetation of the lake fringes and the surrounding areas with wetland and dryland species that are consistent with the natural flora of the area.	31ii	Revegetation of the lake fringes and where possible (e.g. the woodlands to the northwest) the surrounding areas with wetland and dryland species that are consistent with the natural flora of the area.
(vi)	Revegetation of the northwest woodland with appropriate		

	dryland species.		
(vii)	Shading out Bulrush, reducing the lake temperature over the summer and reducing the midge problem by planting species of <i>Melaleuca</i> on the edge or in the shallows along the eastern edge of the lake.	31iv	To shade out bulrush and reduce the lake temperature over the summer by planting paper bark trees on the edge or in the shallows near the edges of the lake.
27	Investigate the potential for a band of emergent aquatic vegetation along the margins of the old refuse disposal site face to intercept any contaminants that may be leaching from the site.	32	That the Town of Claremont investigate the potential for a band of emergent aquatic vegetation along the margins of the old refuse disposal site face to intercept any contaminants that may be leaching from the site.
28	Council should conduct the Perth Biodiversity Project Natural Area Initial Assessment to identify if the remnant Tuart woodland on and adjacent to the Drive-in site is a Locally Significant Natural Area in accord with the Local Government Biodiversity Planning Guidelines.	33	Council should identify the remnant tuart woodland on and adjacent to the Drive-in site as Locally Significant Bushland in accord with the Urban Bushland Strategy.
29	Council should introduce a Landscape Protection Zone into the Town Planning Scheme to encourage the conservation of urban bushland on private land within a redeveloped Drive-in site.	34	Council should introduce a Landscape Protection Zone into the Town Planning Scheme to encourage the conservation of urban bushland on private land within a redeveloped Drive-in site.
30	That Scotch College be requested to implement a revegetation program in its lands abutting the lake with advice from the Town of Claremont.	10	That Scotch College be requested to implement a revegetation program in its lands abutting the lake.
		31iii	Indigenous species of trees to be planted on the golf course to promote the fauna of the area.
FIRE			
31	That the Town of Claremont rationalise the existing firebreaks and ensure that the firebreaks provided are adequate.	35	That the Town of Claremont obtain professional advice on rationalising the existing fire breaks and ensuring that the fire breaks provided are adequate.
ENVIRONMENTAL EDUCATION			
32	That appropriate aesthetically designed signs be erected in the reserve including:	36	That appropriate aesthetically designed signs be erected at each entry to the reserve advising of the physical and biological properties of the reserve. Rehabilitation signs should be maintained where revegetation of the indigenous vegetation is being undertaken. Restriction on the use of off road vehicles and allowing dogs on the reserve with out a lead should feature prominently on the signs.
(i)	"Nature Conservation" Signs at each entry to the reserve advising of the physical and biological properties of the reserve.		
(ii)	Interpretive signage throughout the reserve to enhance visitor experience and appreciation of the historical, environmental, indigenous, cultural and social significance of the area.	39	That the Town of Claremont, in conjunction with the Claremont Museum, undertake research on the history of land use of the lake and its environs with a view to providing suitable interpretative material in the form of signs, brochures, etc. to enhance visitor experience and appreciation of the historical, cultural and social significance of the area.
(iii)	Rehabilitation signs maintained where revegetation of the indigenous vegetation is being undertaken.		
(iv)	Signs detailing the restriction on the use of off road vehicles and allowing dogs on the reserve without a lead.		
33	That community awareness of the environmental issues relating to Lake Claremont is increased by use of resources such as:	37	That brochures be prepared to inform the general public on the rationale behind the restrictions on various forms of land use in the lake's environs.
(i)	Information to be compiled / prepared to inform the general public on the importance of Lake Claremont (including flora and fauna, biodiversity), local issues that have an adverse affect on the lake.		
(ii)	Environmental awareness raising workshops (e.g. Living Smart, Great Gardens, Phosphorus Action Group).		
(iii)	Support the Water Corporation Waterwise Campaign.	18	That an education/awareness program be developed jointly be the Council and the Water Corporation, to help land holders within the catchment area of the lake reduce the water use to the minimum requirement and make them aware of the consequences of excessive ground water use.
(iv)	Support the Waterwise Schools Program.		
(v)	That local schools are involved in Lake Claremont on-ground activities.		
(vi)	Investigate opportunities to use the Lake Claremont Golf Course building for static awareness raising activities.		
34	That the Friends of Lake Claremont should be maintained with ongoing support from the Town of Claremont. Links are developed between the Friends of Lake Claremont and other Friends Groups.		

35	Raise general community awareness of the activities undertaken by the Town of Claremont and the Friends of Lake Claremont to improve the lake and its surrounds.		
36	That as part of the environmental education programme, the Town of Claremont consider a change of name of the area to include an appropriate aboriginal name.	38	That as part of the environmental education programme, the Town of Claremont consider a change of name of the area to include an appropriate aboriginal name.

IMPLEMENTATION

37	That the Town of Claremont be the responsible authority for the implementation of this policy. A Lake Claremont Committee, appointed by the Council, monitor and oversee the implementation of the policy. The Committee consists of two Claremont Town Councillors, one Nedlands City Councillor, the Mayor, one Scotch College Representative and six community members who have an interest in the well being of the lake. The Committee meet bimonthly and report to Council. The Committee should present an annual report to the Council detailing progress of the policy.	40	That the Town of Claremont be the responsible authority for the implementation of this policy. A Lake Claremont Committee, appointed by the Council, monitor and oversee the implementation of the policy. The Committee to consist of one Claremont Town Councillor, one Nedlands City Councillor, the Mayor, the Chief Executive Officer's representative and a group of six people who have an interest in the well being of the lake. The Committee to meet monthly and report to Council through the Technical Services Committee. The Committee should present an annual report to the Council detailing progress of the policy.
38	Duties of the Lake Claremont Committee shall be to provide advice to Council on matters relating to:	41	Duties of the Lake Claremont Committee shall be implementation of the Policy and recommending matters that should be attended to, including amendments to the Policy, and to be available to Council as a coordinating body in the development of community programs approved by the Council.
(i)	The care and maintenance of Lake Claremont and its immediate surrounds		
(ii)	The rehabilitation of Lake Claremont and its environs		
(iii)	Plans for amenities proposed to Lake Claremont and its immediate environs		
(iv)	Proposals for the Lake from the Friends Group		

PART TWO: BACKGROUND INFORMATION

2.1 INTRODUCTION

Lake Claremont is situated approximately ten kilometres south west of Perth and is located within the Municipality of the Town of Claremont (see Figure 1). The lake comprises parts of Perthshire Aw lots 1, 2, 5, to 8, 58 and parts of Perthshire locations 223, 224, 227, to 229 231, 237, 288, and 6223. It is owned in fee simple by the Town of Claremont.

Lake Claremont is a Conservation Category Wetland and protected under the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992. This policy prevents the following activities on the grounds that they are significant causes of degradation or destruction to lakes:

- the filling of lakes with materials
- the carrying out of excavation or mining operations in lakes
- the discharge or disposal of effluent into lakes
- the construction or alteration of drainage systems in lakes

Lake Claremont has been previously recognised by the Government of Western Australia - System 6 Study, and is prominent in the Government of Western Australia - Bush Forever Report (2000). The site (Site Number 220) has significance as a location for JAMBA/CAMBA species, and is subject to protection under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Key recommendations from the Bush Forever Report include:

- Endorsement of the existing care, control and management intent of Lake Claremont and
- Amendment of the purpose of Lake Claremont to include conservation and appropriate mechanisms applied in consultation with the management body (Town of Claremont).

The *Wetlands Conservation Policy* (Government of Western Australia - 1997) also has relevance to Lake Claremont. This policy states that:

“the Government will...

1.2 Encourage cooperation and coordination between Commonwealth, State and Local Government and private sector organisations for the conservation of wetlands...

1.4 Provide for a statutory environmental protection framework under the Environmental Protection Act 1986 for the conservation of important wetlands on private and public lands throughout Western Australia, and assist the EPA in the development and review of statutory environmental protection policies...

1.15 Undertake and facilitate research needed to ensure that wetland conservation measures, including sympathetic catchment management practices, are soundly based and cost effective...

1.16 Establish a wetland management advisory capacity in CALM to provide practical wetland management advice, particularly to landowners and landowner groups...

1.20 Encourage local authorities and government agencies to prepare and implement, with public involvement, management plans for wetlands under their control...

2.8 Develop and provide training programs for wetland policy officers, planners, managers, advisers and education officers employed by State and Local Government and the private sector..."

The Local Government Biodiversity Planning Guidelines were released by the Western Australian Local Government Association (WALGA) – Perth Biodiversity Project in 2004. These guidelines assist local government in the Perth Region to take a more strategic approach to the retention, protection and management of bushland, wetlands and other natural areas, including establishing criteria to assist in the identification of locally significant bushland.

The ecological criteria for the identification of locally significant natural areas, as defined in the Biodiversity Planning Guidelines are as follows:

Criteria	Priority
1. Representation a) Regional	
i) recognised International, National, State or Regional Conservation value (outside Bush Forever sites and CALM Managed Estate) not already protected, for example, System 6 Areas in the Jarrah Forest outside CALM Managed Estate	ESSENTIAL
ii) of an ecological community with only 1500 ha or 30% or less (whichever is the greater) remaining in the IBRA subregion	DESIRABLE
iii) large (greater than 20ha) viable natural areas in good or better condition of an ecological community with more than 30% remaining on the IBRA Subregion	DESIRABLE
iv) of an ecological community with only 1500 ha or 15% or less (whichever is the greater) protected for conservation in the Jarrah Forest IBRA Subregion.	DESIRABLE
v) of an ecological community with only 400 ha or 10% or less (whichever is the greater) protected for conservation in Bush Forever Study Area.	ESSENTIAL
1. Representation b) Local	
i) of an ecological community with 10% or less remaining within the Local Government area.	ESSENTIAL
ii) of an ecological community with 30% or less remaining within the Local Government Area.	DESIRABLE
iii) large (greater than 10 ha), viable natural areas in good or better condition of an ecological community with more than 30% remaining within the Local Government area	DESIRABLE
2. Diversity	
i) natural area in good or better condition that contains upland and wetland structural plant communities	ESSENTIAL
3. Rarity	
i) of an ecological community with only 1500 ha or 10% or less (whichever is the greater) remaining in the IBRA subregion.	ESSENTIAL
ii) of an ecological community with only 400 ha or 10% or less (whichever is the greater) remaining in the Bush Forever Study Area.	ESSENTIAL
iii) contains a threatened ecological community (TEC)	ESSENTIAL
iv) contains declared rare flora (DRF), Specially Protected Fauna (SPF) or significant habitat for these fauna.	ESSENTIAL
v) contains Priority or other significant flora or fauna or significant habitat for these fauna	ESSENTIAL
4. Maintaining ecological processes or natural systems – connectivity	
i) natural areas acting as stepping stones in a Regionally Significant Ecological Linkage	ESSENTIAL
ii) natural areas acting as stepping stones in a locally significant ecological linkage	ESSENTIAL
5. Protecting wetland, streamline and estuarine fringing vegetation and coastal vegetation	
i) Conservation or Resource Enhancement category wetland plus buffer	ESSENTIAL
ii) EPP Lake plus buffer	ESSENTIAL
iii) riparian vegetation plus buffer	ESSENTIAL
iv) floodplain area plus buffer	ESSENTIAL
v) estuarine fringing vegetation plus buffer	ESSENTIAL
vi) coastal vegetation on foredunes and secondary dunes	ESSENTIAL

It is recommended that the Perth Biodiversity Project (PBP) Natural Area Initial Desktop and Field Assessment process be applied to Lake Claremont, to determine if Lake Claremont is locally significant.

Other supporting documents of relevance to the management of Lake Claremont are detailed in Part A, Section 3 of the Guidelines and include Federal, State and local policies (Appendix I).

2.2 HISTORY

The area in which Lake Claremont is located was originally a large wetland area which was abundant in plant and animal life. It formed a part of the hunting and food gathering territory of the Mooroo people. Aboriginal families lingered there until the 1940s, when rising waters and the needs of a "beautification" program led to their eviction.

The first recorded reference to Lake Claremont was in a letter written by Mr John Butler to the Surveyor General Mr J.S. Roe on the 15 November 1831.

"I wish to have a grant of ten acres on the east side of the lagoon about one and a half miles north of my home at Freshwater Bay, in the name of William Burton Butler, my eldest son".

Official records of Butler's occupancy are lacking and it is possible that he used the land for a considerable period without ever receiving an official grant. His farming activities gave rise to the name "Butlers Swamp" (Morris and Knott 1977, 155). There is however no record of a Certificate of Title to this land being issued in his name.

In 1850 military pensioners arriving from England were granted areas of land around Butler's Swamp. A total of eighteen grants each of 3.8 hectares were made. Only a few of the original pensioners remained on their land and development was slow until the completion of the Perth Guildford Railway line in 1881. A station was constructed on the west side of Stirling Road and Butlers Swamp became a popular picnic spot.

Around the turn of the century, orchards and market gardens began to flourish around the swamp and its popularity as a picnic spot began to wane. Rising waters destroyed much of the market gardens, rendered Stirling Road impassable and profoundly changed the character of the vegetation. The Paperbark trees, unable to withstand the permanent submergence, died off (Evans and Sherlock 1950, 150).

It was not until 1949 when further moves were made to turn the swamp into a beauty spot. Naturalists wrote to the paper describing the variety of bird life, and urging that the swamp be cleaned and beautified. After considerable discussion and many suggestions, a plan was agreed to in 1954. Included in the plan was provision for an Olympic pool, football, soft ball, a pavilion, boats for hire, tearooms, amphitheatre and large areas reserved for picnic grounds and natural bush. It soon became apparent that the plan was to be very costly to implement and the Council modified the original proposal.

A drive in cinema was built in lieu of the amphitheatre, the rent from this commercial development meeting loan repayments. Council also exchanged 3.5 acres of land belonging to Scotch College for 4.5 acres which was partly under water. This land was subsequently reclaimed by the College reducing the area of the Lake. Between 1964 and 1970 the area was used as a rubbish tip, the rubbish being used to fill in the marshy areas around the waters edge to the northeast. An island bird sanctuary was built and planted with exotic trees and shrubs. The council then proceeded to construct the golf course, despite objections that it would result in restricted access to the lake foreshore and surrounding areas and objections that it would result in a serious impact on the habitat.

In 1955 the Council, in the face of strong opposition from the Royal W.A. Historical Society, initiated steps that resulted in the swamp being renamed Lake Claremont.

In 1983, the Department of Conservation and Environment of Western Australia prepared the Darling System, System 6 Report. This report recommended that, in conjunction with the Department, Council prepare a management plan for the Lake Claremont area.

Three working parties and a coordinating Council of Elders Committee was appointed in 1985 to prepare reports on aspects of the lake. In 1987, the Lake Claremont project was initiated by Council. This resulted in the Lake Claremont Research Report being prepared by Lantzke, Gabriel and Haynes. The research found that the water of the lake contained sufficiently large quantities of phosphorus for its waters to be classified as hyper-eutrophic.

In February 1991, Council resolved to appoint a committee to prepare a management plan for the lake. Council placed a notice in a local newspaper inviting interested persons to serve on the committee. The first meeting was held on 28 May 1991. Members of the original Committee were;

- Cr B. Haynes (Chairman)
- Mrs M. Brinsden
- Ms M. Brockway
- Mrs A. Chaney
- Ms V. Houghton
- Mr J. Wheeler
- Mr A. Oldfield
- Mr P. Gabriel
- Mr K. McAlpine (Environmental Protection Authority)
- Ms L. Moore (Water Authority of Western Australia)
- Mr R. Brooks (Secretary)

On the advice of the Lake Claremont Management Committee, the following major works have been conducted at the Reserve by the Town of Claremont:

TIMEFRAME	MAJOR WORKS	PLANS
1991-1998	<p>Verge storm water sumps in Gloucester Street;</p> <p>Regrade sections of the west bank of the lake and near Stirling Road park;</p> <p>Weeding and revegetation of Drive-In embankment and remnant woodland;</p> <p>Signage at Stirling Road park;</p> <p>Bird observation platform.</p>	<p>Preparation and adoption of a management plan for Lake Claremont - (April 1992);</p> <p>A study of the drainage basin (Bunny and Ruiz-Avila 1995);</p> <p>Mapping the boundary of the lake and golf course;</p> <p>Planning for nutrient stripping devices for storm water run off from Shenton Road and Alfred Road.</p> <p>The Town Council also constructed a barrier fence around the golf course;</p> <p>Included the following as one of its Key Strategies in the 1995 Strategic Plan, "Review and continue the implementation of the Lake Claremont Management Plan".</p>

<p>1999 - 2007</p>	<p>Verge stormwater sumps in First Avenue, Second Avenue, Alfred Road and Garden Street.</p> <p>Friends of Lake Claremont Stormwater Education Program.</p> <p>Installation of bird and bat boxes on the western island and Bushland Reserve.</p> <p>Removal of dense Typha stands surrounding gazebo and western island and lake edge.</p> <p>Typha control on approximately 3.5ha on eastern lake edge.</p> <p>Weed control and revegetation on western island.</p> <p>Revegetation of the lake banks on the western side near the island.</p> <p>Planting <i>Melaleucas</i> in the lake bed</p> <p>Planting local provenance seedlings with seed collected from the Bushland Reserve.</p> <p>Wetland planting along the western edges near the Scotch College tennis courts north to opposite Drive – in Site embankment.</p> <p>Planting native seedlings on the Golf Course</p>	<p>Included as Key strategy to 'Renew' Claremont in the Plan for the Future 2006 - 2010</p> <p>Friends of Lake Claremont Water Quality Report 2003 – 2004</p> <p>Agreement with the Circle of Elders: Lake Claremont and it's Environs (2002)</p> <p>Lake Claremont Revegetation Report (North East Catchment Committee 2003)</p> <p>Revegetation Plan Lake Claremont Reserve (Ecoscape 2007)</p>
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2.3 LAND USE AND ZONING

Details of ownership of the land in the immediate vicinity of the lake at the 30 June 1991 are shown in Figure 2. Although the Lake Claremont Golf Course and Cresswell Oval are owned by the Council, the managers are responsible for maintenance. Options for the future use of Lake Claremont Golf Course were reviewed by Council in 2006, with a report emphasizing the importance of retaining the area as green space for recreation and conservation value and continuing access to the lake for pedestrians (Town Talk, July/Aug 2006). A stakeholder reference group has been formed to review the options presented in the report and make recommendations to council on the preferred final option for the Lake Claremont Golf Course.

All land within the Lake Claremont reserve is zoned "Parks and Recreation" in the Metropolitan Region Scheme and is zoned "Recreation" under the provisions of the Council's District Planning Scheme. Land owned by Scotch College is zoned "Urban" in the Metropolitan Region Scheme. The former Lakeway Drive-In site has been zoned Residential and has been accorded a density of R20. Zoning of the land within the study precinct is shown in Figure 3.

Generally the land to the west is zoned residential of low to medium density.

To the east along Davies Road, the land is zoned "Residential 30". There is also an area of land bounded by Motteram Avenue and Graylands Road that is zoned "Light Industrial". To the east of Graylands Road is the Royal Agricultural Society Showgrounds.

North of Alfred Road is a reserve that is utilised by the students of the Graylands Primary School for sport and recreation.

Both the Commonwealth and State Governments are advocating higher residential densities in the inner suburbs such as Claremont and, as a result, there has been an increase in the number of houses being constructed in the rear of established lots and in the adjoining area of Mount Claremont in the City of Nedlands. Likely consequences of this are a greater amount of rain water run off due to increased area of paving, with greater nutrient loads, and a reduction in the number of trees resulting in a lower rate of transpiration.

2.3.1 Future Development

The Lakeway Drive-in site is the subject of a recent development proposal. In February 2002, the Town of Claremont conducted a referendum to seek ratepayers advice on the development of the site.

The majority of ratepayers chose to have partial development of the site for residential housing (70%) with retention of the bushland on the north side of the drive-in site (Lakeway Redevelopment Site, Town of Claremont Workshop Outcomes, 2004). Increased residential density will place pressure on the ecology of the lake and the embankment to the east of the drive-in site.

A revegetation plan for the bushland was completed by Ecoscape in February 2007 entitled "Revegetation Plan Lake Claremont Reserve".

Recommendations 9-11

2.4 THE HUMAN ENVIRONMENT

2.4.1 Public Use

The immediate precinct is predominantly an open space recreational area catering for both passive and active recreants. A land use survey undertaken during the period September 28 1987 to June 14 1989 (Lantzke, IR, Gabriel, PW and Haynes, BT 1989) found that 80% of the users were active recreants. Golf was found to be the most significant use of the region, the percentage composition of measured population that golfers made up was between 19 and 40%. Transient activities were made of many performing active (jogging, riding) and passive (walking, walking the dog) recreation and mainly in the mornings and evenings (Lantzke *et al.* 1989).

Current anecdotal evidence on the use of the Lake Claremont Reserve includes the west side used predominantly as a thoroughfare by walkers, joggers and bike riders. The only free-leash area for dogs is located on the north west side from the volunteer notice board (near the western island) to the Strickland Street cul de sac .

The south side includes play equipment and picnic tables, and is used for a range of recreation activities.

2.4.2 Facilities

The golf course occupies approximately 57% of the reserve, (Lantzke *et al* 1989) and is therefore the largest active recreational facility. A cycleway extends from the Stirling Road entry in a northerly direction providing access to Cresswell Park and Alfred Road.

Passive recreational facilities include some picnic facilities near the Stirling Road entry and barbecue facilities and a skateboard track in John and Jean Mulder Park. Due to minimal use the skateboard track will be removed as part of a renewal program for the park. No barbeques are provided in the Lake Claremont Reserve.

The Lake Claremont Golf Course, Stirling Road car park, Cresswell Park and the Claremont Swimming pool all provide car parking for users of the Lake Claremont Reserve, as well as verge parking in Shenton Place and The Cedus.

Available car parking decreased during 1991 as the Council prohibited car parking on the western side of Elliot Road, and the Claremont Tennis Club constructed courts on land previously used for parking. Lantzke *et al.* (1989) noted that the Stirling Road car park was used generally by passive users, with the golf course car park and the Cresswell Park car park being used principally by golfers and hockey players respectively. Signage to facilitate access from public transport should be considered.

Recommendations 7- 8

2.5 PHYSICAL ENVIRONMENT

2.5.1 Climate

Perth experiences a Mediterranean climate characterised by long hot dry summers and cool wet winters. Records of the annual rainfall for the Perth Metropolitan region are available since 1876. On average, Perth receives 863mm of rain per annum, predominantly falling between the 1 April and 31 October each year (BOM).

It has been noted that since 1970, there has been a decrease in the ten month rainfall moving average. With climate change, it is anticipated that weather patterns will continue to fluctuate.

2.6 GEOLOGY AND GEOMORPHOLOGY

Lake Claremont lies in a depression in the Spearwood System of coastal sand dunes. It is a true swamp geographically, that is it is the above ground part of the massive underground water system common to most parts of the Perth coastal plain (Morris and Knott 1979). This subsoil water flows continuously towards the river and ocean in a north east to south west direction.

The swamp lies in a valley between coastal dunes where the ground rises rapidly from 1.5 metres to 12 metres. Immediately prior to 1950, the swamp at high water mark enclosed an area of approximately 20 hectares. During the 1950s and 1960s areas were reclaimed and this reduced the area of the open water to approximately 15.7 hectares at high water mark (Emory 1975).

At the north east and southern end of the swamp are two valleys and it has been hypothesised that these valleys may have been scoured out by river action (Evans and Sherlock 1950, 152). Apart from these two openings, the area consists of coastal sand dunes of aeolian origin, partly consolidated by low shrub vegetation and intermittent wattle (Evans and Sherlock 1950).

The soil of the coastal plain near Claremont is a fine graded silica and calcium carbonate sand. Water action on the carbonate has in places cemented the sand into sandstone mass calcific sheets and pinnacles. In the actual vicinity of the swamp there is a thin deposit of marl, consisting of detrital material settling out of solution from swamp waters (Evans and Sherlock 1950).

Spearwood sands generally have a relatively high iron content in comparison to other sandy soils of the Swan Coastal Plain. As a result they have the capacity to initially adsorb phosphates leached from fertilisers and septic disposal systems. However, in the long term the phosphate adsorption capacity saturates and nutrients are readily leachable to the groundwater, drains or the lake.

2.7 THE HYDROLOGY

2.7.1 General

Lake Claremont is located within a reserve which covers an area of 70ha, with approximately 16ha of open water. The catchment area of Lake Claremont is dominated by residential areas and large recreational facilities, including several sports fields, a public golf course and a public swimming pool. The water quality of Lake Claremont is strongly affected by the activities occurring throughout its catchment area.

Lake Claremont is a surface expression of the superficial aquifer, with groundwater entering the Lake on the north-eastern side, flowing through the Lake and exiting on the south-western side. The quality and quantity of the groundwater will therefore have a significant effect on the quality and quantity of the surface water within the Lake. Six local council drains discharge stormwater into the Lake from the surrounding catchment area (Figure 4). The surface water of Lake Claremont is therefore a combination of both groundwater and stormwater from the surrounding catchment. An overflow pump-operated drainage pipe exists on the southern side of the Lake that removes excess water in winter to prevent flooding of the Scotch College Oval.

2.7.2 Water Levels

Water levels have been monitored by the Western Australian Water Authority since 1912. Water levels reached a maximum between 1956 and 1968, however have been falling since this time. There is little correlation between the recorded rainfall and the water levels of the Lake, although it is noted that Perth has recorded a relatively low rainfall since 1973 and that the water level of the Lake has been falling since 1975.

Groundwater is pumped from the unconfined aquifer for the maintenance of the adjacent playing fields and the Claremont Golf Course. It is currently unknown what effect this pumping is having on the water levels of Lake Claremont and it is therefore recommended that this be investigated.

The Perth Urban Water Balance Study (1987, Vol. 1, 27) documented saltwater intrusion in the unconfined aquifer, about 500m to the west of Lake Claremont (Environmental Protection Authority, 1990). Lantzke *et al* (1989) recorded long lasting salinity gradients in the north east section of the Lake which was attributed to inflowing groundwater. Saltwater intrusion into the Scotch College bores has also been previously reported

Recommendations 1-2

2.7.3 Water Quality

Water quality of the south end of Lake Claremont was monitored by the Water Authority of Western Australia over a sixteen year period from 1970 to 1986. The program involved the regular monitoring (twice yearly) of the following parameters:

- Total nitrogen;
- Total coliforms and faecal coliforms;
- Biological oxygen demand (BOD);
- Total suspended solids (TSS);
- Total dissolved solids (TDS);
- Heavy metals; and
- pH

The program also monitored the concentrations of reactive phosphorus, pH and six common ions (chloride, sulphate, potassium, calcium, magnesium, hydrogen-carbonate) at four sites within the Lake during 1987-1988. In 1993 – 1996 the program also included monitoring for total phosphorus and reactive phosphorus at the south end of the Lake. During 1993, the program expanded to include several forms of nitrogen, chlorophyll and algal density.

In 2003, the Town of Claremont in conjunction with the Friends of Lake Claremont developed a water quality monitoring program for the Lake. Monitoring of four sites within the lake was undertaken in order to determine the general health of the lake and the effects of nutrient enrichment. Samples were collected from four sites located in the centre of the lake on a fortnightly basis throughout 2003 and 2004. These samples were tested for the following parameters:

- Conductivity;
- Total suspended solids;
- Phaeophytin;
- Turbidity; and
- Chlorophyll *a*

In 2004, an additional four sites were added to the program. These sites were located around the perimeter of the Lake, and were sampled throughout 2004 on a fortnightly basis for the following parameters:

- pH;
- Conductivity;
- Soluble reactive phosphorus;
- Total phosphorus.

The Town of Claremont and the Friends of Lake Claremont are currently undertaking a water quality monitoring program for 2006/2007, which includes analysis for general indicators of lake health, total organic carbon, polycyclic aromatic hydrocarbons as well as the following heavy metals:

- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Zinc

A summary of the results of the water quality monitoring programs undertaken in Lake Claremont between 1970 and 2004 is provided below.

(i) pH

pH is a measure of the acidity (or alkalinity) of a water body. pH is measured on a logarithmic scale, with a pH of 7.0 being neutral, a pH of less than 7.0 being acidic, and a pH of greater than 7.0 being alkaline or basic. A pH of between 7.0 – 8.5 is required to sustain aquatic life in wetlands (ANZECC 2000).

The pH of the surface water of Lake Claremont in the 1970/86 period was variable throughout the year, ranging from 7.6 to 10.2, with an average of 8.75, indicating that the surface water of the Lake was slightly alkaline.

The pH recorded in 2003 and 2004 highlighted similar results, with all sites recording slightly alkaline values. These slightly alkaline conditions are expected, as the Lake is located on calcareous sands, and there is generally a large amount of algae present in the Lake (which has the effect of raising the pH). One site located on the north-western perimeter of the Lake recorded a very low pH (3.5) in July 2004, however this returned to a neutral pH in the following month.

(ii) Biological Oxygen Demand

Biological oxygen demand (BOD) is a measure of the amount of oxygen consumed by biological processes in the breakdown of organic matter. In general, the more organic matter available, the higher the biological oxygen demand (given the right conditions for bacterial decomposition) and the less dissolved oxygen concurrently available to other aquatic organisms. The presence of algal blooms can lead to the deoxygenation of the surface waters of lakes, which has significant effects on aquatic organisms. This occurs as a result of the increased oxygen consumption by bacterial decomposition of the algae.

Throughout the 1970/86 period, the biological oxygen demand of the surface water of Lake Claremont ranged from <100mg/L to 7,400mg/L. The biological oxygen demand was consistently higher in summer/autumn months than in winter/spring. The levels were high in comparison to open marine waters and the waters of the Peel Harvey estuary (BOD = 5mg/L and 10 to 120mg/L, respectively), however urban wetlands generally have a high biological oxygen demand as they are closed systems, are highly productive and are often eutrophic.

Biological oxygen demand was not included in the 2003/04 study, and therefore the current biological oxygen demand is unknown.

(iii) Total Dissolved Solids

The concentration of total dissolved solids in water is often used as a measure of salinity. Total dissolved solid concentrations will vary according to annual rainfall and evaporation rates.

The concentration of total dissolved solids recorded in the surface water of Lake Claremont throughout the 1970/86 period varied markedly on a seasonal basis, ranging from 669mg/L in the winter of 1973, to 16,000mg/L in March 1988. The total dissolved solids concentrations were considered high for a freshwater wetland, when compared to the concentration of seawater (35,000mg/L). This study suggested that elevated concentrations of total dissolved solids in Lake Claremont occur over summer when the ions are concentrated by evaporation. Lower total dissolved solids concentrations occur in winter when the surface water of the Lake is diluted by rain and groundwater inflow.

Total dissolved solids were not included in the 2003/2004 study.

(iv) Total Suspended Solids

Total suspended solids in water samples is the total amount of material suspended in the water that can be removed from a water sample by filtration. Suspended solids can include a wide variety of material (such as silt, sand, algae, micro-organisms and decaying plant and animal matter).

In the 1970/86 period, the concentration of suspended solids in the surface water of Lake Claremont varied throughout the sampling period with peaks recorded in the summer/autumn periods of 1972, 1976, 1979 and 1982. It is likely that this was influenced by the concentrated nature of the lake waters in summer and the presence of planktonic blooms during this time. These results may also be due to stormwater inputs through the local council stormwater drains, entering the lake during unseasonal rains.

In the 2003/04 study period, total suspended solid concentrations were generally elevated following the first major rainfall event of the year. Total suspended solid concentrations from samples located in the centre of the Lake during the winter of 2004 ranged from 100mg/L to over 400mg/L. These concentrations are between 16 and 66 times greater than the Department of Water interim guideline of 6mg/L. Other peaks were also observed throughout the year, most likely as a result of stormwater inflow following rainfall events.

(v) Nutrients

Excessive amounts of nutrients can result in eutrophication, with plant and algae growth, increases in nuisance insect numbers (particularly midges and mosquitoes) and unbalanced aquatic ecosystems. Nutrients include nitrogen (in the form of ammonia, nitrate and nitrite, and organic nitrogen), and phosphorus (in the form of reactive phosphorus or particulate phosphorus). Total nitrogen concentrations should not exceed 1.5mg/L and total phosphorus concentrations should not exceed 0.06mg/L, for the protection of wetland aquatic ecosystems (ANZECC 2000).

In the 1970/86 period the concentration of total nitrogen in the surface water of Lake Claremont was elevated, with the maximum concentration of 16.0mg/L in March 1983 being extremely elevated and more than ten times greater than the guideline. Total nitrogen was not included in the 2003/04 study, therefore the current nitrogen concentrations in the surface water of Lake Claremont is unknown.

In the 1970/86 study, the concentration of total phosphorus was also elevated, with the maximum concentration of 4.2mg/L in March 1984 being extremely elevated and exceeding the guideline by more than 70 times. In the 2003/04 study, total phosphorus concentrations of the Lake were variable throughout the year, with the concentrations at the majority of sites being elevated and exceeding the guideline on the majority of sampling occasions. Total phosphorus concentrations were generally more elevated during winter, following the first major rainfall event of the year.

Using the classification system provided by Davis and Rolls (1989), which is provided in Table 1, Lake Claremont can be classified as hyper-eutrophic at the times of maximum nutrient concentrations in summer..

Table 1: Classification of lake trophic status based on nutrient concentration (Davis and Rolls (1989) after Wetzel (1975)).

Trophic status	Total P (mg/L)	Total N (mg/L)	Inorganic N (mg/L)
Ultra-oligotrophic	0 - 0.005	0 - 0.25	0 - 0.2
Oligo-mesotrophic	0.005 - 0.01	0.25 - 0.6	0.2 - 0.4
Meso-eutrophic	0.01 - 0.03	0.3 - 1.1	0.3 - 0.65
Eutrophic	0.03 - 0.1	0.5 - 15.0	1.5 - 1.5
Hyper-eutrophic	>0.1	>15.0	>1.5

The soluble reactive phosphorus concentrations recorded in the 2003/04 study were also elevated, with several sites exceeding the ANZECC guideline of 0.03mg/L. Soluble reactive phosphorus concentrations were generally elevated following the first major rainfall event of the year, where concentrations were up to 15 times greater than the guideline.

In Lake Claremont the concentration of reactive phosphorus is reduced in alkaline conditions through precipitation of hydroxyapatite, (with potential to redissolve in neutral conditions), and in all conditions as the water containing it makes contact with bottom sediments, where iron in the sediment absorbs reactive phosphorus, in a reversible equilibrium process. The speed of this process depends upon the extent of water movement, usually due to wind and diurnal temperature cycles. The extent of reactive phosphorus removal depends upon how much unbound iron is available near the sediment surfaces, and its chemical condition. While there is oxygen in the water the phosphorus holding power of the iron is high. Should the water become anoxic the iron absorption becomes weak, and most of the bioavailable phosphorus held in the sediments will be released.

(vi) Phaeophytin and Chlorophyll a

Phaeophytin and Chlorophyll *a* are indicators of algal biomass. Phaeophytin is a non-photosynthetic accessory pigment present in algae, while Chlorophyll *a* is a photosynthetic pigment found in all green plants (including algae) and is often used as an estimate of algal biomass.

Chlorophyll *a* and Phaeophytin were tested for in Lake Claremont in the 2003/04 study. The results indicated a peak in both Chlorophyll *a* and Phaeophytin following the first winter rainfall event of the year. Concentrations were elevated following the major rainfall event and decreased to levels which were below national guidelines after this time.

(vii) Micro-organisms

The presence of certain micro-organisms in surface waters can pose significant health hazards. Indicator organisms are used to test the suitability of water for drinking and recreation. Coliforms which occur in the intestinal tract of humans and other warm blooded animals are the group that is most widely used as indicators of faecal contamination of water bodies.

The concentration of faecal coliforms in the surface water of Lake Claremont, ranged from 0 counts/100mL in the summer of 1973, to a maximum of 27,000 counts/100mL in the summer of 1981.

Total coliforms were relatively high in the early 1970's, decreasing after 1972 until they increased again in 1982. The concentration of coliforms was generally highest in the summer months when water levels were low and the lake was most concentrated. These high counts may be related to presence of large numbers of waterbirds utilising the Lake during this time. Although waterbirds are present year-round, coliform counts are often higher in summer due to the warm conditions and low lake levels. Faecal coliforms may also enter the lake through the inflow of groundwater contaminated with coliforms from septic tanks.

In the 1970/86 study the concentration of faecal coliforms at Lake Claremont exceeded the guidelines for primary contact recreation (i.e. swimming) and secondary contact recreation (i.e. wading and boating). Based on these results it was suggested that Lake Claremont should not be used for primary or secondary contact recreation during the summer months, especially in years when water levels are particularly low. Faecal coliforms were not included in the 2003/04 study and current levels are unknown, therefore it is still recommended that the lake is not utilized for the listed recreational purposes until faecal coliforms are within safe levels.

Botulism can also be a problem during the summer months in water bodies on the Swan Coastal Plain. It is caused by the bacterium (*Clostridium botulinum*) which occurs naturally in low concentrations in water bodies. However, under certain conditions (i.e. warm water temperatures and low surface water levels in the lake) concentrations can become excessive, leading to waterbirds becoming infected with the bacteria, often resulting in large numbers of bird deaths.

(viii) Heavy Metals

Heavy metals are derived from a variety of sources, such as motor vehicles, tyres, rubber, industrial waste, fertilisers and pesticides, refuse leachate and corrosion of pipes and roofs. Heavy metals are toxic to aquatic organisms at varying levels of concentration and may accumulate in plants, animals and the human body.

Six heavy metals (cadmium, chromium, copper, lead, mercury and zinc) were tested for in the surface water of Lake Claremont between 1976 and 1986. The range of the concentrations of each of these metals in the surface waters of Lake Claremont are displayed in Table 2 below.

Table 2: Range of concentrations for heavy metals in the surface water of Lake Claremont

Heavy metal	Range recorded in Lake Claremont (mg/L)	ANZECC trigger value Wetlands 95% protection (mg/L)
Cadmium	<0.01 – 0.01	0.0002
Chromium	<0.02 – 0.02	0.001
Copper	<0.01 – 0.03	0.0014
Lead	<0.04 – 0.12	0.0034
Mercury	<0.002 – 0.002	0.0006
Zinc	0.01 – 0.05	0.008

Although some heavy metal levels are below the laboratory limit of reporting, these results indicate that on occasion heavy metal concentrations in Lake Claremont exceeded the ANZECC trigger values between the period of 1970 and 1986.

At Lake Claremont the major sources of heavy metals to the surface water appear to be road and urban runoff entering the lake via the drains and possibly leachate from the landfill site. Stormwater run-off in 1993 contained detectable levels of Zinc and Lead in coarser particulates and Cadmium and Chromium in finer particulates. The concentrations of heavy metals in the water column did not appear to be high enough to be of concern and their disappearance after six months suggests they precipitated into the sediments. The concentration of heavy metals contained within the sediments has not been measured. It would be advisable to test the sediment for heavy metal contamination to provide an idea of the potential for bioaccumulation, to determine the current capacity of the sediments adsorb additional metals from the water column, and also to determine the concentration of heavy metals which could potentially be released from the sediments under favourable conditions (i.e. low dissolved oxygen concentrations or low pH).

Heavy metals were not included in the 2003/04 study. Currently a new water quality monitoring program is being developed by the Town of Claremont and the Friends of Lake Claremont, which will include heavy metals as a parameter.

(ix) Other Pollutants

Additional pollution problems may arise from pesticides such as organochlorins, organophosphates and other synthetic compounds, as well as hydrocarbons (which include oil, grease and petroleum products).

Sources of pesticides include house pads treated for white ants, garden herbicides and pesticides, and the direct application of insecticides and larvicide's to control midge and mosquito populations to the surface water of Lake Claremont. Organochlorins are relatively insoluble in water and persist in the environment for long periods, accumulating in aquatic food chains. Organophosphates are water soluble and less persistent than organochlorins. Organophosphates are associated with the treatment of wetlands for midge control (for example 'Abate' and 'Dursban'). These pesticides can have undesirable effects on the aquatic ecology, including the destruction of the natural predators of the midge which may cause problems in the long term.

Hydrocarbons include several hundred chemical compounds that originate from crude oil, polycyclic aromatic hydrocarbons, benzene, toluene, ethylbenzene and xylene. Hydrocarbons generally enter waterbodies via stormwater from urban roads and deliberate or accidental spillage of chemicals into stormwater drains from residential, commercial and industrial areas.

The sampling of Lake Claremont has not included these pollutants and therefore it is currently unknown if these are present in the surface waters of the Lake, and if so, to what extent. It is recommended that these pollutants be included in future monitoring programs.

Recommendations 3-6 and 13-15

2.7.4 Drainage

There are six local council drains that discharge directly into Lake Claremont from a mainly residential catchment area. There is also a pump operated recharge pipe originating from the Scotch College grounds, which drains excess water from the oval in winter and discharges it into the southern end of the lake. Elevations of the lake water level occur after heavy rains due to the increased runoff directed into the lake by these drains. The duration of this raised level is not known.

Recommendations 4, 6 and 15

2.7.5 Acid Sulphate Soils

Acid Sulphate Soils are naturally occurring soils which contain iron sulphide minerals, particularly pyrite. These soils are benign if not disturbed and are referred to as Potential Acid Sulphate Soils (PASS); however, activities where the solids are exposed to oxygen cause the sulfide minerals to oxidise to form sulphuric acid and actual Acid Sulphate Soils (ASS). Acid water leaching from these soils often has high concentrations of arsenic and heavy metals and can cause the soil to become extremely acidic, which can cause serious environmental damage that may last for centuries.

Lake Claremont is located in a “high risk of acid or potentially acid sulphate soils, <3m below the ground surface area” (Department of Environment 2004). Please refer to Appendix 2 for the Department of Environment Acid Sulphate Soil Risk Map. Monitoring or testing for acid sulphate soils to ground-truth this classification has not been completed at Lake Claremont to date and it is recommended that this be included in future monitoring programs to determine if ASS or PASS exist at Lake Claremont or have the potential to become an issue in the future.

Recommendation 16

2.8 THE BIOTIC ENVIRONMENT

2.8.1 Vegetation

The pre-European vegetation of Lake Claremont is Karakatta Complex - Central and South, however the majority has been cleared through recreation and residential development.

In 1977, the indigenous vegetation of the area was recorded by Morris and Knott leading to the assumption that the original vegetation at Lake Claremont would have consisted of a central swamp zone of Paperbarks (*Melaleuca raphiophylla*), with Tuarts (*Eucalyptus gomphocephala*) and Grass Trees (*Xanthorrhoea preissii*) surrounding small water holes. The Bush Forever Report 2000 classified the vegetation surrounding the wetland as a *Melaleuca raphiophylla* Low Closed Forest. Rising waters resulted in many of the Paperbarks dying off, as these trees do not survive in permanently flooded locations. Some of the trunks of the dead trees remain, providing a resting place for birds.

Some of the Tuarts have survived in the golf course and to the northeastern side of the Lake. On the sloping ground to the northwest of the lake there is a reasonably large stand of Tuarts that extend to an area south of the Lakeway Drive-in site.

Early tree planting programs resulted in a number of exotic trees, including Figs and introduced Eucalypts and a number of introduced plants, becoming established around the lake, particularly in the golf course.

The following species are representative of the dominant trees that exist in and around the lake and its environs:

- | | |
|-----------------------------------|--------------------|
| • <i>Agonis flexuosa</i> | Swamp Peppermint |
| • <i>Eucalyptus eximia</i> | Yellow Bloodwood |
| • <i>Eucalyptus globulus</i> | Tasmanian Blue Gum |
| • <i>Eucalyptus gomphocephala</i> | Tuart |
| • <i>Eucalyptus rudis</i> | Flooded Gum |
| • <i>Ficus macrophylla</i> | Moreton Bay Fig |
| • <i>Melaleuca raphiophylla</i> | Swamp Paperbark |
| • <i>Salix babylonica</i> | Willow |
| • <i>Salix chilensis</i> | Chilean Willow |
| • <i>Schinus terebinthifolius</i> | Japanese Pepper |
| • <i>Washington filifera</i> | Cotton Palm |

Lantzke et al. (1989) noted that aquatic plants consisted of three species:

- Bulrush (*Typha orientalis*);
- Lake Club Rush (*Schoenoplectus validus*); and
- One clump of Jointed Twig Rush (*Baumea articulata*).

There are three species of submerged "rooted" plants:

- *Potamogeton pectinatus*; and
- Two species of Stone Wort (tentatively identified as *Chara Australis* and a *Nitella* sp).
- Epiphytic green algae occur in spring on any natural or artificial submerged substrates.
- Since 1993 the dampland plant *Centella Cordifolia* established at the north end.

The Ecoscape 2007 Revegetation Plan for the northwest bushland adjacent to the Lakeway Drive-in site identified a total of 31 native species and 53 weed species, as well as three main vegetation communities including:

- *Agonis flexuosa* (Peppermint) Open Woodland along the slope south of the former Drive-in site
- *Eucalyptus gomphocephala* (Tuart) Woodland on the north-eastern boundary of Lake Claremont
- *Banksia attenuata* Open Woodland at the northern end of the former Drive-in site

Surveys have shown no evidence of declared rare flora or significant flora within the Lake Claremont reserve, although the Peppermint Open Woodland and the Tuart Woodland are considered regionally significant vegetation in need of protection (Bush Forever Report, 2000).

Recommendations 24-30

2.8.2 Fauna

Published references on the bird life of Lake Claremont are few. However, Rook (1963), Emory, et al. (1975), Morris and Knott, (1979); provide some information on a limited scale (Lantzke *et al.* 1989).

A total of 71 species of birds were documented by Lantzke *et al.*, (1989) with the Silver Gull and the Welcome Swallow representing 29% and 14% respectively of the bird population. With the closure of the Brockway Road refuse disposal site, Silver Gull numbers declined significantly. The most common of the 87 species recorded in the bird census carried out for the Town of Claremont between 1993 and 1996 were the Pacific Black Duck, Grey Teal and Eurasian Coot. Lantzke *et al.* further noted that the richest period for bird observation was November to January. This was due to several factors including the presence of breeding pairs and young and the change in habitat structure brought about due to the decline in lake water levels. The species' diversity and abundance were at their highest in January when the lake was nearly dry.

The type of habitat offered to birds included:

- (1) Deep water (to 1.0m in parts in winter)
- (2) Open shallow water
- (3) Shallows in conjunction with old tree trunks and rushes and reeds
- (4) Old tree trunks and stumps
- (5) Rushes and reeds
- (6) Grasslands
- (7) Tuart woodland (which has several different plant associations)
- (8) Few local trees and shrubs scattered over the grassed areas

Despite this variety, many of the bird species were present in small numbers probably indicating a small carrying capacity of the relevant habitat. As a management concern, these areas need enhancing through the planting of local species to increase the quantity and duration of food and protection available to the local fauna.

Perhaps the most valuable habitats for birds in the area are those that provide adequate shelter for breeding. Lantzke et al recorded 10 species using the Bulrush (*Typha orientalis*)

stands; 5 species using the woodland; 3 species using the golf course and other grasslands and 2 species using the dead Paperbark trunks in the lake.

In the 1993-1996 bird census 32 species of bird were positively identified as breeding in the following habitats in the lake environs;

- Open water 1
- Dead paperbarks 4
- Mudflats 1
- Rushes and reeds 7
- Grassland areas 3
- Woodland/trees, etc 16

From October to May, seven species of international migratory birds were recorded, mainly in January when the Lake was almost dry. Species observed by Lantzke et al. include:

- (1) Caspian Tern
- (2) Black Cormorants
- (3) Wood Sandpiper
- (4) Greenshank
- (5) Black Winged Stilt
- (6) Black Fronted Dotterel
- (7) White Egret

The shallows and mudflats are valued by these birds and the five species of local wading birds which have been recorded at Lake Claremont in the 1993-1996 bird census. The least well used areas include all grassed areas and the eastern peninsula. The openness of grassed areas and the regular human traffic deterred most birds from any usage other than using them for a travel corridor. The eastern peninsula is actually connected with the golf course and is littered with building rubble and is overrun with exotic grasses such as Kikuyu (*Pennisetum* sp). It is almost surrounded by Bulrushes, which offer some value for birds however it is easily accessible to humans.

Bird surveys conducted between 2005 and 2006 identified a total of 64 species of which 11 species are significant birds of the Swan Coastal Plain. Four feral species were also identified and included the Rainbow Lorikeet, Laughing Kookaburra, Laughing Turtle-dove and the Spotted Turtle-dove. A further 6 bird species were observed outside of the survey periods and included the Long-billed Corella, an Eastern Australian species. (Brockman and Free, Town of Claremont records). Refer to Appendix 3 for a list of the bird species observed at Lake Claremont.

There is no evidence that the reserve supports any native mammals. However, the Peppermints and older Tuart trees provide food and nesting sites which would suit animals such as the local Brush Tail Possum (an unidentified possum was sighted in the early 1990s). These hollows support birds and may offer shelter to bats (an unknown species of bat has been sighted on a number of occasions).

Other fauna in the area include the Long Necked Tortoise, the Mosquito Fish, (*Gambusia affinis*) and an array of invertebrates. Lantzke et al (1989) sampled 29 genera, with the highest density occurring in June (15 species in the Bulrushes and 11 species in open water). Low densities were recorded in the dry periods of January to March.

Other species reported include the Dugite, a legless lizard and a number species of skink and at least 3 species of frog.

A notable terrestrial insect in the area is the Tuart Longicorn Beetle. This insect plays a role in the life of the Tuart tree. The beetle larvae which is laid inside the bark of the small tree branches, bore into the wood and escape predation. This causes the branches to die back. It does not kill the tree however, which shoots new growth from the base of the dead area of the branch. This phenomenon is noticeable in the woodland area and shows a significant ecological relationship. (Robert Powell pers comm 1991).

Recommendations 17-23

2.9 FIRE

Fire can be damaging to an ecosystem, particularly if frequent. Destruction of the lower storey vegetation will produce ideal conditions for the proliferation of weeds. It is believed that there is a relatively low risk of fire in the reserve, the major source being the deliberate lighting of the bulrushes in late summer. It is believed that school children may be the principal instigators of deliberate fire lighting. Burning of the bulrushes may lead to a loss of habitat for indigenous fauna; the construction of island refuges would reduce the risk of fire to the indigenous fauna.

Recommendation 31

2.10 BASIS OF THIS POLICY

This policy is based on the following considerations:-

1. There are many inter-related processes occurring in a lake.
2. For Lake Claremont the most important are those contributing to its biological health, taken as being shown by:
 - Diverse and sustainable suites of water fowl
 - Low incidence of mosquitoes and midges
 - Absence of algal blooms (and associated bird deaths)
 - A predominantly open lake surface, with little change in areas of bulrush
 - Healthy, diverse natural bush areas, with low weed densities.
3. The key processes involved in achieving and maintaining these are not adequately known, but the best available option is the control of aquatic plant growth, which depends on the concentrations of bio-available nutrients and water.
4. Frequently the existence, extent, and rate of plant growth is limited by the availability of one nutrient. The assumption made for Perth's lakes (and many WA drylands too) is of phosphorus being the limiting nutrient. High concentrations of phosphorus in lake water appear related to excessive growths of alga and midge. Limited nitrogen and phosphorus measurements of Lake Claremont in 1993, suggest phosphorus limiting for slow processes, but nitrogen limiting for rapid.
5. Council resolved that as part of the former Lakeway Drive-in Site development, the Lake Claremont Policy (Revised 1998) would be reviewed. Consultation with

Aboriginal elders and an anthropological study of the area would be included as part of the review process.

PART THREE: RECOMMENDATIONS AND RATIONALE

3.1 MISSION STATEMENT

The Town of Claremont is committed to managing Lake Claremont as a healthy natural seasonal wetland to provide both a natural conservation and recreational resource for the community in perpetuity.

3.1.1 Management

Responsibility for management in accord with State and national policies for wetland and bushland conservation extends to the limits of Lake Claremont's drainage basin.

3.2 SURROUNDING LAND USE

3.2.1 Groundwater Management

3.2.1.1 Objectives

- 1) To reduce the nutrient, heavy metal and sediment load of groundwater entering the lake.
- 2) To determine to what degree, if any, the former refuse disposal site impacts on the water quality in the lake with reference to the well being of flora and fauna and particularly, human health.
- 3) In the event that evidence is obtained to show that leaching of contaminants from the refuse disposal site is occurring and resulting in pollution of the lake, determine the most appropriate steps to be taken.
- 4) To identify the influence of groundwater quality and other consequences of refuse disposal, on vegetation on the refuse disposal site.

Recommendation 1

The Town of Claremont should employ a suitable consultant to investigate and report on the nature and extent of groundwater flow and contamination from the refuse disposal site.

Rationale

Previous studies have highlighted that refuse sites have the potential to contaminate groundwater (CSIRO, 2006). Lake Claremont is a groundwater flow-through wetland, with groundwater entering the lake on the northeast side, and exiting the lake on the southwestern side. It would be expected that Lake Claremont receives a significant portion of its surface water inputs via groundwater inflow along its northeastern border. This northeastern side of Lake Claremont was historically used as a rubbish disposal facility, and therefore groundwater entering the lake has the potential to be effected by the leachate from the refuse site. The nature of the waste discarded on the refuse disposal site is currently unknown, including the types of rubbish placed there and if any contaminant barrier has been constructed between the site and the lake.

Given this uncertainty, together with the lack of knowledge of the extent of inflow of groundwater into the lake, it is difficult to predict the effect of leaching from the refuse disposal site into the groundwater (which then flows into the lake). Until the nature and extent of pollution of groundwater from the refuse disposal site has been determined, it will be difficult to establish how best to reduce the effect on the water quality of the lake. Therefore monitoring of the groundwater quality up and downstream of the refuse site is considered a priority, as it will allow the contaminants entering the groundwater from the landfill site (if any) to be determined. Once the extent of the contamination of groundwater from the former refuse disposal site has been evaluated, an appropriate course of action can be determined, which will target the identified pollutants. Long-term monitoring of the groundwater would be essential in determining the identity of any pollutants leaching from the refuse site into groundwater, and to determine the potential effects of these contaminants on the health of Lake Claremont. There are several potential courses of action that may be pursued if the monitoring program highlights a groundwater contamination problem, which may include chemical treatment options, capping, construction of groundwater treatment facilities, or revegetation works. Each option has potentially a positive and negative implication, and therefore professionals should be consulted to determine the most appropriate course of action specific to the problems found at Lake Claremont.

Recommendation 2

Council should consult with the Department of Environment and Conservation to develop a suitable ground water management strategy in the light of potential saltwater intrusion.

Rationale

Saltwater intrusion is a major coastal management problem confronting the conservation of freshwater wetlands, flora and fauna all over the world, which leads to the loss of freshwater vegetation and major alterations of the ecology of freshwater systems (Department of Environment, 2004).

The salinity of the Swan River is variable throughout the year. Because of the large amount of rain in upstream catchments in winter, a lot of fresh water flows into the Swan River and therefore the salinity of the River is low (University of Western Australia, 2007). In early spring, the amount of rainfall decreases and fresh water flow into the estuary is reduced (University of Western Australia, 2007). As a consequence, the seawater moves further into the River and as seawater is much denser and heavier than fresh water, it will flow into the estuary along the bottom of the river (University of Western Australia, 2007). The two bodies of water (fresh and saline) will flow over each other like a wedge, creating a "salt wedge" (University of Western Australia, 2007). The two layers will gradually be mixed by the wind and the salinity of surface waters will increase. As the weather becomes even drier and inflow from the upper catchments is decreased, the saline water will continue to move upstream and by the end of summer, most of the estuary will almost be as saline as the sea (University of Western Australia, 2007).

Subsequently, areas located close to the coast or close to the Swan River are prone to saltwater intrusion through groundwater flow (Water and Rivers Commission, 1998). The excessive bore use in these areas is a major contributing factor to the influx of saline water (Water and Rivers Commission, 1998). Due to Lake Claremont's proximity to the coast and also the Swan River, the risk of saltwater intrusion as a result of the overuse of groundwater (or declining groundwater levels) is elevated. It is because of this that a groundwater management strategy is recommended, in order to identify current groundwater issues, and determine appropriate management actions, to prevent saltwater intrusion.

3.2.2 Nutrient and Irrigation Management

3.2.2.1 Objectives

- 1) To reduce the nutrient, heavy metal and sediment load of stormwater runoff entering the lake.
- 2) To ensure appropriate land management techniques are adopted including appropriate fertiliser use and irrigation management, to minimise any adverse effects on the lake and its environs.
- 3) To reduce the amount of surface water emptying directly into the lake to the absolute minimum
- 4) Implement best practice stormwater management techniques to retrofit the drains to improve the water quality of Lake Claremont

Recommendation 3

Ensure that fertiliser and irrigation use is minimised on lands surrounding Lake Claremont. Seek appropriate professional advice on the minimal quantities of fertiliser and irrigation necessary to maintain parks and ovals in an acceptable condition. Research turf species suited to low fertiliser and irrigation. Specifically:

- (i) That the Town of Claremont prepare a nutrient and irrigation management plan for Cresswell Oval and Stirling Road Park. These plans need to ensure that fertiliser and irrigation use is minimised.
- (ii) If the Lake Claremont Golf Course is to remain as a golf course or contain parkland, then a nutrient and irrigation management plan should be prepared to ensure that fertiliser and irrigation use is minimised in this area.
- (iii) That Scotch College prepare a nutrient and irrigation management plan for the school grounds and in particular the ovals. Once in place, the plan should be regularly audited by Council.

Rationale

Surrounding land use has a large influence on the nutrient status of Lake Claremont. There are many areas containing turf surrounding the lake including Stirling Road Park, Cresswell Oval, Scotch College and the Lake Claremont Golf Course.

Whilst grassed areas are a valuable amenity, activities associated with turf cultivation including excess water and fertiliser application and the inappropriate use of chemicals such as herbicides, pesticides, wetting agents and fungicides can have a negative impact on the environment (DEP & WRC, 2001).

Nutrients, particularly nitrogen and phosphorus, are essential for turf growth, but applications in excess of that being absorbed by turf can lead to eutrophication of waterbodies (DEP & WRC, 2001). Excess water application can alter groundwater levels and cause nutrients to leach into groundwater and wetlands (DEP & WRC, 2001). Nutrient and irrigation management planning to minimise use on surrounding lands, consistent with acceptable standards of turf management, can very quickly have a positive effect on the nutrient status of Lake Claremont.

Minimising the use of fertiliser will assist in reducing the nutrient inputs to the lake. Management planning could incorporate options to assess the nutrient requirements of turf including soil testing and leaf tissue analysis to prevent over application.

Although no record of the quantity of groundwater being extracted to maintain the turf of the major proximate land users is available, minimising the use of groundwater extraction will reduce the need for fertiliser applications to replace leached nutrients and assist in maintaining a higher water table (and hence higher surface water level of Lake Claremont) during summer.

Recommendation 4

There should be no additional direct discharge of surface water into the lake via any new drainage network.

Rationale

Lake Claremont is currently used as a drainage sump to dispose of stormwater and excessive groundwater from roads and private property. There are six drains which discharge into the lake, of which only one has some form of oil and grease trap and another that has verge storm sumps. Studies have highlighted that stormwater drains have the potential to deliver a wide range of contaminants to the receiving environment, including heavy metals, nutrients, debris and hydrocarbons. The types of contaminants being delivered to the receiving environment are determined by the landuse of the drainage sub-catchment. Although testing of the stormwater contaminants has not yet been undertaken, meaning it is not clear what contaminants are entering Lake Claremont through the stormwater system, it can be assumed that the stormwater is contributing some level of contaminants to the Lake. Therefore, extension of the drainage network, or the development of new drainage networks that will discharge into the Lake, should be prevented, in order to reduce this contamination risk.

Lake Claremont is protected under the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992. This Act prevents the discharge or disposal of effluent into lakes or the alteration of drainage systems in lakes (applicable to drainage systems constructed after 1992).

Therefore, the current drainage system, which discharges stormwater into Lake Claremont, should not be extended, and no new drains should be constructed which discharge into the lake. The latter particularly applies to new developments throughout the catchment area. Steps should be taken to improve the water quality entering the lake through existing stormwater drains, including establishing constructed wetlands and revegetation around inlets. However these options should be determined using the results of the water quality monitoring program.

Recommendation 5

The Town of Claremont should ensure that all future developments within the Lake Claremont catchment area retain all stormwater on site.

Rationale

Stormwater consists of rainfall runoff and any material picked up in its path of flow. If stormwater is not infiltrated close to where it falls, it can collect contaminants and litter from impervious surfaces leading to nutrient enrichment, pollutant contamination and erosion of the receiving waterbody.

Land development increases the amount of impervious surfaces, which in turn reduces the level of infiltration of stormwater to groundwater, and increases the potential for the mobilisation of contaminants. (Department of Environment², 2004)

Suitable consideration of stormwater management during the planning and construction of urban, commercial and industrial areas has the potential to minimise many of the impacts of land development on stormwater. Local government planners can help protect stormwater quality by ensuring the land is capable of sustaining urban development and that development follows the water sensitive urban design principles. This will provide adequate space for stormwater management, minimise the extent of impervious surfaces, integrate stormwater quality treatment measures with public open space and ensure the impact of stormwater on receiving environments is minimal (Department of Environment², 2004). Water sensitive urban design offers an alternative to the traditional conveyance approach to stormwater management. It seeks to minimise the extent of impervious surfaces and mitigate changes to the natural water balance, through on-site reuse of the water as well as through temporary storage (CSIRO, 1999). By integrating major and minor flow paths in the landscape, and adopting a range of water sensitive urban design techniques, the size of the structural stormwater system required can be reduced (CSIRO, 1999). These techniques can include retention and detention basins to lower peak flows, and grassed swales and vegetation to facilitate groundwater infiltration and pollutant infiltration (CSIRO, 1999). Managing urban runoff in a water sensitive manner not only resolves problems associated with stormwater, but it enhances the social and environmental amenity of the urban landscape (CSIRO, 1999). Reducing peak flows and maintaining a more natural stormwater system can also reduce capital and maintenance costs of drainage infrastructure (CSIRO, 1999).

It is essential that construction activities are undertaken in such a way that contaminated runoff is not discharged off-site. Management of stormwater is crucial during construction, as soil is often removed and left exposed to erosion (Department of Environment², 2004). Implementation of the Clean Site program is an excellent way to reduce the environmental impact of construction and development. Clean Site is an education program run by Keep Australia Beautiful and the Department of Environment that focuses on four main areas; stormwater management, erosion control, litter management and resource recovery. Specific construction activities it targets include:

- Site excavation
- Delivery, stockpiling and removal of materials
- Concreting, brickworks and cutting
- Painting, plastering and plumbing
- Management policy and site supervision

The implementation of this program to all new construction sites in the catchment area is recommended in order to reduce the impact of these activities on the health of Lake Claremont.

Recommendation 6

The Town of Claremont should investigate the construction of vegetated wetlands or other appropriate nutrient and sediment stripping devices on the relevant drain(s) which empty into Lake Claremont, using the results of the water quality monitoring to identify priority sites.

Rationale

Most urban areas in Western Australia have traditional (predominantly piped) drainage systems to reduce the risk of flooding.

Retrofitting a traditional drainage system provides the opportunity to reduce changes to the natural water balance caused by development and in particular to reduce the levels of nutrients and contaminants present in stormwater.

Planning for retrofitting should examine opportunities to improve the management of stormwater at-source, in-transit and at end-of-pipe. Best practice stormwater management should retain and detain runoff and aim to infiltrate to groundwater where possible. (Department of Environment², 2004)

To effectively retrofit a system, it is necessary to know something about the catchment including land use, current stormwater management practices, soil types and hydrology as well as something about the pollutants such as typical components and dominant transport pathways (Department of Environment², 2004). As a primary goal is to improve the water quality in Lake Claremont, it is essential that the water quality of the stormwater is known beforehand, as this will influence the choice of retrofitting strategy. Different techniques are required for removing different pollutants and a number of strategies are often required to treat the range of pollutants that may be present in stormwater. The order of the techniques implemented in the treatment of stormwater is also important to ensure that each works to its maximum efficiency.

Table 2 provides is a summary of the various techniques that can be implemented to improve the water quality of stormwater and receiving waterbodies.

Table 2: Stormwater Management Tools for Targeting Key Parameters to Improve Water Quality (extracted from the Stormwater Management Manual for Western Australia, Chapter 6: Retrofitting, pg 19)

Best Management Practice	Provide Habitat	Improve aesthetics	Improve Water Quality								Issues	
			Reduce Total Suspended Solids	Reduce Litter	Reduce particulate total nitrogen, total phosphorus	Reduce dissolved nutrients	Increase oxygen	Reduce hydrocarbons	Reduce Heavy Metals	Reduce Bacteria	Increase Risk of Mosquitoes	
GPTs			✓	✓	~				~	~		✓
Trash racks etc				✓								✓
Grass swales		✓	✓		✓		~		~	~		
Filter strips	~	✓	✓	✓	✓		~			~		
Sand filters			✓		✓							
Oil and grit traps									✓			
Riffles	✓	✓	✓					✓				
In-stream plants	✓	✓	✓		~		✓	✓				
Soil amendments							✓					
Permeable / Porous paving							✓			✓		
Bioretention systems	✓	✓	✓				✓					
Infiltration areas			✓		✓					✓		
Open water (UV exposure)	✓	✓									✓	✓
Constructed wetlands	✓	✓	✓		✓		✓	✓				✓
Sediment basins			✓	✓	✓				~	~		✓

✓ denotes parameter/issue is applicable to this best management practice

~ denotes parameter/issue is applicable to some extent to this best management practice

3.2.3 Conservation and Recreation Zoning

3.2.3.1 Objectives

- 1) To protect the natural assets of Lake Claremont through delineation into conservation and recreation zones.
- 2) To provide suitable infrastructure for both the recreation and conservation areas of Lake Claremont.
- 3) To determine and provide required car parking. Car parks to have a natural sand or grassed surface and are unsealed.
- 4) Facilitate access for visitors traveling on public transport.
- 5) Preserve the northwest area of the site adjacent to the Drive-in as a conservation and wildlife observation zone.
- 6) To revegetate the area, particularly the conservation areas, with indigenous species.

Recommendation 7

Establish clear delineation of Lake Claremont into conservation and recreation zones to achieve the following outcomes:

- (i) Both upland and wetland communities are represented in the conservation area.
- (ii) Restricted public access within the conservation area with no access to open water.
- (iii) Provision of appropriate infrastructure in the conservation area to address path erosion issues. (i.e. boardwalk construction, semi-permeable path materials, moving the lake path and fence with agreement from Scotch College).
- (iv) The conservation area is a "Dogs on Leash" only zone
- (v) The recreation area is restricted to areas of existing turf around the perimeter of the reserve.
- (vi) Any existing exotic species (i.e. Fig trees) are confined to the recreation area. If Fig trees are removed it should be through a staged process in conjunction with replacement with appropriate native species.
- (vii) Provision of appropriate infrastructure within the recreation area (i.e. picnic areas, cycle paths, dog exercise areas). Provision of modern picnic facilities in suitable locations in John and Jean Mulder Park and Stirling Road Park.
- (viii) Review the provision of additional car parking facilities and signage to facilitate access from public transport.

Rationale

Lake Claremont is a conservation category wetland and an important habitat for fauna, however there is also demand from the community for recreational use of the area. It is important to meet the recreational demands of the community whilst still protecting the natural assets of Lake Claremont. Inappropriate recreational use of natural areas can reduce their long-term viability through disturbance to vegetation caused by erosion and the introduction of weeds, disease, rubbish and nutrients (Del Marco et al, 2004). Therefore it is essential to physically separate the recreation and conservation areas, which can be achieved through methods including fencing, paths and signage. As conservation and recreation areas require different management approaches, clear delineation of the lake into zones will ensure management practices are appropriate to each area. In establishing the conservation zoning of Lake Claremont there is the opportunity for Council to formalise the protection of these areas through Town Planning Scheme zonings and provisions.

Provision of suitable infrastructure can be an effective way to control threats in conservation areas (i.e. uncontrolled access and erosion) and assist the community to acquire the most benefit from recreational areas. It would be advantageous to conduct community consultation regarding the zoning of Lake Claremont, particularly to determine the recreational requirements of the area and their optimum locations. The areas adjacent to John and Jean Mulder Park and Stirling Road Park appear to be the most suitable for picnic areas as they are adjacent to parking and play areas. The area adjacent to Stirling Road is popular for visitors and would be the most appropriate area to construct public toilets, providing it is possible to connect to the Hon. Ministers sewer.

The location of car parks will to some degree determine to what extent the general public uses the area. Limited car parking facilities should therefore be provided in the north western area to discourage inappropriate use of this portion of the reserve.

The Council should periodically monitor the existing access points to determine if the car parking requirements are sufficient. Currently the number of car bays at Cresswell Oval is sufficient, however some formalised car parking should be provided on the east side of Strickland Street by locally increasing the width of the carriageway by approximately 2 metres. Car parks should have a natural sand or grassed finished surface, to significantly reduce the stormwater run off into the lake.

Recommendation 8

That the northwest area of the reserve below the former drive-in theatre site be reserved as a conservation and wildlife observation zone. The only public facilities to be provided in this area should be an unobtrusive path.

Rationale

In the northwest area, below the former drive-in theatre, there is a sensitive dunal slope with little understorey vegetation that will be damaged by inappropriate access or activities. This area contains remnant Tuart and Peppermint woodland that is considered regionally significant vegetation and should be protected. Therefore this area is ideal to reserve for conservation and should continue to be revegetated with appropriate indigenous vegetation to provide a dryland buffer to Lake Claremont.

3.2.4 Lakeway Drive-in Site

3.2.4.1 Objectives

- 1) To prevent or ameliorate any adverse effects that development of this site may have on the Lake and environs.
- 2) To retain the existing vegetation and contours of the land to be developed.
- 3) To ensure access from the site to the lake is possible only at appropriate points to minimise disturbance to the bushland.
- 4) To encourage the use of local and Western Australian plants within the development to reduce the amount of water and nutrients used on urban gardens and landscapes, provide habitat for fauna and reduce the incidence of environmental weeds.
- 5) To educate future residents on environmental issues relating to Lake Claremont.
- 6) To ensure that vegetated buffers are provided on the southern and eastern embankments.

Recommendation 9

Prior to the former Lakeway Drive-in site being developed, the Town of Claremont make a stated requirement on the Certificate of Title(s) to ensure;

- (i) That the existing topography of the land is generally retained, that is, the land falls to the northwest and all stormwater is disposed of in a suitably designed sump located in the northwest corner of the site.
- (ii) Retention of the existing vegetation where possible. In particular ensure no felling of trees for views.

- (iii) Impose a fencing requirement to restrict access through the regenerating bushland.
- (iv) Preferential use of local and Western Australian plant species in the landscaping of the Lakeway Drive-in site. The use of environmental or potential environmental weed species and deciduous trees is avoided.

Rationale

Development of the former Lakeway Drive-in site will bring new concerns for the management of Lake Claremont including increased groundwater extraction, greater stormwater runoff, increased human activity in the regenerated bushland to the west of the lake and greater numbers of domestic animals frequenting the lake.

To minimise the adverse effect of these impacts, it is essential any stormwater runoff is retained on site through effective stormwater management (refer to Recommendation 5) and access is restricted to the bushland through fencing, designated paths and signage.

Residential development will bring about other changes to the Drive-in site including the removal of vegetation and the introduction of a broader range of plant species through landscaping works. Many environmental weed species and deciduous trees are used in the landscaping of new housing developments. Environmental weeds are species that threaten the values of natural ecosystems through invading and out competing indigenous plant communities, reducing plant diversity and resulting in a loss of habitat.

Deciduous trees are the cause of many environmental problems. Some include:

- Blockage of rivers and streams
- Increased amount of organic matter entering drainage systems and waterways in autumn and early summer. This leads to increased nutrient levels in these systems resulting in eutrophication and algal blooms
- Displacement of indigenous flora through dense shade in spring and summer restricting plant growth
- Displacement of fauna through loss of habitat and their inability to recognise deciduous trees as a food source
- Many deciduous trees are environmental weeds (eg Willows)

(Waters and Rivers Commission, 2002)

The preferential use of local and Western Australian plant species in landscaping and the retention of remnant vegetation wherever possible within the Drive-in site will help to minimise the impacts of the development on Lake Claremont.

Recommendation 10

That council, in conjunction with the developer, undertake an environmental education program for residents including the following:

- (i) the consequences of excessive water and fertiliser use
- (ii) the impact of dumping garden waste in the reserve
- (iii) appropriate local and Western Australian plant species for use in gardens and landscaping
- (iv) information on environmental weeds and their impact on natural areas

Rationale

Increasing the number of people living in an area places added pressure upon nearby natural areas. In particular with the establishment and maintenance of lawns and gardens within residential developments, there tends to be an increased use of water and fertilizer, resulting in higher levels of nutrients (especially nitrogen and phosphorus) in runoff from these areas and an adverse impact on water quality. The majority of Western Australia's environmental weeds have escaped from home gardens due to inappropriate plant choices and dumping of garden waste into natural areas.

An education program could reduce the incidence of these undesirable activities through an increased awareness of their effect on Lake Claremont. This could be accomplished through an information package provided to residents or a series of workshops. In particular, information should be provided on suitable local or Western Australian plant species for use in gardens. These species are adapted to our climate, soils and environmental conditions and require less care and additions of nutrients and water to survive and flourish in comparison to plants that have evolved elsewhere.

Recommendation 11

That Council ensure that appropriate dense vegetation is provided on the southern and eastern embankments of the Drive-in site to prevent erosion and provide a buffer to the development.

Rationale

Retention of the existing vegetation on the embankments and additional revegetation using locally indigenous species will assist in preventing further degradation of these areas and enhance their value both aesthetically and as fauna habitat. It is also desirable to restrict uncontrolled access from any residential lots through the regenerated bushland to Lake Claremont, which can be achieved through the construction of fencing and defined paths.

3.2.5 Lake Claremont Golf Course

3.2.5.1 Objective

- 1) To provide easily identifiable, safe and convenient access around the lake.

Recommendation 12

To be completed following recommendations from the Golf Course Stakeholder Reference Group.

Rationale

The preferred option of the Golf Course Stakeholder Reference Group was to "Upgrade the Golf Course" (Town of Claremont, 2007).

Currently the golf course is rated 2/10 requiring a considerable number of changes to upgrade the rating to a 4/10 including:

- Replacement of the irrigation system
- Re-grading of the fairways to eliminate un-mowable humps and hollows
- Evaluation of existing turf grasses and reseeding where required
- Implementation of a suitable fertiliser regime
- Upgrading of maintenance machinery (i.e. mowers)

The course would also need to be redesigned to meet with current safety standards especially to ensure the safety of residents accessing the lake (Town of Claremont, 2007). The current fairway widths and separations would need to be increased resulting in the golf course taking up a larger area (Town of Claremont, 2007).

However it is important for the long-term viability of Lake Claremont to have an appropriate wetland buffer. "A wetland buffer zone is an area of vegetation which usually begins from the boundary of wetland dependant vegetation and extends outward" (Water and Rivers Commission², 2000). Buffers perform various environmental functions some of which include maintenance of good water quality, reduction in runoff, provision of habitat, contribution to wildlife corridors, provision of a barrier to physical disturbances and the minimisation of weed invasion and nuisance insects (Balla, 1994).

Currently there is very little fringing vegetation surrounding Lake Claremont and a lack of a wetland buffer. The width of a buffer is dependant upon its intended purpose, other factors including slope, vegetation type, the intensity of surrounding landuses, the potential for weed invasion and management strategies as well as the conservation significance of the wetland. For Conservation Category wetlands such as Lake Claremont, buffers are recommended to be at least 50 metres from the edge of the wetland dependant vegetation. For the largest range of environmental benefits, the best option is for the buffer to be as wide as possible; however this could be limited due to the proximity of the golf course, particularly if it is upgraded.

3.3 WATER QUALITY AND QUANTITY

3.3.1 Objectives

- 1) To reduce the concentration of nutrients in the lake.
- 2) To prevent the formation of algal blooms through appropriate nutrient management.
- 3) To reduce the concentration of faecal coliforms and maintain low levels of other contaminants in the lake.
- 4) To minimise salt groundwater intrusion.
- 5) That the lake continues to be managed as a shallow wetland drying out in late summer.
- 6) That groundwater use in the locality be minimised.

Recommendation 13

That the Town of Claremont should institute a water quality monitoring program to measure both the lake health and nutrient inputs. Samples of water should be taken regularly (e.g. monthly, bimonthly or quarterly) to provide an ongoing record of nutrient concentrations and

to identify hotspots. Monitoring should include sites located within drains to identify nutrients and contaminants entering from surrounding land uses (i.e. stormwater drains, refuse site). Sampling should also occur within Lake Claremont itself to monitor its health over time.

Rationale

Water quality monitoring is important for environmental protection, managing waterways and their catchments, identifying pollution events and community education (Department of Water, 2006). Monitoring consists of making observations and taking measurements that are analysed and reported for the purpose of providing information and knowledge about catchments and waterways (Department of Water, 2006). Identifying a clear purpose for monitoring is the first and most critical step for an effective monitoring program and should be based on an analysis of issues affecting the catchment and/or waterbody (Department of Water, 2006). Where the purpose of monitoring is to provide data for local action planning, or catchment-wide decision making, it is important that the monitoring provides data of a known quality; it is absolutely essential to know how good the data is if it is going to be used to make good catchment management decisions or develop meaningful resource condition targets (Department of Water, 2006).

A regular water monitoring program is important to determine ongoing trends, determine the overall ongoing health of the lake, and to identify pollution hotspot areas, which can then be targeted for future management actions. Results of the water monitoring program can be used to prioritise potential upgrade works, allowing for the more efficient, effective and targeted use of resources.

Results of the current monitoring program (implemented by the Friends of Lake Claremont and the Town of Claremont) highlight that the lake is nutrient enriched and is affected by algal blooms. The results highlight that the concentrations of nutrients and algal bloom indicators (chlorophyll *a*) are increased in the surface water of the lake following major rainfall events, suggesting stormwater could be a major contributor of pollutants to the lake. Therefore the inclusion of stormwater in the water monitoring program is important. Collecting regular water samples from stormwater drains entering the lake will provide an indication as to the identity and loading of pollutants originating from each stormwater drainage sub-catchment. The results of this can be used to identify particularly polluted drainage sub-catchments, and prioritise them for upgrade works or other programs, specific to the pollutants recorded at that location.

Regular monitoring of the surface water of the lake will allow long-term baseline data to be gathered, allowing long-term trends in water quality to be determined, including seasonal fluctuations in pollutant concentrations. This data can also be used to compare to future data following any changes that may occur throughout the catchment area, which may include further developments throughout the catchment area, upgrades of stormwater drainage systems, or the implementation of community education programs. Comparison to the baseline data will allow the impacts of future changes in the catchment to be determined and the effectiveness of any remediation programs to be evaluated.

The water monitoring program should include nutrients (totals and dissolved fractions) and other contaminants regularly found in residential catchments and areas with landfill sites. Consultation with professionals to develop the water monitoring program for the lake and stormwater drains will allow a robust and effective program to be developed which will provide reliable results from which future planning and programs can be based upon.

Recommendation 14

Council should implement a range of strategies to improve water quality in Lake Claremont. Council should continue to seek professional advice on means to improve water quality in the lake.

Rationale

Good water quality is important to maintain the current environmental and social values of Lake Claremont and current studies have highlighted that the lake suffers from algal blooms, nutrient enrichment, and incidences of bird deaths. There are numerous options available to improve the water quality in wetland systems ranging from at-source controls (particularly education programs) or end-of-pipe controls, including structural controls, revegetation works and chemical controls. The choice of controls needs to be determined based upon the pollutants found, and therefore should be closely linked with the results of the water monitoring program.

One option is retrofitting stormwater drains that are identified as hotspots to target the identified pollutants, with appropriate devices suited to that particular pollutant. This may include gross pollutant traps (general rubbish), sediment traps (sediment and sediment-bound nutrients), Humeceptors, revegetation works, treatment drains throughout the catchment and the development of living streams and artificial wetlands.

Education programs are useful for wide-scale, non-point source pollution problems, such as overuse of fertilisers in residential gardens. These can include programs run through schools, signage and media articles, educational materials, surveys and talking directly to residents. Nutrient control can also be targeted by the development of nutrient management plans for public and privately owned parks and gardens and sporting fields throughout the catchment area (refer to Recommendation 3).

Chemical controls involve the addition of a chemical to the surface water of the lake, which will remove the available forms of nutrients (particularly phosphorus) from the water column. These controls can be expensive and are ongoing if the inputs of pollutants to the system are not controlled.

There are potential positive and negative impacts associated with each option. Consultation with professionals will allow an option (or options) to be determined for Lake Claremont that is specific to the lake and the pollutants recorded there.

Recommendation 15

Retain the lake's natural water fluctuations (i.e. Lake Claremont to be managed as a seasonal wetland). The use of bore water to maintain water levels in the lake should not be considered (except under exceptional circumstances and not until the sources of significant water recharge of the lake has been investigated).

Rationale

Lake Claremont was originally a seasonal wetland, which has had its hydrology drastically altered following European development, whereby groundwater infiltration rates throughout the catchment area have been significantly decreased (due to an increase in impervious surfaces) and surface runoff to the lake has increased (through stormwater drains). Lake Claremont is a groundwater flow-through lake, with the lake water level being directly related to the groundwater level.

Naturally, Lake Claremont is a seasonal wetland, which is traditionally wet in winter, when groundwater levels are high and stormwater inputs are high, with lower surface water levels in summer, when groundwater and stormwater inputs are reduced.

It is recommended that Lake Claremont be managed as a seasonal wetland and the natural fluctuations in water levels are maintained in order to protect the seasonal habitats of the area, particularly for waterbird species.

Studies have shown that there are generally no significant differences in waterbird abundance, number of breeding species or breeding activity between permanent and seasonal wetlands on the Swan Coastal Plain (Storey *et al*, 1993). Seasonal wetlands often record species that are not recorded at permanent wetlands, and on a regional scale, seasonal wetlands support twice as much breeding as permanent wetlands (Storey *et al*, 1993).

Overuse of groundwater throughout the catchment, or wide-scale lowering of the groundwater table can lead to lower than normal surface water levels in the lake. As the surface water level of the lake is directly related to groundwater levels, continued heavy drawings on the aquifer will reduce the water levels in the lake, increasing the risk of salt water intrusion and a range of other impacts, including changes to flora and fauna species and abundances and the potential activation of acid sulphate soils. It is therefore a priority that the overuse of groundwater throughout the catchment be addressed, particularly through education programs for bore users, to prevent the localised lowering of the groundwater table and the subsequent effects that this will have on the water levels at Lake Claremont.

3.4 ACID SULPHATE SOILS

3.4.1 Objectives

- 1) To identify and define the extent of acid sulphate soils in Lake Claremont and surrounds.
- 2) To avoid disturbance of Acid Sulphate Soils in Lake Claremont wherever possible.

Recommendation 16

Conduct an Acid Sulphate Soils / Potential Acid Sulphate Soils assessment to ground-truth the current risk maps produced by the Department of Environment, as Lake Claremont falls in an area at "high risk of acid sulphate soils or potential acid sulphate soils". This should be completed before any earthworks or disturbance occurs in or around the lake.

Rationale

Acid sulphate soils occur naturally in many parts of the world. They are most common in waterlogged swampy environments, particularly near the coast, where peaty soils are formed. These peaty soils contain naturally occurring iron sulphide minerals, especially pyrite (FeS_2), and are benign if not disturbed or exposed to oxygen. However activities where the soils are exposed to oxygen, including dewatering for development, excavation and the lowering of the groundwater table, cause the sulphide minerals to oxidise and form sulphuric acid (H_2SO_4). Once formed, this acid can then flow into groundwater and move with the groundwater flow, causing acidic groundwater plumes.

These peaty soils are also a rich store of nutrients and the oxidation of these materials can cause high concentrations of nutrients to also be released into the groundwater flow.

Acidic groundwater has the potential to strip naturally occurring metals (particularly arsenic and aluminium) from the soil structure, converting them to a soluble form, which then enter the groundwater and travel with the groundwater flow. These metals can be toxic to aquatic life and are a serious public health issue. The acidic and contaminated groundwater can cause severe environmental and public health concerns, particularly in areas where groundwater is accessed by the public (including public bore water use), or at groundwater discharge points, including lakes, wetlands, rivers and drains. Acidic groundwater flowing into wetlands can cause the death of aquatic flora and fauna, heavy metal contamination of the surface water, increased toxicity of certain heavy metals and also the destruction of infrastructure such as boardwalks, drainage pipes, signage and retaining walls. Once the peaty materials are oxidised and acid flows are established, the effects can be almost impossible to remediate.

Areas throughout the Perth metro area have been mapped where acid sulphate soils may have the potential to generate significant amounts of acidity if the watertable is lowered by drainage, over-production or is exposed by development (Department of Environment, 2004). The Perth area has been ranked into three categories based upon the occurrence of acid sulphate soil (peaty sediments) at different depths (Department of Environment, 2004). High risk areas are those areas where acid sulphate soils may occur within 3m of the ground surface, Moderate risk areas refer to areas where there is a low chance of acid sulphate soil occurring within 3m of the ground surface, but it may be present below this depth and low risk areas are those areas where the geomorphology limits the occurrence of wetlands and the associated deposition of peaty sediments (Department of Environment, 2004).

Lake Claremont is located in a 'high risk of acid sulphate soils or potential acid sulphate soils <3m from the surface'. This classification is based on modelling and predictions of localised soil types, however needs to be ground-truthed. Therefore, conducting an acid sulphate soil/potential acid sulphate soil assessment for the area is a priority, and needs to be conducted before any earthworks or disruption of the soil or sediment occurs. The results of this assessment should be referred to when any case of disruption of the sediments or dewatering activities are considered.

3.5 FAUNA

3.5.1 Objectives

- 1) To ensure management of the lake is compatible with the conservation of fauna.
- 2) To enhance the fauna habitat provided by Lake Claremont through vegetation rehabilitation programs.
- 3) To minimise the disturbance of fauna by predators.
- 4) To minimise the incidence of nuisance insects such as mosquitoes and midges.

Recommendation 17

That the management of the lake be compatible with the conservation of flora and fauna, in particular, to maintain or enhance its value as a waterbird refuge.

Rationale

The importance of Lake Claremont as a habitat for waterbirds has been identified in the Perth Wetlands Resource Book. A study on the Waterbird Usage of Swan Coastal Plain Wetlands placed Lake Claremont in the top twenty wetlands (out of a total of 251) supporting the highest numbers of waterbirds and the highest numbers of breeding species during surveys conducted from 1990-1992 (Storey et al, 1993). Other native fauna recorded in and around the lake include the Long Necked Tortoise, various species of reptiles and three species of frogs.

Some management options to conserve and enhance the environment for flora and fauna include:

- Retain and enhance existing indigenous vegetation including establishing a vegetated wetland buffer zone to provide habitat and protection for native fauna
- Establish or enhance areas of upland and wetland vegetation to provide the broadest range of habitats and vegetation structures
- Designate conservation areas
- Ensure domestic pets are kept under control

The linking of areas of remnant vegetation via corridors is important in ensuring their long-term viability by allowing movement of fauna in response to threats (i.e. fire) and allowing movement of flora and fauna to access suitable habitat, resources and for reproduction (Del Marco et al, 2004). Retention and enhancement of the vegetation inside the northern and eastern boundaries of the Drive-in site would create a local corridor for bird species linking the Wembley Golf Complex, Bold Park, Cottesloe Golf Course and Lake Claremont.

For specific details on maintaining and enhancing the value of Lake Claremont as a waterbird refuge refer to Recommendation 20.

Recommendation 18

That the lake continue to be managed as a shallow drying wetland since this increases its productivity and variety of bird habitat.

Rationale

Seasonal wetlands often have a higher diversity of aquatic and fringing vegetation in comparison to permanent wetlands, as there are a greater number of microhabitats in seasonal wetlands. This provides shelter for a wide range of waterbirds and increases macroinvertebrate species richness, providing food for waterbird populations. (Water and Rivers Commission¹, 2000)

The drying process of seasonal wetlands means more nutrients and organic matter are available for primary and secondary production resulting in a higher breeding success for waterbirds (Storey et al, 1993).

Recommendation 19

That non-vegetated areas of open water (which may be subject to seasonal drying) are retained to provide habitat for fauna.

Rationale

Waterbirds have specific adaptations that enable them to utilise particular habitats within a wetland and limit direct competition with each other (Water and Rivers Commission³, 2000). Some species have higher preferences for particular habitats than others. A study on the waterbird usage of Swan Coastal Plain Wetlands found that the largest number of bird species had a preference for open water (Storey et al, 1993). Areas of open water and an array of water depths within the wetland also lead to a higher diversity of waterbird species. Therefore it is recommended that areas within Lake Claremont remain free of vegetation (i.e. are not revegetated) to ensure areas of open water are retained to provide the greatest variety of bird habitats.

Recommendation 20

That the vegetation (and drainage) rehabilitation programs should be designed to minimise nuisance insects and improve the lake habitat for waterbirds, terrestrial birds and any remaining terrestrial and aquatic fauna (i.e. tortoises). This involves staged weed removal coupled with adequate revegetation to provide protection for fauna from predators.

Rationale

Waterbirds depend on wetlands for a range of activities including feeding, breeding, nesting and protection from predators (Water and Rivers Commission³, 2000). Waterbird usage of wetlands is linked to a number of environmental factors including wetland size (including the length of shoreline and the area of open and closed water), water depth, primary productivity and vegetation structure and complexity (Storey et al, 1993). The highest number and species of waterbirds are usually found in wetlands with a complex vegetation structure including a high diversity of plant species and vegetation types, as there is a wide range of habitats (Water and Rivers Commission³, 2000). The number of breeding waterbirds is related to water quality, the width of the wading zone, the abundance of food and the extent of the fringing vegetation (Storey et al, 1993).

Some characteristics that enhance wetland habitat for waterbirds and should be considered in the revegetation of Lake Claremont are:

- Some logs and rocks protruding from the water for waterbirds to roost on
- Branches and large logs around the edge of the wetland at varying heights to provide roosting and nesting sites
- A range of water depths
- Mature trees around the wetland
- Natural bank slopes of between 1:4 and 1:15, rather than steep banks.
- Some bare areas to provide birds with access to the water and allow them to see predators
- Fringing emergent aquatic vegetation around the wetland to provide waterbird habitat
- Fencing to protect revegetation areas, limit access and disturbance to fringing vegetation and to provide protection from predators
- An island as a safe breeding site for ground nesting birds and as a refuge for wading birds
- Eradication of weeds as they have the potential to degrade waterbird habitat and reduce food resources

- Maintenance of water quality to prevent the formation of algal blooms as these can lead to outbreaks of botulism

Establishing fringing vegetation and a wetland buffer is the most essential task in improving the lake habitat for a range of other fauna. The preferred nesting sites of the Long-necked Tortoise (*Chelodina oblonga*) are sandy banks with a north facing aspect and patchy vegetation cover. Tortoises may travel anywhere from 20-100 metres before looking for a nest site. Hatchlings require dense aquatic emergent vegetation coverage for protection from predators until mature. Adult tortoises mainly require vegetation cover for protection when wetland areas dry out.

As well as aquatic emergent vegetation being important as habitat for macro-invertebrates and frogs, good water quality is essential. In particular adequate dissolved oxygen concentrations, a neutral pH and low levels of nutrients and other contaminants. Good water quality and fringing vegetation cover results in a large number and diversity of macro-invertebrates and insects which provide a food source for other types of fauna.

Recommendation 21

That users of the reserve be discouraged from allowing pets to run free in the vicinity of the lake. Signs should be erected with a warning that offenders will be issued with an infringement notice. The reason for the restriction should also be shown on the signs and conveyed by a public education program.

Rationale

Predation is responsible for the reduction in the numbers of many species of native fauna and is the most important factor affecting the breeding success for most waterbird species accounting for about 80% of breeding failure (Storey et al, 1993). The extent of losses to predation depends on the number of predators in the vicinity and to a lesser extent the amount of vegetation to provide protection to fauna.

Currently Lake Claremont is in a degraded state with little remaining fringing vegetation, meaning native fauna are vulnerable to predation from domestic pets including dogs and cats. Pets can also disturb existing and regenerating native vegetation, damaging habitat and exposing native fauna to predation from a range of species.

Strategies to protect native fauna from domestic pets include fencing off areas to prevent access by pets and protect regenerating vegetation, designating conservation areas that are a "Dogs on leash" only zone (recommendation 7iv), placement of "Dogs on lead" signs (recommendation 32iv) and implementation of a public education program.

Bins and "Pooch pouches" should be placed at appropriate locations around the lake to minimize any adverse effect on water quality through nutrient enrichment from pet excreta.

Recommendation 22

That there be ongoing monitoring of mosquito and midge larvae at the relevant time of the year to ensure densities remain below the threshold where they become a nuisance to residents. Provide residents with information on mosquitoes and midges and ways to reduce their breeding.

Rationale

Where there is water, there is the potential for mosquitoes and midges to breed. Both midges and mosquitoes can create nuisance problems for residents interfering with outdoor activities, however mosquitoes are known to present a serious health risk to humans by acting as carriers of diseases. (Environmental Protection Authority, 2000)

Midges are predominantly a problem in summer and higher numbers are often associated with nutrient enriched environments as there is more organic matter providing a food source. Large numbers of pest mosquitoes are often present in disturbed sites and those overgrown with *Typha orientalis*. (Environmental Protection Authority, 2000)

Ongoing monitoring programs are important to assess midge and mosquito numbers as well as to provide guidance for control procedures and for assessing the effectiveness of a control program (Environmental Protection Authority, 2000). If numbers of midges or mosquitoes reach nuisance levels, there are a variety of control methods that can be used to manage populations including:

- Revegetation of wetland vegetation to absorb nutrients and encourage native aquatic fauna, which are the natural predators of these pests
- Provision of vegetated buffers
- Reduction in nutrient inputs to the waterbody
- Maintaining the natural water fluctuations
- Chemical control (pesticides and insecticides) in conjunction with monitoring insect numbers

As chemical control measures can have a detrimental affect on other fauna and have the potential to have long-term environmental impacts their use should be avoided wherever possible.

Public education is also a valuable tool in mosquito and midge management and can include raising public awareness of the nuisance and health risks associated with these pest insects, encouraging self protection through the use of insect repellents, screens, nets and insect-proof clothing as well as reducing potential breeding sites on domestic properties.

Recommendation 23

Monitor feral animals (in particular foxes) and implement control programs as required.

Rationale

Feral animals have had an enormous impact on native wildlife. Feral foxes and cats reduce the numbers of native medium-sized mammals, reptiles, frogs, birds and insects in natural areas. Foxes can also swim and take ducklings and tortoises. Feral bees decrease the pollination success in some native plants, compete for nesting sites and compete with nectar feeders including other insects, birds and small mammals. (Hussey & Wallace, 1993)

Monitoring should be conducted periodically to determine if feral animals are present at Lake Claremont. If feral foxes or cats are detected, the only feasible control method is trapping, as this doesn't pose a threat to humans or domestic pets. Feral bees can be controlled either through placement of Shelltox strips in hollows, which are safe for native birds, or by hiring an apiarist if sites are difficult to access.

3.6 VEGETATION

3.6.1 Objectives

- 1) Revegetate the environs of the lake with wetland and dryland indigenous species to provide habitat and a food source for birds and other fauna.
- 2) To remove all the exotic terrestrial plant species around the lake and in the northwest bushland area.
- 3) To remove the *Typha orientalis* within Lake Claremont and replace it with indigenous emergent aquatic vegetation.

Recommendation 24

That the Town of Claremont implement policies to protect and maintain the local indigenous plant gene pool and the natural seed source in the reserve where possible.

Rationale

Local provenance is where a population of a particular species has become specifically adapted to local conditions and individual habitats (Waite, 2003). There are many benefits associated with using local provenance materials in revegetation including:

- Better survival mechanisms as plants are suited to local conditions including climate, topography and soils
- More effective adaptation to changes in condition in their local area due to genetic variations in the plant population
- Maintenance of a balanced and healthy ecosystem as the flora and fauna have a strong interdependence through evolving together over time
- Natural pest and disease control through balanced populations of pests and predators

The introduction of new genetic material can degrade the gene pool causing a loss of local adaptations and an increase in the susceptibility of the population to sporadic environmental changes, which eventually results in a decrease in biodiversity (Waite, 2003).

However there are difficulties associated with sourcing adequate local seed from Lake Claremont, as there is very little remnant vegetation both within and surrounding the lake and the majority is in degraded condition. There are also limited similar ecological communities in nearby surrounding areas from which to source seed.

In attempting to maintain the local indigenous plant gene pool, there is a need to determine what geographic range will be considered "local" for the purposes of revegetating Lake Claremont. It may also prove beneficial to use revegetated areas as a seed bank for future works.

Recommendation 25

That the drowned Paperback stumps in the lake be retained to provide roosting opportunities for water birds in the vicinity.

Rationale

Originally there were Paperbark (*Melaleuca raphiophylla*) trees present in the centre of the lake that died off due to rising water levels causing long-term inundation. As there is currently very little vegetation in the centre of the lake, the *Melaleuca* stumps should be retained as they substantially increase the roosting opportunities for water birds.

Recommendation 26

That the Town of Claremont implement and regularly review a strategic rehabilitation program with specialist advice that will achieve the following objectives:

- (i) Prioritised, staged removal of exotic terrestrial plant species around the lake, particularly weeds including Japanese Pepper, Figs, Giant Reed, Weeping and Chilean Willows and grasses including Couch, Buffalo and Kikuyu.
- (ii) Prioritised, staged removal of exotic terrestrial plant species within the northwest portion of the reserve, particularly weeds such as Perennial Veldt Grass, Geraldton Carnation Weed, Castor Oil, Blackberry Nightshade, Lupins, Chasmanthe.
- (iii) Staged removal of the Bulrush within Lake Claremont in conjunction with the establishment of indigenous emergent aquatic vegetation to replace it.
- (iv) Revegetate the lake edges to create a 10 metre buffer of fringing wetland vegetation.
- (v) Revegetation of the lake fringes and the surrounding areas with wetland and dryland species that are consistent with the natural flora of the area.
- (vi) Revegetation of the northwest woodland with appropriate dryland species.
- (vii) Shading out Bulrush, reducing the lake temperature over the summer and reducing the midge problem by planting species of *Melaleuca* on the edge or in the shallows along the eastern edge of the lake.

Rationale

Lake Claremont is in a degraded state with little remaining fringing vegetation to provide habitat and protection for native fauna. A large number of exotic species have become established in and around the lake including a number of exotic trees, grasses and *Typha orientalis* (Bulrush).

It is important that the existing indigenous vegetation be preserved and increased to provide habitat for native fauna and to maintain the natural gene pool and local seed source. Therefore it is imperative that weed removal is staged over a number of years and carried out in conjunction with revegetation using locally indigenous species to ensure there is no net loss of habitat. The total eradication of *Typha* in the short term is not practical nor is it desirable as it provides a safe refuge for water birds and intercepts some nutrients and sediments, thus there should be no reduction in the area of *Typha* without a habitat replacement program. It may be possible to control *Typha* to some extent by shading it out through planting species of *Melaleuca* on the edge of the lake and in the shallows. This would also have the effect of locally lowering water temperature in summer and would reduce the incidence of algal growth.

As well as establishing fringing wetland vegetation around the lake and a wetland buffer, it is important to establish or revegetate existing upland vegetation wherever possible (i.e. the northwest woodland) as this increases the range of habitats available to fauna. An area with both upland and wetland vegetation communities will enable a greater diversity of species of flora and fauna (Del Marco et al, 2004).

Refer to the Lake Claremont Implementation Plan Revegetation Section for further details on the strategic rehabilitation of Lake Claremont.

Recommendation 27

Investigate the potential for a band of emergent aquatic vegetation along the margins of the old refuse disposal site face to intercept any contaminants that may be leaching from the site.

Rationale

On the northeastern side of Lake Claremont is a former rubbish disposal facility and groundwater entering the lake has the potential to be effected by the leachate from this site. There are several potential courses of action that may be pursued if the monitoring program highlights a groundwater contamination problem, one of which is conducting revegetation works to establish a buffer of emergent aquatic vegetation along the margins of the former refuse site.

Vegetated buffers are key strategic elements among a series of protection barrier options that reduce the risk of contaminant impact on water quality (Department of Environment, 2005). Dense stands of rushes and sedges are fundamental to water quality protection and improvement through sediment trapping, nutrient cycling and the uptake and transformation of pollutants. Their root activity increases the infiltration capacity of the soil, which in turn reduces the amount of surface runoff and the amount of soluble pollutants that are transported into the waterbody (Water and Rivers Commission⁴, 2000).

Many species act as 'nutrient-strippers', accumulating significant amounts of nutrients in stems and rhizomes and supporting the bacterial transformation of nutrients and other pollutants on their extensive mass of roots and rhizomes (Water and Rivers Commission⁴, 2000). Certain emergent aquatic species are known as high nutrient assimilators such as *Schoenoplectus validus*, *Juncus kraussii*, *Eleocharis sphacelatus* and *Baumea articulata* (Water and Rivers Commission⁴, 2000). These species would be ideal to use along the margins of the refuse site to help reduce contaminants entering Lake Claremont, due to their fast growth rate and nutrient stripping ability. Using them as fringing vegetation would have the added benefit of stabilizing the bank and providing fauna habitat. Determining the width of the emergent aquatic vegetation required to adequately protect the water quality of the lake would require knowledge of what contaminants (if any) are entering from the refuse site. Different contaminants enter groundwater at varying rates and require buffers of various widths for adequate interception (Meney, 1999).

Recommendation 28

Council should conduct the Perth Biodiversity Project Natural Area Initial Assessment to identify if the remnant Tuart woodland on and adjacent to the Drive-in site is a Locally Significant Natural Area in accord with the Local Government Biodiversity Planning Guidelines.

Rationale

Ecological information for all natural areas under Local Government control should be collected using a standard template (Natural Area Initial Assessment templates) in order to enable identification and prioritisation of those areas for protection according to their ecological value and to assist with management planning.

As the vegetation in both the Tuart and Peppermint woodland adjacent to the Drive-in site is considered to be regionally significant, there is the potential that this vegetation would also be considered locally significant under the Local Government Biodiversity Planning Guidelines.

Recommendation 29

Council should introduce a Landscape Protection Zone into the Town Planning Scheme to encourage the conservation of urban bushland on private land within a redeveloped Drive-in site.

Rationale

The addition of a Landscape Protection Zone into the Town Planning Scheme will provide some means for managing and protecting the environmental values of the Drive-in site.

Recommendation 30

That Scotch College be requested to implement a revegetation program in its lands abutting the lake with advice from the Town of Claremont.

Rationale

To be effective, vegetated buffers should extend the entire wetland perimeter and be of the maximum width possible to provide the most value in terms of fauna habitat and nutrient stripping abilities. As the Scotch College oval is located very close to the western edge of the lake there is the potential for runoff containing nutrients to enter Lake Claremont. Therefore it would be beneficial for some revegetation works to occur on Scotch College land in order to achieve an adequate level of fringing wetland vegetation. Technical advice from the Town of Claremont as to suitable species and techniques for revegetation would ensure works are in line with best management practices.

3.7 FIRE

3.7.1 Objective

- 1) To suppress the incidence of uncontrolled or unauthorised burning of the Bulrushes or of the bushland.

Recommendation 31

That the Town of Claremont rationalise the existing fire breaks and ensure that the firebreaks provided are adequate.

Rationale

An uncontrolled fire can have detrimental biological effects on native flora and fauna. At the end of summer, the dry *Typha orientalis* in the northern area of Lake Claremont poses the greatest fire risk, as the senescent leaves become highly flammable as they dry out. Any resulting fire would be classed as a hot fire and prove difficult to extinguish due to the terrain and potential distance from the bank. It's also possible that a *Typha* fire in the wetland could cause a ground fire.

A reduction in the amount of *Typha* through staged weed control would reduce the fire risk, with a long-term view of replacing all of the *Typha* with native species. In the short term, a 10m firebreak should be cut around the *Typha* to isolate it from the edge as well as from other stands of *Typha*. This will make it more difficult to start a fire and reduce the loss of habitat if a fire does occur. For further details on fire management of *Typha orientalis* refer to the Lake Claremont Implementation Plan Revegetation Section.

There are numerous firebreaks within the Tuart woodland in the northwest corner of the site. There may be an opportunity to rationalise these firebreaks to reduce the level of disturbance to the bushland and control access.

3.8 ENVIRONMENTAL EDUCATION

3.8.1 Objectives

- 1) To provide opportunities for the local community and the general public to enjoy and appreciate both the active and passive recreational potential that Lake Claremont has to offer.
- 2) To ensure that public use of the area is compatible with the conservation values of the lake.
- 3) To initiate a public education program so that the general public understands the environmental issues relating to Lake Claremont and is fully aware of the fragility of the lake's ecosystem and the need to preserve and protect the flora and fauna.
- 4) To provide the visiting public with interpretative information on the historical, environmental, indigenous, cultural and social aspects of the lake and its environs.
- 5) To increase public awareness of the activities undertaken by both the Town of Claremont and the Friends of Lake Claremont to improve the lake and its surrounds

Recommendation 32

That appropriate aesthetically designed signs be erected in the reserve including:

- (i) "Nature Conservation" signs at each entry to the reserve advising of the physical and biological properties of the reserve.
- (ii) Interpretive signage throughout the reserve to enhance visitor experience and appreciation of the historical, environmental, indigenous, cultural and social significance of the area.
- (iii) Rehabilitation signs maintained where revegetation of the indigenous vegetation is being undertaken.
- (iv) Signs detailing the restriction on the use of off road vehicles and allowing dogs on the reserve without a lead.

Rationale

Appropriately designed interpretive signage is an excellent means of conveying a message at a site. The recommendation is to divide the site into conservation and recreation zones and therefore signage to indicate the different areas of usage and the activity encouraged within these zones is extremely important, including:

- "Nature conservation" signs with background information
- "Dogs on lead" signs in conservation areas
- "Rehabilitation area" signs.

Appropriate signs should be used to indicate preferred points of access to the reserve.

Other interpretive signage provides useful site information, eg. local flora and fauna, indigenous significance and European history and should be designed to inform the wide range of visitors and recreational users of the Lake, so that they may appreciate the past and present land use.

Further information on the site could be made available in brochure format from the Town of Claremont offices, including self guided walks, restricted use zones and the rationale behind these restrictions.

Recommendation 33

That community awareness of the environmental issues relating to Lake Claremont is increased by use of resources such as:

- (i) Information to be compiled / prepared to inform the general public on the importance of Lake Claremont (including flora and fauna, biodiversity), local issues that have an adverse affect on the lake.
- (ii) Environmental awareness raising workshops (e.g. Living Smart, Great Gardens).
- (iii) Support the Water Corporation Waterwise Campaign.
- (iv) Support the Waterwise Schools Program.
- (v) That local schools are involved in Lake Claremont on-ground activities.
- (vi) Investigate opportunities to use the Lake Claremont Golf Course building for static awareness raising activities.

Rationale

There is a vast range of environmental information available for use in community awareness raising programs. Much of this can be easily tailored to suit specific areas and messages to be conveyed. Common sources of information include Water Corporation, Swan River Trust, regional and subregional catchment groups (eg. North Metro Conservation Group), Department of Environment and the Phosphorus Action Group.

Opportunities for workshops and information sessions are also offered by many of the environmental organisations. Examples include Living Smart (local government managed project), Great Gardens (Swan River Trust) and Sustainable Living courses (Environment House).

Another method for environmental information dissemination is through the education system, both at a school and tertiary education level. The Water Corporation Waterwise Schools Program is ideal for school level curriculum material and can also provide opportunities for linking into on ground activities at Lake Claremont.

Another opportunity unique to this site that can be investigated for a static display is the Lake Claremont Golf Course building.

Recommendation 34

That the Friends of Lake Claremont should be maintained with ongoing support from the Town of Claremont. Links are developed between the Friends of Lake Claremont and other Friends Groups.

Rationale

The Friends of Lake Claremont are a very active, well supported group of local residents. The Town of Claremont provides a level of support to this group and it is important that this is maintained to retain the impetus within the group.

There is also the opportunity to expand the membership from the new residents in the Drive-in site, and to investigate the feasibility of linking to other Friends Groups in the area. Already a link has developed between the Friends of Shenton Park Bushland, Friends of Allen Park and the Friends of Lake Claremont through the Bush to Beach walks and this could also be encouraged by the Town of Claremont through the provision of a level of support.

Recommendation 35

Raise general community awareness of the activities undertaken by the Town of Claremont and the Friends of Lake Claremont to improve the lake and its surrounds.

Rationale

Promotion of the activities at Lake Claremont within the community to raise awareness and encourage local engagement is extremely important to ensure that the activities of the group are locally supported.

There are a number of promotional opportunities within the Town of Claremont that are readily accessible including the local newspaper, Town of Claremont publications ("Town Talk") and links to the Town of Claremont website.

North Metro Conservation Group also provides opportunities for the promotion of Friends Group activities in their quarterly newsletter and through their networks that can be accessed by the Friends of Lake Claremont.

Recommendation 36

That as part of the environmental education program, the Town of Claremont consider a change of name of the area to include an appropriate aboriginal name.

Rationale

Lake Claremont has indigenous heritage significance. From earliest times, the lake and its environs was a rich hunting and gathering area for the Wadjuk-Nyungar people. The presence of the traditional owners persisted in some manner through to the 1960's. To raise community awareness regarding the cultural significance, the Town of Claremont could investigate a change of name to reflect the indigenous significance, accompanied by appropriate interpretive signage.

3.9 IMPLEMENTATION

3.9.1 Objective

- 1) To ensure effective implementation of the Lake Claremont Policy.
- 2) To ensure adequate reporting on the progress of the implementation of the Lake Claremont Policy

Recommendation 37

That the Town of Claremont be the responsible authority for the implementation of this policy. A Lake Claremont Committee, appointed by the Council, monitor and oversee the implementation of the policy. The Committee consists of two Claremont Town Councillors, one Nedlands City Councillor, the Mayor, one Scotch College Representative and six community members who have an interest in the well being of the lake. The Committee meet bimonthly and report to Council. The Committee should present an annual report to the Council detailing progress of the policy.

Rationale

The Council of the Town of Claremont is the responsible authority for the implementation of the Lake Claremont Policy. The Lake Claremont Committee was appointed by the Council to monitor and oversee the implementation of the policy. The rate of implementation of the policy will be dependant upon the resources and funding available. Priorities for implementation are detailed in Part Four of this policy.

Recommendation 38

Duties of the Lake Claremont Committee shall be to provide advice to Council on matters relating to:

- (i) The care and maintenance of Lake Claremont and its immediate surrounds
- (ii) The rehabilitation of Lake Claremont and its environs
- (iii) Plans for amenities proposed to Lake Claremont and its immediate environs
- (iv) Proposals for the Lake from the Friends Group

3.10 TERM OF THE POLICY

The 1992 Lake Claremont Management Plan was the basis for the 1998 Lake Claremont Policy, which has been reviewed to form this document. The degraded state of the lake indicates that the management policies defined in this document are relatively long-term.

An annual review of the progress in achieving the recommendations outlined in the policy should be conducted with a summary presented to Council. A full policy review should be conducted at the end of the term of the implementation plan.

Once rehabilitation of the lake and surrounds has been achieved, the policy will require amendment to a maintenance program document, which should be a flexible program to take account of changing climatic conditions and human activities.

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Figure 1: Aerial map of Lake Claremont

Figure 1: Aerial Map of Lake Claremont



1:15,000

Figure 2: Land ownership of Lake Claremont

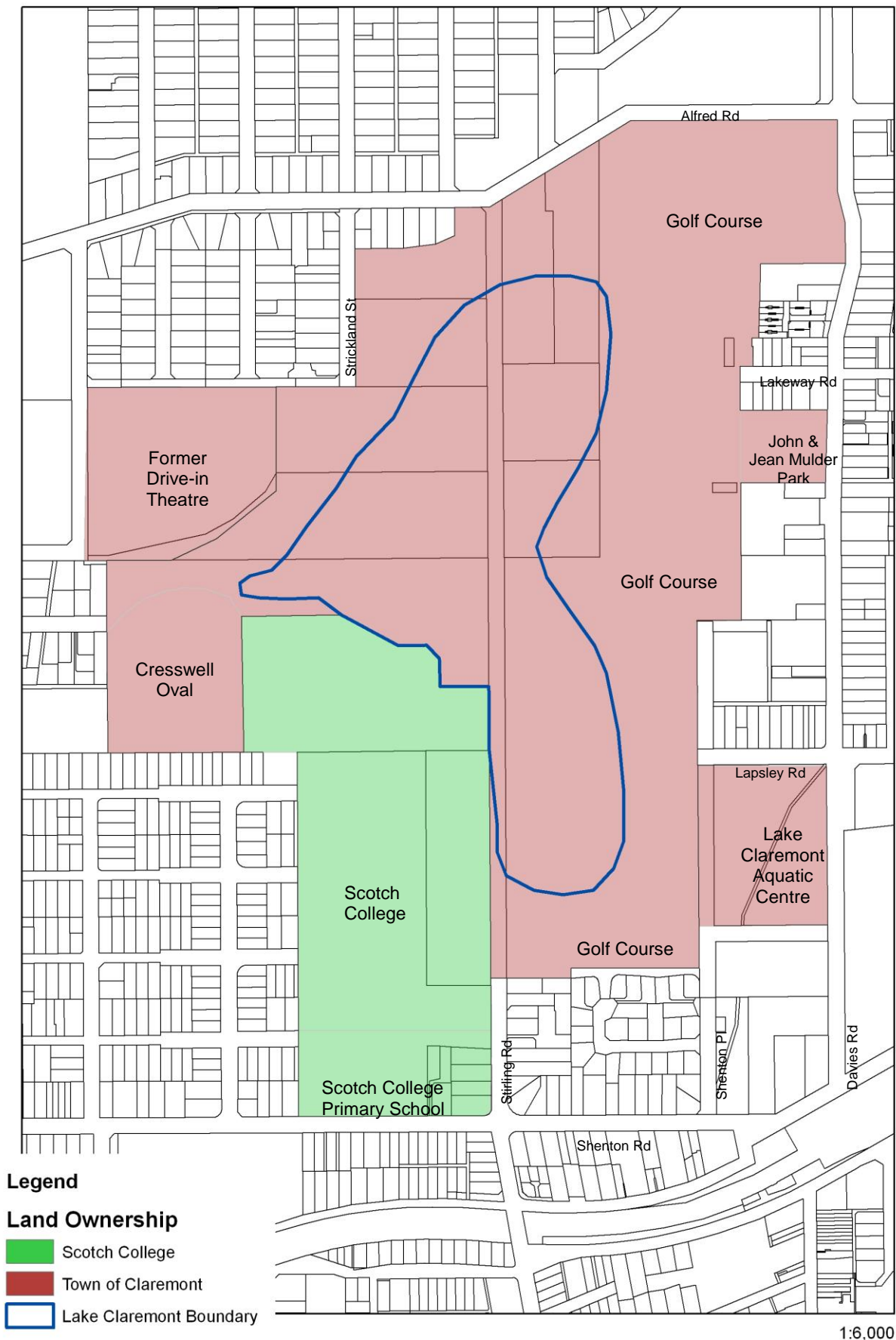


Figure 3: MRS Zoning of Lake Claremont

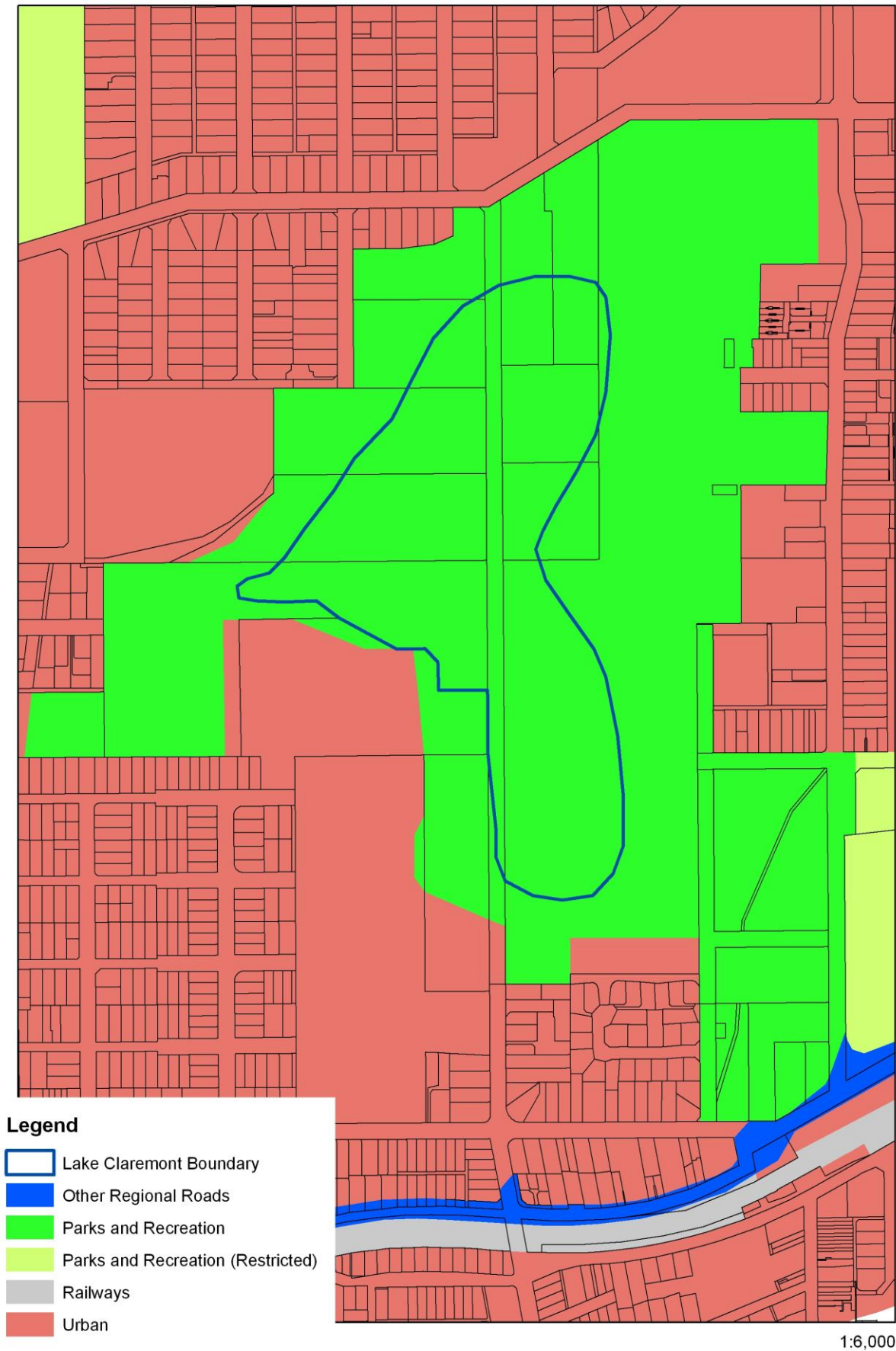
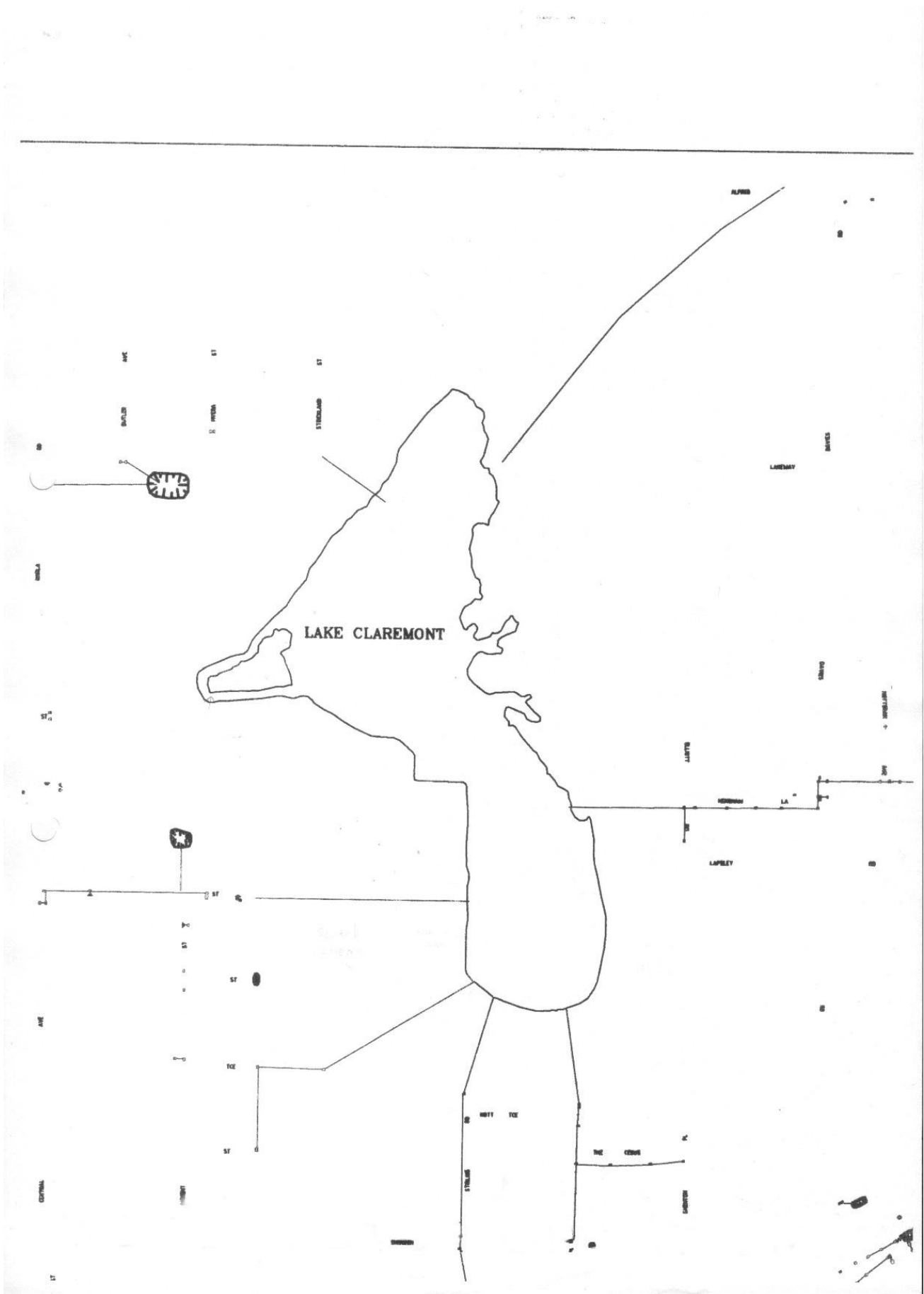


Figure 4: Stormwater drains entering Lake Claremont



APPENDIX 1: Local Biodiversity Planning Guidelines. Part A, Section 3 – Legislation and Policies

3. Legislation and policies

There are numerous international arrangements, as well as Federal, State and Local laws and policies that are linked to biodiversity conservation. Local biodiversity planning will enable Local Governments to meet their responsibilities under these laws and policies as well as achieve sustainable development and natural resource management (NRM) objectives. The key message is that the 'bar' is being lifted: all land owners, planners, managers and developers and Local Governments will need to perform to a higher standard to meet expectations created by legislation and policy as well as the expectations of the community.

Legislation and policies particularly significant for the preparation of Local Biodiversity Strategies is discussed in more detail below.

LEGISLATION AND POLICIES

3.1. Federal Government legislation and policies relating to biodiversity

3.1.1. Federal Government legislation

The most significant Federal Government legislation relating to biodiversity is the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Environment Protection and Biodiversity Conservation Act 1999

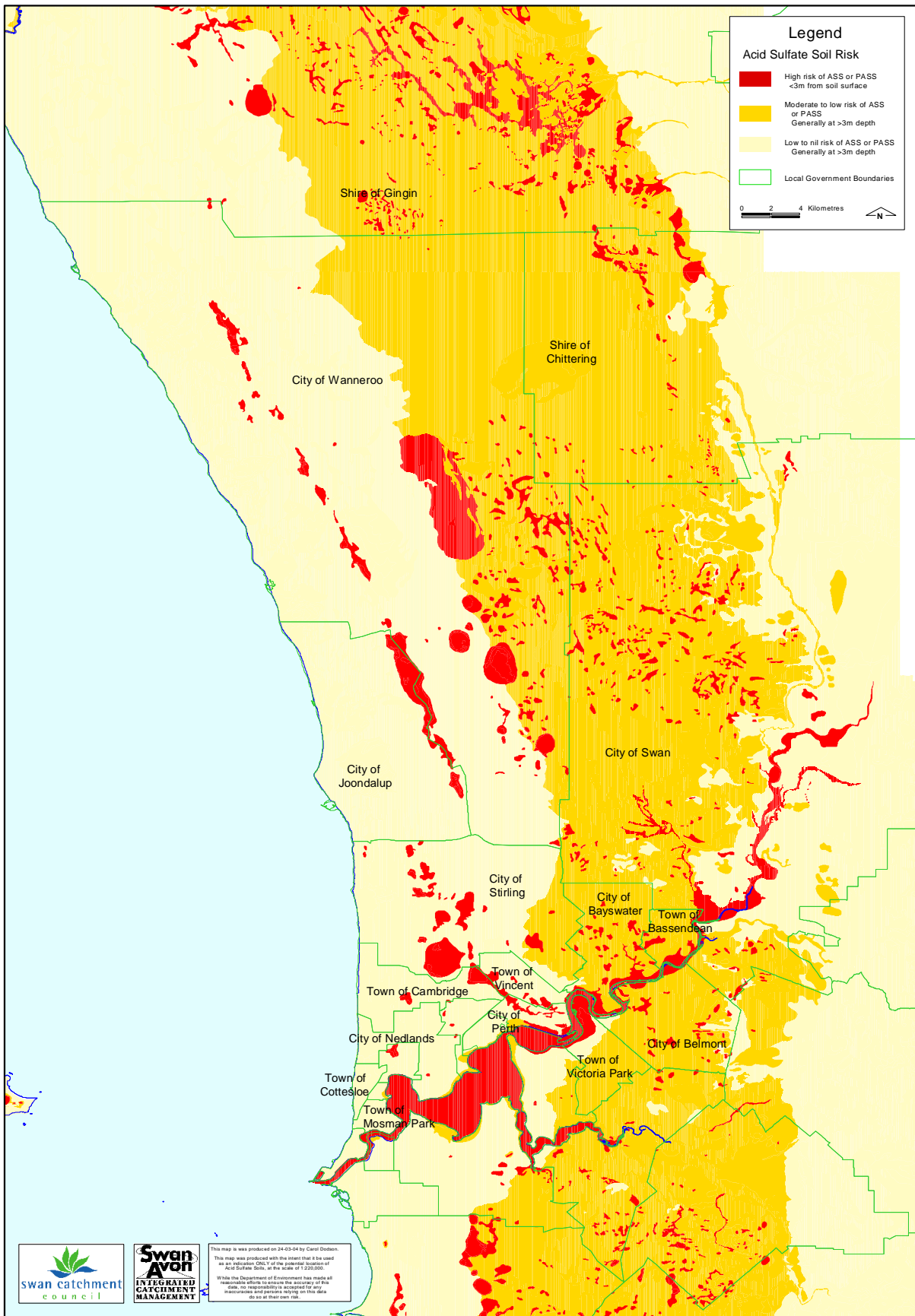
The EPBC Act provides for the assessment of actions, which, if implemented, may significantly impact on a matter of national environmental significance. There are seven matters of national environmental significance that are triggers for Commonwealth assessment and approval (Department of the Environment and Heritage 2003). These are:

- World Heritage properties
- National Heritage places
- wetlands which are listed as Ramsar wetlands of international importance
- nationally threatened species and communities which are listed under the EPBC Act (note that these species may not be the same as those listed under State legislation)
- migratory species that are listed under the EPBC Act (these are migratory species protected under international agreements)
- nuclear actions, including uranium mining
- the Commonwealth marine environment (which is generally Australian waters beyond the 3 nautical mile limit of State waters).

Under the EPBC Act a person must not take an action that has, will have or is likely to have a significant impact on any of these matters of national environmental significance without approval from the Commonwealth Environment Minister. There are penalties for taking such an action without approval (Department of the Environment and Heritage 2003).

Listings of Threatened Ecological Communities under the Federal EPBC Act are about two years out of date with current State of Western Australia listings. In addition, only those ecological communities in Western Australia identified as 'critically endangered' are identified under the Act. The communities within the Perth Metropolitan Region (PMR) currently listed under the EPBC Act are presented in Section 16.4.

APPENDIX 2: Acid Sulphate Soils Risk Map



APPENDIX 3: List of Bird species observed at Lake Claremont

Common Name	Species
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>
Australasian Shoveler	<i>Anas rhynchotis</i>
Australian Hobby	<i>Falco longipennis</i>
Australian Kestrel	<i>Falco cenchroides</i>
Australian Magpie	<i>Gymnorhina tibicen</i>
Australian Raven	<i>Corvus coronoides</i>
Australian Ringneck	<i>Barnardius zonarius</i>
Australian Shelduck	<i>Tadorna tadornoides</i>
Australian White Ibis	<i>Threskiornis molucca</i>
Australian Wood Duck	<i>Chenonetta jubata</i>
Black Swan	<i>Cygnus atratus</i>
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>
Black-fronted Dotterel	<i>Elseyornis melanops</i>
Black-shouldered Kite	<i>Elanus axillaris</i>
Black-winged Stilt	<i>Himantopus himantopus</i>
Blue-billed Duck	<i>Oxyura australis</i>
Brown Goshawk	<i>Saccipiter fasciatus</i>
Brown Honeyeater	<i>Lichmera indistincta</i>
Buff-banded Rail	<i>Gallirallus philippensis</i>
Chestnut Teal	<i>Anas castanea</i>
Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>
Dusky Moorhen	<i>Gallinula tenebrosa</i>
Eurasian Coot	<i>Fulica atra</i>
Galah	<i>Cacatua roseicapilla</i>
Glossy Ibis	<i>Plegadis falcinellus</i>
Great Cormorant	<i>Phalacrocorax carbo</i>
Grey Butcherbird	<i>Cracticus torquatus</i>
Grey Fantail	<i>Rhipidura fuliginosa</i>
Grey Teal	<i>Anas gracilis</i>
Great Egret	<i>Ardea alba</i>
Hardhead	<i>Aythya australis</i>
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>
Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Laughing Turtle-dove	<i>Streptopelia senegalensis</i>
Little Corella	<i>Cacatua sanguinea</i>
Little Eagle	<i>Hieraaetus morphnoides</i>
Little Grassbird	<i>Megalurus gramineus</i>
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>
*Long-billed Corella	<i>Cacatua tenuirostris</i>
Magpie Lark	<i>Grallina cyanoleuca</i>
Marsh Sandpiper	<i>Tringa stagnatilis</i>
Nankeen Night Heron	<i>Nycticorax caledonicus</i>
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>
Night Heron	<i>Nycticorax caledonicus</i>
Pacific Black Duck	<i>Anas superciliosa</i>
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>
Purple Swamphen	<i>Porphyrio porphyrio</i>
Rainbow Bee-eater	<i>Merops ornatus</i>
*Rainbow Lorikeet	<i>Trichoglossus haemotodus</i>
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>
Red Wattlebird	<i>Anthochaera carunculata</i>

Sacred Kingfisher	<i>Todiramphus sanctus</i>
Silver Gull	<i>Larus novaehollandiae</i>
Silvereye	<i>Zosterops lateralis</i>
Singing Honeyeater	<i>Lichenostomus virescens</i>
Spotted Turtle-dove	<i>Streptopelia chinensis</i>
Straw-necked Ibis	<i>Threskiornis spinicollis</i>
Striated Pardalote	<i>Pardalotus striatus</i>
Tree Martin	<i>Hirundo nigricans</i>
Welcome Swallow	<i>Hirundo neoxena</i>
Western Gerygone	<i>Gerygone fusca</i>
Whistling Kite	<i>Haliastur sphaerurus</i>
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>
White-faced Heron	<i>Egretta novaehollandiae</i>
White-fronted Chat	<i>Epthianura albifrons</i>
White-tailed Black Cockatoo	<i>Calyptorhynchus latirostris</i>
Willie Wagtail	<i>Rhipidura leucophrys</i>
Wood Sandpiper	<i>Tringa glareola</i>
Yellow-billed Spoonbill	<i>Platalea flavipes</i>