



Town of Claremont



LAKE CLAREMONT POLICY

Revised 1998

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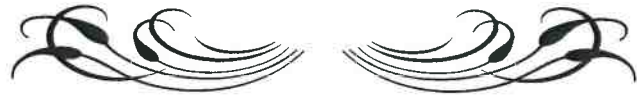
Revised 1998

**Prepared for the Lake Claremont
Committee**

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30 September 1998

TOWN OF CLAREMONT



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LAKE CLAREMONT POLICY

PART ONE

1.1 OBJECTIVES AND SUMMARY

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. 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.

Summary

Lake Claremont is a wetland that is a prominent urban landscape feature with considerable conservation value. It is a complex and dynamic ecosystem that should be carefully managed to preserve the diverse and abundant life in the water and the environs.

1.2 RECOMMENDATIONS

3.2 Land Use

Recommendation 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.

Recommendation 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.

Recommendation 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.

Recommendation 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.

Recommendation 5

That the Town of Claremont prepare a nutrient and irrigation plan for Cresswell Oval and Stirling Road park.

Recommendation 6

That Scotch College be requested to permit Council to construct vegetated wetlands on each required drain crossing its land.

Recommendation 7

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

Recommendation 8

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

Recommendation 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.

Recommendation 10

That Scotch College be requested to implement a re-vegetation program in its lands abutting the lake.

Recommendation 11

That modern appropriate picnic facilities be provided in suitable locations in John Mulder Park and Stirling Road Park.

Recommendation 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.

Recommendation 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;

- (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.
- (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.
- (d) Impose a fencing requirement to restrict access through the regenerating bushland.

Recommendation 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.

Recommendation 15

Council should permit access on the golf course of persons, other than those playing golf, in accordance with a local law.

3.3 Water Quality

Recommendation 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.

Recommendation 17

Council should seek a range of professional advice on means to improve water quality in the lake.

3.4 Water Levels

Recommendation 18

That an education/awareness program be developed jointly by 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.

Recommendation 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.

3.5 Fauna

Recommendation 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.

Recommendation 21

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

Recommendation 22

The depth of the water between the islands and the bank could be increased to provide a refuge from predators.

Recommendation 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.

Recommendation 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.

Recommendation 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.

Recommendation 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.

3.6 Vegetation

Recommendation 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.

Recommendation 28

That the Town of Claremont control bulrush in areas where it has spread recently.

Recommendation 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.

Recommendation 30

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

Recommendation 31

That the Town of Claremont continue a vegetation rehabilitation program with specialist advice that will achieve the following objectives:

- * Regrade the lake edges to create suitable conditions for the survival of a 10 metres buffer of fringing wetland vegetation.
- * 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.
- * Indigenous species of trees to be planted on the golf course to promote the fauna of the area.
- * 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.

Recommendation 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.

Recommendation 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.

Recommendation 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.

3.7 Fire

Recommendation 35

That the Town of Claremont obtain professional advice on rationalising the existing fire breaks and ensuring that the fire breaks provided are adequate.

3.8 Environmental Education

Recommendation 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.

Recommendation 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.

Recommendation 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.

Recommendation 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.

3.9 Implementation

Recommendation 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.

Recommendation 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.

PART TWO

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.

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 has been recognised by the System Six Study which recommended that the Claremont Town Council in consultation with the Department of Conservation and Environment, prepare a management plan for the area. Important management considerations noted include: only allowing recreation activities which are compatible with the conservation of flora and fauna; improving the lake's value as summer refuge for water birds; and the area's potential for water.

Since then, the State Government has issued the *Wetlands Conservation Policy* (1997) in which it states, amongst other things,

“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..."

In addition, both the State Government and the Western Australian Municipal Association are in the final stages of preparation of documents to assist in the management of urban bushland. The State Government published a Draft Urban Bushland Strategy (1994) which set out the criteria for identification of locally significant bushland.

"Significance is determined by meeting one or more of the criteria

- * size should be greater than 4 hectares, but can be smaller;
- * shape does not have to be regular, but preferably not too elongated;
- * vegetation in fair to excellent condition;
- * representative of a local vegetation system;
- * possible presence of rare or endangered flora or fauna;
- * suitable for scientific research;
- * used for recreation for local people;
- * used for education by local primary and secondary schools;
- * local heritage value."

WAMA has produced a draft document Local Government and Natural Resource Management (1998) in which it indicates that local government may seek to create a Landscape and Conservation Zone for locally significant urban bushland and wetland. The document recommends, amongst other things,

- 11.3.1 That the State Government recognise the increased pressure it has placed on Local Governments by changes to state policies and agency restructure to manage bushland and wetlands. A commitment is sought from the State Government that financial and other resource assistance will be provided to Local government to increase its technical expertise in this area."

The draft report by the CSIRO, Beyond Roads Rates and Rubbish Volume 2 (1998), provides a legislative overview. This Lake Claremont Policy should be read in the light of changing policies and practices at State and Commonwealth government levels.

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 paper bark 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. 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 which 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 a 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, between 1991 and 1998 the Town of Claremont has undertaken the following major works in the Lake Claremont environs:

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

IMPLICATIONS FOR MANAGEMENT

- Whether the name of the lake should remain "Lake Claremont" or whether an appropriate aboriginal name should be added as an alternative name.

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 Claremont Golf Course and Cresswell Oval are owned by the Council, both properties are leased and the lessees are responsible for maintenance.

All land surrounding the Lake is zoned "Parks and Recreation" in the Metropolitan Region Scheme and, with the exception of the land owned by Scotch College Inc., is zoned "Recreation" under the provisions of the Council's District Planning Scheme. Land owned by Scotch College is zoned "Educational". Zoning of the land within the study precinct is shown in fig. 4. The former Lakeway Drive-In site has been zoned Residential and has been accorded a density of R20.

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 lower rate of transpiration.

FUTURE DEVELOPMENT

All that remains on the former Lakeway Drive-in site is the bitumen paving.

The density accorded to this site will allow the creation of approximately 50 lots, or alternatively, 80 grouped dwellings. Potential also exists to develop the land owned by Scotch College Inc. for educational purposes.

Under the provisions of the Town Planning and Development Act, a Council is required to review its Town Planning Scheme every five years. Section 7A1(b) of that Act requires the Town of Claremont to provide the Environmental Protection Agency with "such written information about the town planning scheme or amendment as is sufficient to enable the EPA to comply with section 48A of the EP Act in relation to the town planning scheme or amendment." Increased residential density will place even greater pressure on the ecology of the lake and recreational facilities surrounding the lake.

IMPLICATIONS FOR MANAGEMENT

- Disposal of additional storm water resulting from increased run off.
- Nutrient recharging of the lake water through surface water.
- Provision of safe and clearly defined public access points to the reserve.

2.4 The Human Environment

(a) 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 et al. 1989, i) 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. 1989,8).

During weekends and public holidays, there is an increase in people picnicking and participating in non organised sporting activities such as kite flying, frisbee throwing and children playing.

(b) Facilities

The golf course occupies approximately 57% of the reserve, (Lantzke et al 1989 7) 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 Mulder Park. Both of these facilities receive regular use.

The 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.

In addition to the foregoing, there is some 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 construction of courts on land previously used for parking. Lantzke et al.(1989,14) noted that Stirling Road car park was used generally by passive users, with the golf course carpark and the Cresswell carpark being used principally by golfers and hockey players respectively. Signage to facilitate access from public transport should be considered.

IMPLICATIONS FOR MANAGEMENT

- Provision of appropriate recreational facilities.
- Provision of additional car parking facilities.
- Provision of signage to facilitate access from public transport.

2.5 Physical Environment

(a) 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. Perth receives 870mm of rain per annum, 780 mm of which falls between the 1 April and 31 October.

It can be seen that since 1970, there has been a decrease in the ten month moving average. June, July and August has the highest mean monthly rainfall of 167mm, 162mm and 111mm respectively. December, January and February have falls of 7mm 10mm and 13mm respectively. Average maximum mean monthly temperature in the summer months of December, January, February and March are 27.5, 29.6, 30 and 28 respectively.

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 1979,145). 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 35).

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 1950,151).

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 1950,152).

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 longer term the phosphate adsorption capacity saturates and nutrients are readily leachable to the ground water, drains or lake.

IMPLICATIONS FOR MANAGEMENT

- Potential for nutrients to leach through the soil profile and to be transported to the lake.

2.7 The Hydrology

(a) General

Lake Claremont, like other wetlands of the Swan Coastal Plain appears to be a surface expression of the unconfined aquifer with water levels varying according to the elevation of the water table. Water tables vary seasonally, but are also affected by land use changes and ground water extraction. Surface drainage also affect the lake's water level and in Lake Claremont the discharge from a total of six drains empty into the lake and this has the effect of rapidly increasing the water level in the event of a significant fall of rain. Water levels are therefore influenced by both surface drainage and water table elevation.

(b) Water Levels

Water levels have been monitored by the Western Australian Water Authority since 1912 and the results are reproduced in figure 4. An examination of figure 4 shows that the water levels reached a maximum between 1956 to 1968 and have been falling since. There appears to be little correlation between the recorded rainfall and the water levels of the Lake, except that Perth has recorded a relatively low rain fall since 1973 and that the water level of the Lake has been falling since 1975.

Use of bore water from the unconfined aquifer for the maintenance of the adjacent playing fields and the Claremont Golf Course may be a factor in affecting the water levels although there has been no documented evidence of this.

The Perth Urban Water Balance Study (1987, Vol. 1, 27) documented salt water intrusion in the unconfined aquifer about 500 meters west of Lake Claremont (Environmental Protection Authority, 1990). Lantzke et al (1989) found long lasting salinity gradients in the north east section of the Lake which was attributed to inflowing ground water. A consultant employed by Scotch College, Terraqua Pty. Ltd., has reported that a bore servicing the senior school, recently suffered salt water intrusion.

(c) 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 April 1970 to October 1986. Measurements of total coliforms, faecal coliforms, biological oxygen demand (BOD), suspended solids, total dissolved solids and the pH, nitrogen and heavy metals were taken twice yearly. Reactive and total phosphorus, pH and 6 common ions (Cl; HCO₃; SO₄; K; Ca; Mg) were measured at 4 sites in 1987-88. Reactive and total phosphorus at the south end were measured in 1993-96 and several forms of nitrogen, chlorophyll and algal numbers in early 1993.

The following is a summary of these data.

pH

pH is the measure of the relative acidity or alkalinity of water. Values below 7 indicate that the water is acidic and values above 7 indicate that the water is alkaline. If the pH is between 6.5 and 7.5, the water is effectively neutral.

The pH ranged from 7.6 to 10.2. The mean value over the sampling period was 8.75. The lake water is alkaline as would be expected given that the lake occupies the Spearwood dunes where the ground water picks up carbonate ions as it percolates through the calcareous sands.

Biological Oxygen Demand (BOD)

BOD is a measure of the amount of oxygen consumed by biological processes in the breakdown of organic matter. The more organic matter available, the higher the BOD (given the right conditions for bacterial decomposition) and the less dissolved oxygen concurrently available to other aquatic organisms. Algal blooms can lead to deoxygenation of lake waters and massive fish deaths. This occurs as a result of the increased oxygen consumption by bacterial decomposition of the algae.

The BOD was consistently higher in summer/autumn months than in winter/spring. It ranged from 7,400mg/1 to <100mg/1 throughout the sampling period. This level is 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 BOD as they are closed systems, are highly productive, and often eutrophic.

Total Dissolved Solids

TDS is a measure of the total dissolved solids in water and is equivalent to the salinity. The level of TDS recorded in Lake Claremont varied markedly on a seasonal basis. High concentrations occur in summer when the ions are concentrated by evaporation and low levels occur in winter when the lake is diluted by rain and ground water flow. Evaporatic concentration during summer yielded levels up to 8,900mg/L (8.9 parts per thousand) in 1981 and salinity of 16,000mg/L in March 1988. This is high for a fresh water wetland, (sea water = 35 parts per thousand). The lowest level was recorded in the winter of 1973 (669mg/L). TDS will vary according to annual rainfall and evaporation rates.

Suspended Solids

The level of suspended solids varied throughout the sampling period with peaks recorded in the summer/autumn of 1972, 1976, 1979 and 1982. It is likely that this is influenced by the concentrated nature of the lake waters in summer and the presence of planktonic blooms. It may also be related to inputs through drains entering the lake during unseasonal rains, however, this cannot be confirmed without further study.

Nutrients

Lake trophic ("nourishment") status is usually estimated on the basis of phosphorus and nitrogen concentrations in the water (Davis and Rolls (1987) after Wetzel (1975))

Table 1

Classification of Lake Trophic Status Based on Nutrient Concentration (mg/L)
(Davis and Rolls (1987) after Wetzel (1975))

Category	Total P	Total N	Inorganic N
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 maximum total nitrogen concentration recorded in Lake Claremont was 16.0mg/L in March 1983 and the highest total phosphorous concentration was 4.2mg/L in March 1984. Inorganic nitrogen concentrations reached a maximum of 1.8mg/L in September 1972. Based on Table X, Lake Claremont would be classed as hyper-eutrophic at the times of maximum concentrations in summer and somewhere between ultra-oligo and oligo-mesotrophic in the winter/spring when the lake is more dilute. This trophic status is common for freshwater wetlands in the metropolitan area.

Micro-organisms

Water that appears clean and pure may be sufficiently contaminated with pathogenic microorganisms to pose a health hazard. Indicator organisms are used to test the suitability of water for drinking and recreation. The 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.

Total coliforms were relatively high in the early 1970's decreasing after 1972 until they increased again in 1982. The highest level of total coliform was 2,300 counts/100mL in the summer of 1972. Faecal coliforms ranged from 0 counts/100mL in the summer of 1973 to a maximum of 27,000 counts/100mL in summer of 1981. Numbers of coliforms were generally highest in the summer months when water levels were low and the lake was most concentrated. High counts may be related to presence of waterbirds. 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 ground water contaminated with coliforms from septic tanks. It is unlikely, however, that this source is responsible for the high counts in the summer of 1981.

Botulism is also a problem during the summer months in a number of the urban wetlands and compensating basins. It is caused by the bacterium *Clostridium botulinum*. The organism occurs naturally in low concentrations but under certain conditions (ie. warm conditions and low lake levels) concentrations can become excessive infecting waterbirds, generally resulting in large numbers of bird deaths.

In terms of the suitability of the water of Lake Claremont for recreation, the water level criteria for primary contact recreation (ie. swimming) is a median value not exceeding 150 faecal coliforms per 100 mL for a minimum of 5 samples. These samples must be taken at regular intervals not exceeding 1 month with 4 out of 5 samples containing less than 600 faecal coliforms per 100mL (NHMRC, 1990).

The criteria for secondary recreation (ie wading and boating) is a median value of 1000 organisms per 100 mL recorded as stated above with 4 out of 5 samples containing less than 4000 organisms per 100mL (NHMRC, 1990). From these criteria and based on the available data for the lake, Lake Claremont should not be used for primary or secondary contact recreation during the summer months, especially in years where water levels are particularly low.

Heavy Metals and Other Pollutants

Six heavy metals were tested for in Lake Claremont between 1976 and 1986. The range of levels for each is as follows:

Chromium <0.02-0.02	Zinc <0.01-0.05	Cadmium <0.01-0.01
Lead <0.04-0.12	Copper <0.01-0.03	Mercury <0.002-0.002

Sources of heavy metals include leachates from beneath rubbish tips, commercial sites (eg. electroplating, metal fabrication), industrial sites and runoff from roads and the urban areas. Heavy metals such as zinc, cadmium, lead, chromium and mercury cannot be metabolised and excreted by organisms and are accumulated by the biota and sediments of wetlands. In the case of Lake Claremont, the major sources of heavy metals 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 Zn and Pb in coarser particulates and Cd and Cr in finer particulates. The concentrations of heavy metals in the water column do not appear high enough to be of concern and their disappearance after 6 months suggests they precipitate as would be expected in the alkaline, bicarbonate rich water. The level 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.

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 which often enter wetlands through storm water runoff. The sampling of Lake Claremont has not included these other pollutants.

It should be noted that pesticide sources include house pads treated for white ants, garden herbicides and pesticides, and the direct application of insecticides and larvicides to control midge and mosquito populations. Organochlorins are relatively insoluble in water and persist in the environment, accumulating in aquatic food chains.

Organophosphates are water soluble and less persistent. They are associated with the treatment of wetlands for midge control eg. 'Abate' and 'Dursban'. These pesticides can have undesirable effects like the destruction of the natural predators of the midge which may cause problems in the long term. Other wetlands (Lake Neerabup, Carabooda, Goollelal, Mariginiup and Loch McNess) are reported as having greater than trace amounts of pesticides in the sediments (Davis et al, 1990). Local residents should be encouraged to use more environmentally friendly products for pest control.

Drainage

There are six drains that empty into Lake Claremont. There is also a recharge pipe coming from Scotch College grounds, entering the "south arm" of the lake. It removes excess water in the winter and is operated by a pump. Elevations of lake 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.

IMPLICATIONS FOR MANAGEMENT

- Water Quality
 - (a) High nutrient content in the lake.
 - (b) Heavy metals have the potential to enter the food chain.
 - (c) Human and animal health risks posed by water contact.
 - (d) Potential for environmental impact from pesticides used to control midges and mosquitos.
- Water Levels
 - (a) Potential for salt water intrusion to impact on deep rooted plants and bore water quality.

2.8 The Biotic Environment

- (a) Vegetation

The indigenous vegetation of the area has been recorded by Morris and Knott(1977,145) and is believed to have consisted of a central swamp zone of Paper Barks (*Melaleuca raphiophylla*), with Tuarts (*Eucalyptus gomphocphala*) and Blackboys (*Xanthorrhaea presissii*) surrounding small water holes. Rising waters resulted in many of the Paper Barks 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 north eastern side of the Lake. On the sloping ground to the north west of the lake there is a reasonably large stand of Tuarts that extend to an area south of the Lake way Drive-In.

Tree planting programs has resulted in a number of introduced Australian native eucalyptus, figs, and a number of introduced exotic trees and plants becoming established around the lake, particularly in the golf course. In the period between 1991 and 1998, a number of introduced specimens have died and the opportunity exists to replace them with indigenous vegetation.

A survey has shown that the following is representative of the dominant species of trees that now exist in and around the lake and its environs.

- | | |
|-----------------------------------|--------------------|
| • <i>Ficus macrophylla</i> | Moreton Bay Fig |
| • <i>Ficus rubiginosa</i> | |
| • <i>Eucalyptus rudis</i> | Swamp Gum |
| • <i>Eucalyptus camaldulensis</i> | Red River Gum |
| • <i>Eucalyptus St. johnii</i> | Sydney Blue Gum |
| • <i>Eucalyptus globulus</i> | Tasmanian Blue Gum |
| • <i>Washington filifera</i> | Palm |
| • <i>Pinus pinea</i> | Stone Pine |
| • <i>Agonis flexusa</i> | Western Peppermint |

Lantzke et al. (1989 77) 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.

(b) 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. 1989,4).

A total of 71 species of birds were documented by Lantzke et al, (1989,19) 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 have declined significantly. The most common of the 87 species recorded in bird census carried out for the Town of Claremont between 1993 and 1996 were 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 include:

- (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 with planting of more local species both in number and density 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.

Since 1992, 32 species of bird have been 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, 7 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 since 1992. The least well used areas include all grassed areas and the bird sanctuary island. The openness of grassed areas and the regular human traffic deter most birds from any usage other than using them for a travel corridor. The bird sanctuary is actually connected with golf course and is littered with building rubble and is over run 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.

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 such animals as the local Ring Tail Possum (a 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 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 are 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).

IMPLICATIONS FOR MANAGEMENT

- Degradation of the indigenous vegetation community
- Invasion by exotic plant species
- Need for enhancement of habitat to encourage use by native fauna
- Impact of human activity on use of some areas by wildlife

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.

IMPLICATIONS FOR MANAGEMENT

- Illegal burning of wetland habitat
- Fire breaks

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 mosquitos and midge
 - 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 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 1 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.

IMPLICATION FOR MANAGEMENT

- Nutrient limitations in the lake need investigation

Phosphorus dynamics in Lake Claremont

Discharges to any lake bring nutrients, including phosphorus. Some phosphorus is readily bio-available (reactive phosphorus) and some is less accessible, but can be freed. The plants in, and adjacent, the lake contribute phosphorus in fallen material, taken up from the sediments by their roots. Phosphorus in the sediments may also be released directly.

Technical descriptions of Lake Claremont's phosphorus dynamics are contained in Lantzke et al 1989, and the 1998 Lake Claremont Management Review, and references therein. In general terms the situation appears to be as follows.

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 sorbs reactive phosphorus, in a reversible equilibrium process.

The speed of this process probably 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 sorption becomes weak, and most of the bioavailable phosphorus held in the sediments will be released.

The policy aims at reducing phosphorus and other unwanted inflows, and limiting the concentration of bio-available phosphorus in the water.

PART THREE

PLANNING ISSUES AND RECOMMENDATIONS

Note: The 1992 Management Plan recommendations are included with the relevant 1998 revised recommendations and are prefixed by (1992:#)

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. 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 Land Use

3.2.1 Effect of Proximate Land Use on Water Quality

3.2.1.1 Objectives

- (a) To reduce the nutrient, heavy metal and sediment load of surface and ground water entering the lake.
- (b) Reduce the number of drains emptying directly into the lake to the absolute minimum.
- (c) To provide drainage sumps constructed as mini wetlands to receive the discharge of any drains before they empty into the lake.
- (d) 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.
- (e) 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.

- (f) In the event that evidence is obtained to show that leaching of contaminants is occurring and resulting in pollution of the lake, determine the most appropriate steps to be taken.
- (g) To identify the influence, of ground water quality and other consequences of refuse disposal, on vegetation on the refuse disposal site.

3.2.1.2 Rationale

3.2.1.2.1 Surface Drainage

Lake Claremont is currently used as a drainage sump to dispose of storm water and excessive ground water from roads and private property. There are six drains discharging into the lake, of which only one has some form of oil and grease trap and another which has verge storm sumps.

Many factors besides nitrogen and phosphorus concentrations can contribute to excess algal growth, but the best identified and least difficult to control is the concentration of bio-available phosphorus. Clearly some consideration must be given to the phosphorus source.

Lantzke et al. (1989,62) noted that to determine the precise quantity of phosphorus added to the lake would require continuous gauging and analysis of all drains over the entire twelve months. An estimation of the average phosphorus concentrations in the top 1 centimetre of the lake sediments is 3.37 tonnes (Lantzke 1989,70).

A significant portion of the phosphorus entering the lake is carried in stormwater and originates from surrounding privately owned land. An education program aimed at reducing excessive fertiliser use and containing on site of plant detritus, detergent spillage and car washings would further reduce the phosphorus discharge into the lake.

A first step should be to prevent any extension of the current drainage system, or new drains being permitted to discharge into the lake. Where discharge into the lake cannot be avoided, the drains should discharge into constructed wetlands revegetated with indigenous species.

Professionally designed oil and grease traps installed in all those drains that collect water from roads, sealed car parks and industrial areas, upstream from the constructed wetlands, would trap significant quantities of pollutants before they enter the constructed wetlands.

3.2.1.2.2 Ground Water Drainage

There is a natural ground water inflow from the north east to the south west. This direction of flow is to be expected from the published ground water contours of the Gngara Mound. (Allen, 1976; Water Authority of Western Australia 1981 Quoted in Lantzke 1989, 29). It is believed this ground water flow is important for maintaining water levels and in flushing away salt from the lake. It is not known what other effects this ground water flow has on the quality of water in the lake. A significant documentation of the ground water inflow, outflow and catchment to the lake, was undertaken by Bunny and Ruiz-Avila (1995) at the request of the Lake Claremont Management Committee. The extent of ground water inflow to the lake is unknown and the recent water table levels raise the question of whether there has been a change to the significance of this water source.

Minimising the use of fertiliser, consistent with acceptable standard of turf management, will assist in reducing the nutrient input to the lake from the major proximate land users, viz. the golf course, Stirling Road park, Cresswell Oval and Scotch College ovals. The grassed area north of Alfred Road is also important as a potential contributor of nutrient input into the lake and the co-operation of the City of Nedlands should be sought in this regard.

Another possible source of nutrients could be from septic tanks, particularly as the low lying residential areas in the catchment area are unable to connect to the reticulated sewer.

No record of the quantity of ground water being extracted to maintain the turf of the major proximate land users is available. Minimising the use of ground water extraction, consistent with acceptable standard of turf management, will assist in maintaining a higher water table during summer and reduce the need for fertiliser applications to replace leached nutrients.

There is potential for intrusion of salt water to reach the lake environment (as indicated in Figure 1)

The drain currently discharging from Scotch College into the lake is contributing some nutrients. Reduced inflow will reduce the quantity of nutrients from this source. By discharging the drain into an open sump with appropriate fringing vegetation, the pollutants entering the lake should be significantly reduced. The sump should be designed similar to those proposed on the golf course and would be easily cleaned when dry each summer.

The nature of the refuse disposed on the refuse disposal site is not known nor what, if any, containment barrier is in place. Given this uncertainty, together with lack of knowledge of the extent of inflow of ground water into the lake, it is difficult to predict the effect of ground water leaching from the site to the lake. Until the nature and extent of pollution of ground water 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. Monitoring of any pollution from this source should be considered a priority.

3.2.1.2.3 Salt Water Intrusion

The extent of the salt water intrusion is largely determined by the rate of ground water outflow. Between the top fresh water and the (stagnant) bottom sea water is a 5 - 15 metre wide diffuse zone. The seasonal behaviour of the salt water wedge varies around the shores of the Swan estuary, but in 1985 the freshwater lens was about 15 metres thick in the vicinity of the Jarrad Street railway crossing (Careeg et al 1987, 29)

3.2.1.3 Management Strategy

3.2.1.3.1 Nutrient Input (Surface)

- (a) There should be no additional direct discharge of surface drainage into the lake via any drainage network. In all future developments within the Lake Claremont catchment area, storm water should be contained on site.

- (b) The vegetated sump proposed at the end of the drain originating in the subdivision known as Heritage Fields, should form a barrier between the park and the golf course.
- (c) Existing drains should discharge into constructed wetland filters heavily planted with appropriate indigenous vegetation. These wetland filters should also be designed so that sediment build up may be easily removed by light machinery each autumn.
- (d) All drains from roads, car parks and industrial zones should be provided with effective oil and grease traps prior to discharging into the wetland filter.
- (e) A monitoring program should be instituted to measure the effectiveness of the program in reducing nutrients in the lake. Water levels and samples should be taken monthly to provide a continuous record of nutrient concentrations of the lake.

3.2.1.3.2 Nutrient Input (Ground water)

- (a) Council should seek appropriate professional advice on the minimum quantities of fertiliser and water necessary to maintain the turf of major proximate land users in an acceptable condition.
- (b) The proximate major land users should prepare a nutrient and irrigation management plan for the information of Council. This plan needs to include a nutrient budget to ensure fertiliser and irrigation is minimised and could include provision for monitoring by Council.
- (c) Recommend to Scotch College that it implement a revegetation program in the part of their land fringing the lake.
- (d) Request Scotch College to ascertain the necessity for its sub-surface drain and Council to construct sumps at the mouth of each required drain to trap nutrients. The sumps to function as mini wetlands and to be designed to be accessible to light machines so that sediments trapped may be removed each summer.

- (e) An education program should be instituted to make owners/occupiers of land in the catchment area aware of sources of contaminants, the effects of excessive fertiliser and water use and of appropriate fertiliser rates and water regimes.
- (f) No new developments be permitted within the catchment area unless they are connected to a reticulated sewer.
- (h) Investigate if, or to what extent, contamination of ground water flowing into the lake from the refuse disposal site is occurring. This will require the appointment of specialist consultants and an appropriate allocation of funds in the Council budget.

Once the extent of the contamination of ground water from the former refuse disposal site has been evaluated, determine course of action. Some of the options which may be considered are;

- Removal of refuse (if serious pollution is occurring).
- Implement an ongoing ground water monitoring program. (If investigation indicates pollution is not significant)
- Manage recharge of the refuse disposal site to reduce contaminant leaching.
- Take no action. (If there is no indication that pollution is occurring).
- Revegetate the refuse disposal site with suitable species.

3.2.1.3.3 Salt water intrusion (ground water)

As the potential for and likely impact of salt water intrusion is presently unknown, Council should consult with the Waters and Rivers Commission to develop a suitable ground water management strategy.

Recommendation 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.

(1992:1) *The Town of Claremont should employ a suitable consultant to investigate and report on the potential threat to health and lake water posed by the former refuse site.*

Recommendation 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.

Recommendation 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.

(1992:2) *The Town of Claremont should seek appropriate professional advice on the minimum quantities of fertiliser and irrigation necessary to maintain the golf course in an acceptable condition.*

Recommendation 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.

(1992:3) *The lessee of the Golf Course should be required to prepare a nutrient and irrigation management plan for endorsement by Council. This plan needs to ensure that water and fertiliser use is minimised. Once the plan is in place, it should be regularly audited by the Council.*

Recommendation 5

That the Town of Claremont prepare a nutrient and irrigation plan for Cresswell Oval and Stirling Road park.

Recommendation 6

That Scotch College be requested to permit Council to construct vegetated wetlands on each required drain crossing its land.

(1992:6) *That Scotch College be requested to;*

- (a) *Seek appropriate professional advice on the minimum quantities of fertiliser and water necessary to maintain the playing fields in an acceptable condition and as a student project, develop a nutrient and irrigation management plan to ensure that nutrient and water use are minimised.*
- (b) *Implement a re-vegetation program in its lands abutting the lake.*
- (c) *Construct vegetated wetlands at the mouth of each drain crossing its land*

Recommendation 7

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

(1992:9) *There should be no additional direct discharge of surface water into the lake via any new drainage network.*

Recommendation 8

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

(1992:10) *The Town of Claremont should ensure that all future developments within the Lake Claremont catchment area retain all storm water on site.*

(1992:11) *The Town of Claremont should initiate an investigation by appropriately qualified people to determine if there are alternative methods of disposing of water from the catchment area of the drains.*

Recommendation 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.

(1992:12) *The Town of Claremont should construct vegetated wetlands at the mouth of each drain to trap nutrients with a design that enables access by light machines, so that trapped sediments may be removed each summer.*

3.2.2 Effect of Proximate Land Use on Lake Environs

3.2.2.1 Objectives

- (a) Provide suitable picnic facilities in appropriate locations.
- (b) Preserve the north west area of the site adjacent to the Drive-in as a conservation and wildlife observation zone.
- (c) To revegetate the area, particularly the conservation and wildlife observation areas, with indigenous species.
- (d) Determine and provide required car parking. Car parks to be a natural sand or grassed surface, and not sealed.
- (e) Facilitate access for visitors travelling on public transport.

3.2.2.2 Rationale

Those areas adjacent to John Mulder Park and Stirling Road Park are the most suitable for picnic areas as they are adjacent to parking and play areas. In the north west area, below the former drive-in theatre, there are sensitive sand dunes with little understorey vegetation. Inappropriate activities in this area will further damage the sand dunes. This area with its natural stand of tuarts and peppermints is the ideal area to reserve for wildlife conservation. This area should continue to be revegetated with appropriate indigenous vegetation.

Location of car parks will to some degree determine to what extent the area is used by the general public. Limited car parking facilities should therefore be provided in the north western area to discourage inappropriate use of this portion of the reserve. A natural sand or grassed finish to the surface of the car parks will significantly reduce the storm water run off into the lake. Some additional car parking should be provided on the east side of Strickland Street by locally increasing the width of the carriageway by approximately 2 metres. It is believed that the number of car bays at Cresswell Oval is sufficient for the present time. The Committee should from time to time monitor the existing access points to determine if the car parking requirements are sufficient.

From general observation it appears that the area adjacent to Stirling Road is most popular for visitors and this would be the most appropriate area to construct public toilets providing it is possible to connect to the Hon. Ministers sewer.

3.2.2.3 Management Strategy

- (a) Modern appropriate picnic facilities be provided in suitable locations in John Mulder Park and Stirling Road Park.
- (b) That the north west area, below the former drive in theatre be reserved as a conservation and wildlife observation zone. The only public facilities to be provided in this zone should be an unobtrusive access path, possibly in conjunction with fire breaks.
- (c) That the areas reserved for passive recreation be revegetated with indigenous species of vegetation. Stirling Road park may be a suitable site to plant non endemic trees of other Australian damplands.
- (d) Determine and institute appropriate fertiliser and irrigation management.
- (e) Determine appropriate car parking in the Stirling Road area and John Mulder Park to encourage the use of the picnic and other public facilities in these locations.

Recommendation 10

That Scotch College be requested to implement a re-vegetation program in its lands abutting the lake.

Recommendation 11

That modern appropriate picnic facilities be provided in suitable locations in John Mulder Park and Stirling Road Park.

(1992:7) *That the existing picnic facilities be removed from the north west corner of the of the reserve and modern appropriate facilities be provided in suitable locations in John Mulder Park and Stirling Road Park.*

Recommendation 12

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

(1992:8) *That the north west area of the reserve, below the former drive in theatre site, be reserved as an a conservation and wildlife observation zone. The only public facilities to be provided in this area should be an unobtrusive path.*

3.2.3 Lakeway Drive-in Site

3.2.3.1 Objectives

- (a) To prevent or ameliorate any adverse effects that development of this site may have on the Lake and environs.
- (b) To retain existing vegetation and contours of the land to be developed.
- (c) To educate future residents in the most economical use of ground water and fertiliser.
- (d) To ensure that vegetated buffers are provided on the southern and south eastern embankments.
- (e) Provide a 6.6 metre height restriction on any proposed development on this site as per Clause 40 (2) of the Town of Claremont Town Planning Scheme # 3.
- (f) To ensure access from the site to the lake is possible only at appropriate points through a developer's fence or wall by means of a constructed path.

3.2.3.2 Rationale

It is likely that the former Lakeway drive in site will be developed for residential use. Development of this land will bring new concerns for management of the lake, including increased ground water extraction, greater storm water run off, 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 residential development, it is essential the stormwater runoff is retained on the site. Retention of existing, and additional planting of, vegetation on the embankments and sand dunes will assist in preventing further degeneration of these areas. It is desirable to restrict uncontrolled access from any proposed residential lots through the regenerated bushland to the reserve. It is undesirable that residents dump garden waste on the reserve as this is a likely source of exotic plants and weeds. An education program could reduce the incidence of dumping of garden refuse on to the reserve and increase awareness of the impact of domestic and feral animals on the wildlife.

The 6.6 metre height restriction should be implemented to assist in aesthetic considerations. To ensure that there can be no exceptions, the Council should not have the discretion to grant approval for a greater height than 6.6 metres.

Management Strategy

- (1) Prior to the Former Lakeway Drive-in site being developed the Council by means of a caveat on the Title Deed, ensure;
 - (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 of in a suitably designed sump in the north west section of the site.
 - (b) Retention of the existing vegetation should be a consideration when considering redevelopment proposals.
 - (c) All buildings on the site are limited to a maximum height of 6.6 metres as per Clause 40 (2) of the Town of Claremont Town Planning Scheme # 3.
 - (d) That a fencing requirement is in place to restrict access to the bushland.
- (2) Council should undertake a program to educate residents living in the vicinity of Lake Claremont of the consequences of excessive fertiliser and water use and dumping of garden waste in the reserve.
- (3) Council should protect the existing embankment from further degradation, by providing dense vegetation on the southern and eastern embankments.

Recommendation 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;

- (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.

- (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.
- (d) Impose a fencing requirement to restrict access through the regenerating bushland.

(1992:4) *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;*

- (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.*
- (b) *Retention of the existing vegetation where possible.*
- (c) *That dense vegetation is provided on the southern and eastern embankments and within a 15 metre distance of the embankment.*
- (d) *Restricting the height of all buildings on the site to a maximum of 6.6 metres.*
- (e) *That a fencing requirement is in place to restrict access to the bushland*

Recommendation 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.

(1992:5) *That the Town of Claremont 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 water in the reserve.*

3.2.4 Golf course access

3.2.4.1 Objective

- (a) To provide an easily identifiable, safe and convenient access around the lake

3.2.4.2 Rationale

Many residents of the Town of Claremont and surrounding areas have an expectation that they should have access to all parts of the lake.

As Council's by laws have restricted access on to the golf course since the course was first opened, there has been a conflict between what residents expected (and did) and what Council authorised.

Fundamental to the issue of access to the lake, where it adjoins the golf course, is the question of safety. There are consequent issues of legal liability and capacity to operate a golf course with adequate insurance cover. Given that casual access on to the golf course during playing times creates a danger for walkers and others which is greater than that for golfers, Council must consider the issue of safety of access. Council, as owner of the course, and any lessee must also be cognisant of the legal liability arising from allowing or encouraging access on the course of persons other than those playing golf (at least during playing hours). Any lessee must be required by Council to carry adequate insurance to cover liabilities arising from the operation of the course. Council must provide any lessee with the conditions as would reasonably enable the lessee to carry out the operations of the course under the terms of the lease.

As part of the negotiations for the lease of the golf course in the early 1990s, agreement was reached to erect three barrier fences to prevent inadvertent access to the golf course by people walking around the edge of the lake. Access was to be possible around the end of those fences and access was to be open when golf was not being played (generally understood to be dusk to dawn). As part of the lease arrangements, a boundary between the golf course lease and the lake was surveyed and pegged (generally one metre back from the top of the lake bank). Council has responsibility for maintenance of the bank outside the golf course lease.

In May 1996 Council erected barrier fences around part of the boundary of the golf course. Subsequent public furore led to the creation of Lake Claremont Access Advisory Committee and the presentation to Council of the Lake Claremont Access Advisory Committee Report in December 1996. In 1998 the then lessee vacated the course and Council took over. The future of the course is (in 1998) a matter of public debate.

3.2.4.3 Management Strategy

- (a) Council should enact a local law, consistent with any model local law on the subject, restricting access on the golf course.

- (b) Council should maintain adequate public liability insurance for its responsibility for the golf course and its environs (including the lake).
- (c) Council should provide such openings or other access through the barrier fences around the golf course as would enable legitimate and deliberate access to the golf course by persons other than those playing golf. Such openings should bear appropriate warning signs. It should deter inadvertent access by those who are unaware of the existence of the golf course and who cannot understand appropriate signage.

Recommendation 15

Council should permit access on the golf course of persons, other than those playing golf, in accordance with a local law.

3.3 Water Quality

3.3.1 Objectives

- (a) To reduce the concentration of nutrients in the lake.
- (b) To prevent the formation of algal blooms through appropriate nutrient management.
- (c) To reduce the concentration of faecal coliforms and maintain low levels of toxins in the lake.
- (d) To minimise salt ground water intrusion.

3.3.2 Rationale

Lantzke et al. (1989, 44) has estimated that assuming phosphorus was removed from the water column at a rate of 6 Kg per fortnight, it would take over 19 years to remove the estimated 3 tonne that is in the top 1 cm of the sediments in the lake. Chemical treatment of the water column to render the phosphorus or nitrogen unavailable is an option, particularly in the short term, but it may be expensive.

Dredging of the surface sediments will remove a large portion of the nutrients but it may have adverse effects. Firstly, the wetland sediments all contain phosphorus and are much finer than the underlying sand but their role for lake floor hydrology are unknown. Secondly, dredging may remove the necessary carbon in the sediment and disrupt the invertebrate habitat, the water bird food chains and roosting areas.

Thirdly, Lantzke et al (1989, 9) notes that any action that disturbs or exposes sediments containing phosphorus from past times is likely to lead to phosphorus re-release, so dredging may actually increase the phosphorus problem, at least for a period of years. Deep dredging is not a desirable option because of the stratification and aeration problems of deep ponds and the closeness of the lake to mean sea level (Lake floor 0.9m ahd). Clearly, all options need to be evaluated by qualified professionals before dredging is considered.

Lantzke (1989,9) also noted that a large quantity of surface phosphorus appeared to be released by dead algae when the water was shallow and warm at the end of summer. The quantity of phosphorus released from the algae was almost double that released by dead bulrushes. Although it is desirable that some of the bulrushes be removed, Lantzke et al (1989, 88) notes that if one tenth of the total area were cut, this would not even equal the amount of phosphorus entering in storm water.

An on going monitoring program is necessary to determine the effectiveness of the policy in reducing nutrient levels.

Algal blooms, if large enough, can lead to deoxygenation of the water column, resulting in fish deaths and foul odours and re-release of sediment nutrients. The optimum method of controlling algal blooms is generally considered to be reduction of available nutrients, especially phosphorus. Algal blooms can be controlled by the application of a herbicide to the water column. This option should only be considered after a thorough investigation to determine the environmental impact and only after all other options have been tested and have proved unsuccessful.

Similarly, to minimise the concentration of pesticides, their use on or in the vicinity of the lake should be avoided or used only as a last resort with controls that reflect the conservation values of the system.

“Tannins” from the breakdown of organic material from native wetland plants tend to colour the water of wetlands in sandy soils. There is some evidence to suggest that some “tannin” containing waters are less susceptible to algal growth, for as yet undetermined reasons. Increased staining of the water can be achieved by revegetating the fringes of the lake and the side of the open drains with paper barks, reeds and other “tannin” producing vegetation, provided conditions are appropriate for humic and fulvic acid production. This option may have a detrimental effect on the aesthetics of the lake as some may find the darkly stained water unattractive. However, it is both aesthetically and ecologically more attractive than the green scummy water observed during algal blooms.

The optimum method to control algal blooms is by reducing the excessive nutrients.

Faecal coliforms are at their highest in autumn when lake water levels are low, possibly the result of many birds defecating in the small remaining body of water, providing ideal conditions for bacteria to multiply. In some years it is during this period when most bird deaths occur. A program of regular monitoring should include microbiological evaluation each autumn to assist in determining the cause of the bird deaths should they occur.

Options suggested for preventing botulism deaths include;

- (a) oxygenation of the remaining water;
- (b) deepening portions of the lake to preserve a greater quantity of water;
- (c) reducing water nutrients rapidly, e.g. pumping contaminated water onto nearby turf or nutrient stripping device and refreshing the water body with waste water discharge, e.g. from the swimming pool; and/or
- (d) control of the bird population. Domestic ducks have appeared on the lake at times and should be removed if they return.

Each of these options has side effects which would need investigation before determining whether action should be taken.

3.3.3 Management Strategy

3.3.3.1 Treatment or Removal of Nutrients from the Water Column

- (a) Chemical treatment of the water column to render the phosphorus or nitrogen unavailable could be an expensive and unnecessary option, as the sediments are still absorbing phosphorus. If the slower, more sustained, 'natural' removal mechanisms do not reduce nutrient concentrations to desired levels, this option should be investigated by appropriate consultants.
- (b) The effects of removing the top layer of sediments from the surface of the bed of lake when it has dried out should be investigated. Particular attention will need to be given to the effects on hydrology, micro flora and fauna. Maintaining the food chain and roosting areas essential for the survival of the water birds. This investigation should be undertaken by appropriately qualified consultants.
- (c) The bulrushes will need to be kept in check to prevent them from covering the entire lake. Regular cutting and removal of the bulrush vegetation at appropriate times should assist in reducing the nutrient store in the lake.

- (d) An ongoing monitoring program for the nutrients nitrogen and phosphorus needs to be initiated to determine the lake's nutrient status and the effectiveness of the management program.

3.3.3.2 Control of Algal Bloom

The constructed wetlands at the mouth of each remaining drain and the fringes of the lake should be vegetated with "tannin" producing species of vegetation.

The application of a herbicide to control algae should not be considered until the management options for removing the existing phosphorus from the water column, reducing the inflow of phosphorus into the lake and inhibiting algal growth have been undertaken and evaluated for their effects on alga, biodiversity and conservation values.

3.3.3.3 Control of Coliforms

- (a) All domestic ducks should be removed from the lake.
- (b) There should be an education program to advise the public against releasing domestic ducks at the lake, feeding waterfowl and tortoises. Appropriate signs should be displayed at the access points to the lake.
- (c) Professional advice needs to be sought from appropriate consultants on the effects of dredging a portion of the lake deeper to provide a greater quantity of water, recycling water or the oxygenation of the remaining pool of water.
- (d) The use of pesticide in the vicinity of the lake should be avoided and their use be permitted only when there are no other practical options and the effects of the use has been evaluated.

Recommendation 16

The Town of Claremont should institute a monitoring program to measure the effectiveness of the management plan 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.

(1992:14) *The Town of Claremont should institute a monitoring program to measure the effectiveness of the management plan in reducing nutrients from the lake. Samples of the water should be taken monthly to provide a continuous record of the nutrient loading of the lake.*

Recommendation 17

Council should seek a range of professional advice on means to improve water quality in the lake.

(1992:13) *That the Town of Claremont obtain the services of an appropriately qualified consultant to prepare a plan for controlling exotic species of vegetation and revegetating the area with indigenous species.*

3.4 Water Levels

3.4.1 Objectives

- (a) That the lake continue to be managed as a shallow wetland drying out in late summer.
- (b) That ground water use in the locality be minimised.

3.4.2 Rationale

Lake Claremont is essentially a swamp that has been utilised as a sump. If the lake continues to be managed as a shallow drying wetland, productivity will remain high and hence water bird life will remain high. As the level of the water in the lake seems to be a surface expression of the unconfined aquifer, continued heavy drawings on the aquifer will reduce the water levels in the lake and quantities discharging into the ocean and the estuary. It is therefore desirable that land holders in the locality should be aware of the consequences of excessive use of ground water in terms both of water levels and salt intrusion.

3.4.3 Management Strategy

- (a) On the advice of the W.A. Department of Agriculture and other organisations and in the light of the TINS study, an irrigation management plan to be developed for all proximate land users, with a view to reduce the use of ground water.
- (b) An education/awareness program developed jointly by the Council and the Water Corporation of Western Australia, could ensure that the land holders within the catchment area of the lake reduce the water use to the minimum requirement and are aware of the site consequences of excessive ground water use.
- (c) That the use of bore water to maintain water levels in the lake all year around be generally not supported, but the concept be investigated, so that under exceptional circumstances the practice could be considered. In such cases, the timing of water additions should be made with due consideration of the natural cycles of the lake's biota.

- (d) Council should update its records of ground water and lake levels from Waters and Rivers Commission each year.
- (e) Council should investigate the relative significance of ground water and surface water recharge of the lake.

Recommendation 18

That an education/awareness program be developed jointly by 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.

(1992:15) That an education/awareness program be developed jointly by the Town of Claremont and the Water Authority of Western Australia, to ensure that the land holders within the catchment area of the lake reduce the water use to the minimum requirement, and are aware of the site consequences of excessive ground water use.

Recommendation 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.

(1992:16) That the use of bore water to maintain water levels in the lake all year around be generally not supported, but the concept be investigated, then under exceptional circumstances only, the practice be considered.

3.5 Fauna

3.5.1 Objectives

- (a) To maintain and, if possible, increase bird sanctuaries in the lake by providing a barrier to disturbances by other land users.
- (b) To minimise the disturbance of fauna by predators.

3.5.2 Rationale

The importance of Lake Claremont as a habitat for water birds has been identified in the Perth Wetlands Resource Book. It is therefore important that safe refuges for breeding are provided by constructing an area safe from predators and ensuring that domestic pets are kept under control. It is also important that feeding areas are maintained for use by birds. Ideally mosquito/midge plagues could be reduced by the larvae being a food source for the water birds.

If the vegetation inside the northern and eastern boundaries of the drive - in site were retained, this would continue to provide a corridor for the smaller bird species en route from the Cottesloe golf course to the lake. This vegetation will become even more important if the Swanbourne High School site is developed. This vegetation is a recorded breeding site for birds.

3.5.3 Management Strategy

- (a) The Environmental Protection Authority's System Six Red Book study and the Perth Wetlands Resource Book identifies the importance of the lake as a habitat for water birds. The management of the lake should be compatible with the conservation of flora and fauna and, in particular, should maintain or enhance its value as a water bird refuge.
- (b) The lake should continue to be managed as a shallow drying wetland since this increases its productivity and variety of bird habitat.
- (c) Islands, inaccessible vegetation and dead trees surrounded by water act as breeding and roosting refuges for water birds. Accordingly the dead trees should remain. Increased vegetation to reduce disturbance of the birds is likely to increase successful breeding. Increasing the depth of the water between the islands and the bank could provide a refuge from predators.
- (d) The vegetation and drainage rehabilitation program should be designed to improve the lake habitat for water birds, terrestrial birds and any remaining terrestrial fauna.
- (e) Users should be discouraged from allowing pets, including cats, 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 programme.
- (f) All resident domestic/feral ducks should be removed from the lake and the community discouraged from dumping unwanted ducks around the lake. There should be appropriate signs advising of the problem of interbreeding between domestic and Pacific Black ducks.
- (g) Mosquito and midge larvae can be the main food source for water birds at some times of the year. A program should be introduced to monitor 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.

- (h) Council should encourage and assist RAOU bird census activities for Lake Claremont.
- (i) Feeding of waterfowl and tortoises should be discouraged because of poor nutritional value, potential for rotten material and potential for behaviour change resulting from frequent feeding.

Recommendation 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.

(1992:17) *That the management of the lake be compatible with the conservation of flora and fauna, to maintain or enhance its value as a water bird refuge.*

Recommendation 21

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

(1992:18) *That the lake continue to be managed as a shallow drying wetland since this increases its productivity and variety of bird habitat.*

Recommendation 22

The depth of the water between the islands and the bank could be increased to provide a refuge from predators.

(1992:19) *The islands, inaccessible vegetation and dead trees surrounded by water act as breeding and roosting refuges for water birds. Accordingly, the dead trees should remain and the depth of the water around the islands should be increased to provide a refuge from predators.*

Recommendation 23

That the vegetation and drainage rehabilitation programs should be designed to minimise nuisance insect numbers and improve the lake habitat for water birds, terrestrial birds and any remaining terrestrial fauna.

(1992:20) *That the vegetation and drainage rehabilitation program should be designed to improve the lake habitat for water birds, terrestrial birds and any remaining terrestrial fauna.*

Recommendation 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 with an infringement notice. The reason for the restriction should also be shown on the signs and conveyed by a public education programme.

(1992:21) *That users of the reserve be discouraged from allowing pets to run free in the vicinity of the lake. Signs should be erected warning an infringement notice will be issued if caught. The reason for the restriction should also be shown on the signs and conveyed to the residents by a public education program.*

Recommendation 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.

(1992:22) *That all resident domestic/feral ducks be removed from the lake and the community discouraged from dumping unwanted ducks around the lake. There should be appropriate signs advising of the restriction.*

Recommendation 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.

(1992:23) *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 only and chemicals should be applied with strict controls on application.*

3.6 Vegetation

3.6.1 Objectives

- (1) Revegetate the environs of the lake with indigenous species to rehabilitate remnant bushland and provide a natural habitat and food source for terrestrial birds and fauna.
- (2) To remove all the exotic terrestrial plant species around the lake, particularly castor oil trees, watsonia and bamboo.

3.6.2 Rationale

A large number of exotic species of vegetation have become established around the lake and reserve generally. Some of these species have been deliberately introduced while others have become established, possibly from the dumping of garden waste.

It is important that the existing indigenous vegetation be preserved and increased so as to provide a habitat for native birds and to maintain the natural gene pool and local seed source. Total eradication of the bulrushes is not practical nor is it desirable as they provide a safe refuge for water birds. The bulrushes need to be kept in check however to prevent them from covering the entire lake. It may be possible to control bulrushes by shading out by planting paperbark trees 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. To obtain the most favourable conditions it is desirable that the banks of the lake be regraded to a more gentle slope. Since 1992, the west bank of the lake and part of the bank at Stirling Road park have been regraded. To regrade the banks on the edge of Scotch College playing fields will require their cooperation.

Kikuyu and veldt grass are both firmly established on the reserve and should be eradicated, if possible, where vegetation rehabilitation is required.

3.6.3 Management Strategy

3.6.3.1 Exotic Vegetation

- (a) Council should continue to remove all the exotic terrestrial plant species around the lake, particularly weeds such as the castor oil tree, watsonia and bamboo.
- (b) Council should continue to investigate and assess methods for controlling bulrush (see Lantzke 1998). Control measures should be introduced as a matter of priority to prevent the open water being engulfed. The kikuyu grass should be eradicated, or at least controlled in areas where vegetation rehabilitation is to occur.

3.6.3.2 Existing Native Vegetation

- (a) Existing native vegetation around the vicinity of the lake should be protected to maintain the local gene pool and a natural seed source.

- (b) 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.
- (c) 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.
- (d) Council should consult with the Department of Conservation and Land Management for advice on management of the urban bushland.
- (e) Management of the lake will be consistent with maintaining and enhancing the native vegetation community in the area by providing an opportunity for natural recruitment. The drowned Paper Bark stumps in the lake should not be removed since these substantially increase the roosting opportunities for water birds in the area.

3.6.3.3 Vegetation Rehabilitation

- (a) Council should continue a vegetation rehabilitation program with specialist advice that will achieve the following objectives.
 - Regrading of the lake edges to create suitable conditions for the survival of a 10 metres buffer of fringing wetland vegetation.
 - Revegetation of the lake fringes and where possible (e.g the woodlands to the north) the surrounding areas with wetland and dryland species that are consistent with the natural flora of the area.
 - Indigenous species of trees to be planted on the golf course to promote the fauna of the area.
 - To shade out bulrush by planting paper barks on the edge or in the shallows near the edges of the lake. This would also have the benefit of reducing lake temperature over the summer.
- (b) The Town of Claremont investigate the potential for a band of emergent aquatic vegetation along the margins of the old tip face to intercept any contaminants that may be leaching from the site.

3.6.3.4 Drains and Wetland Filters

- (a) Open drains should be contoured to increase the area available for revegetating with emergent native wetland species and hence interception of contaminants.
- (b) Wetland filters constructed at the drain mouths should be planted with emergent native wetland species consistent with the natural flora of the area.

Recommendation 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.

(1992:24) *That a program be initiated by the Town of Claremont to remove all exotic terrestrial plant species around the lake and within the north western portion of the reserve generally, particularly weeds such as bamboo and the castor oil trees.*

Recommendation 28

That the Town of Claremont should control bulrush in areas where it has spread recently.

(1992:25) *That the Town of Claremont provide resources to investigate and assess methods for controlling bulrush as a matter of urgency.*

Recommendation 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.

(1992:26) *That the Town of Claremont implement a policies to protect and maintain the local gene pool and the natural seed source in the reserve.*

Recommendation 30

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

(1992:27) *That the drowned paperbark stumps in the lake be retained to provide roosting opportunities for water birds in the vicinity.*

Recommendation 31

That the Town of Claremont continue a vegetation rehabilitation program with specialist advice that will achieve the following objectives;

- Regrade the lake edges to create suitable conditions for the survival of a 10 metres buffer of fringing wetland vegetation.
- 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.
- Indigenous species of trees to be planted on the golf course to promote the fauna of the area.
- 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.

(1992:28) *That the Town of Claremont develop and co-ordinate a vegetation rehabilitation program that will achieve the following objectives;*

- *Contouring of the lake edges to create suitable conditions for the survival of a buffer of fringing wetland vegetation to 10 metres wide.*
- *Revegetation of the lake fringes and where possible the surrounding areas (e.g the woodlands to the north) with wet land and dryland species that are consistent with the natural flora of the area.*
- *Trees planted on the golf course will be indigenous species to promote the fauna of the area.*
- *To shade out Bulrush by planting Paper Barks on the edge or in the shallows near the shallow edges of the lake. This would also have the benefit of reducing lake temperature over the summer.*

Recommendation 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.

(1992:29) *That the Town of Claremont investigate the potential for a band of emergent aquatic vegetation along the margins of the old tip face to intercept any contaminants that may be leaching from the site.*

Recommendation 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.

Recommendation 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.

3.7 Fire

3.7.1 Objective

To suppress the incidence of uncontrolled or unauthorised burning of the bulrushes or of the bushland.

3.7.2 Rationale

An uncontrolled fire can have a detrimental biological effects on the native flora and fauna. At the end of the summer the dry bulrushes pose the greater fire risk. A reduction in the bulrushes and firebreaks would reduce the fire risk.

There are numerous fire breaks within the Tuart woodland in the north west corner of the site and as these are a possible source of erosion, there may be a opportunity to rationalise these fire breaks as formed paths.

3.7.3 Management Strategy

- (a) The existing fire breaks be rationalised to provide an adequate level of fire protection with minimum risk of soil erosion.
- (b) Reduce the extent of the bulrushes growing in and around the lake.
- (c) Harvesting of bulrushes (nutrient removal) and cutting firebreaks (fire prevention).

Recommendation 35

That the Town of Claremont obtain professional advice on rationalising the existing fire breaks and ensuring that the fire breaks provided are adequate.

(1992:30) *That the Town of Claremont obtain professional advice on rationalising the existing fire breaks and to ensure that the fire breaks provided are adequate.*

3.8 Environmental Education

3.8.1 Objectives

- (a) 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.
- (b) To ensure that the public use of the area is compatible with the conservation values of the lake.
- (c) To initiate a public education program so that the general public understands the environmental process and is fully aware of the fragility of the lake's ecosystem and the need to preserve and protect the flora and fauna.
- (d) To preserve the north west of the reserve below the former drive in theatre as a conservation and wildlife observation zone.
- (e) To promote the use of the bird observation platform for environmental education purposes by providing suitable signage to complement signage in Stirling Road park and elsewhere.
- (f) To provide the visiting public with interpretative information on all aspects of the history of land use of the lake and its environs.

3.8.2 Rationale

Interpretation by the public of the reserve's physical and biological properties and processes is a critical aid in conserving and upgrading the natural environment. This may be achieved by erecting appropriate signs and through the distribution of brochures. The Lake Claremont reserve caters for a wide diversity of recreational uses. To prevent a conflict between public use and conservation and conflict between the various uses, it may be necessary to restrict each use to an appropriate location within the reserve. The management plan includes a map depicting where the various uses may take place. This information should be conveyed to the public through the signs and brochures. Preferred points of access to the reserve should be indicated by appropriate signs and paths. This would reduce the danger to the public from errant golf balls and minimise damage to the sand dunes.

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 1960s. From the time of Butler's allotment, through the time of the pensioner guard's farms to the time of the Smith brothers' fruit and vegetable growing and Rome's dairy there has been agricultural activity in the area.

The urban uses of swampland as recreation site, refuse disposal site, sports facility and increasing residential density are significant recent forms of land use of the area. The visiting public should be educated about the historical, cultural and social significance of the area so that they may appreciate the past and present land use.

3.8.3 Management strategy

- (a) Erect signage to inform visitors of restrictions on land use and the reasons for those restrictions.
- (b) In conjunction with the Claremont Museum, conduct research into the past land use with a view to producing appropriate interpretative signage and brochures. Brochures may be available both at the Council chambers and the Museum.
- (c) Interpretative tours, featuring both natural and cultural heritage, may be conducted at the lake.

Recommendation 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.

(1992:31) *That appropriate aesthetically designed signs be erected at each entry to the reserve advising of the importance of retaining the physical and biological properties of the reserve. Rehabilitation signs should be erected where revegetation of the indigenous vegetation is being undertaken. Restriction on the use of off road vehicles and permitting dogs on the reserve with out a lead would feature prominently on the signs.*

Recommendation 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.

(1992:32) *That brochures be prepared to inform the general public on the rationale behind the introduction of the restrictions.*

Recommendation 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.

(1992:33) *That in order to enhance environmental education, the Town of Claremont initiate action to change the name of the area back to "Butler's Swamp".*

Recommendation 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.

3.9 Implementing and Monitoring the Policy

3.9.1 Rationale

The Council of the Town of Claremont is the responsible authority for the implementation of this policy. A Committee was appointed by the Council to monitor and oversee the implementation of the policy. The Committee consists 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. Duties of the Committee include implementation of the Policy and recommending matters that should be attended to including amendments to the Policy. The Committee 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 plan.

Rate of implementation will be dependant upon the resources and funding available. Priority shall be given to improving the quality of the water, vegetating the fringes of the lake and the area between Cresswell Oval and Strickland Street.

Recommendation 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 plan. 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.

(1992:34) *That the Town of Claremont be the responsible authority for the implementation of this management plan. A Management Advisory Committee be appointed by the Council to monitor and oversee the implementation of the plan. The Management Committee shall consist of one Claremont Town Councillor and a group of six people who have an interest in the well being of the lake. The Management Advisory Committee shall meet at least quarterly and report to Council through the Heritage Committee and the structure of the Heritage Committee be reviewed to allow the Management Advisory Committee representation.*

3.9.2 Term of the Policy

The degraded state of the lake indicates that the management policies defined in this document are relatively long term. This is to allow for the nutrient flow in to the lake to be reduced and the effects of the revegetation program to take affect. Once rehabilitation 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.

The 1992 Management Plan was the basis for the 1998 review which has produced this Policy. A full review should be conducted in 2003.

Recommendation 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.

(1992:35) *Duties of the Management Advisory Committee shall be implementation of the Management Plan and recommending matters that should be attended to, including amendments to the Management plan and to be available to Council as a coordinating body in the development community programs approved by the Council.*

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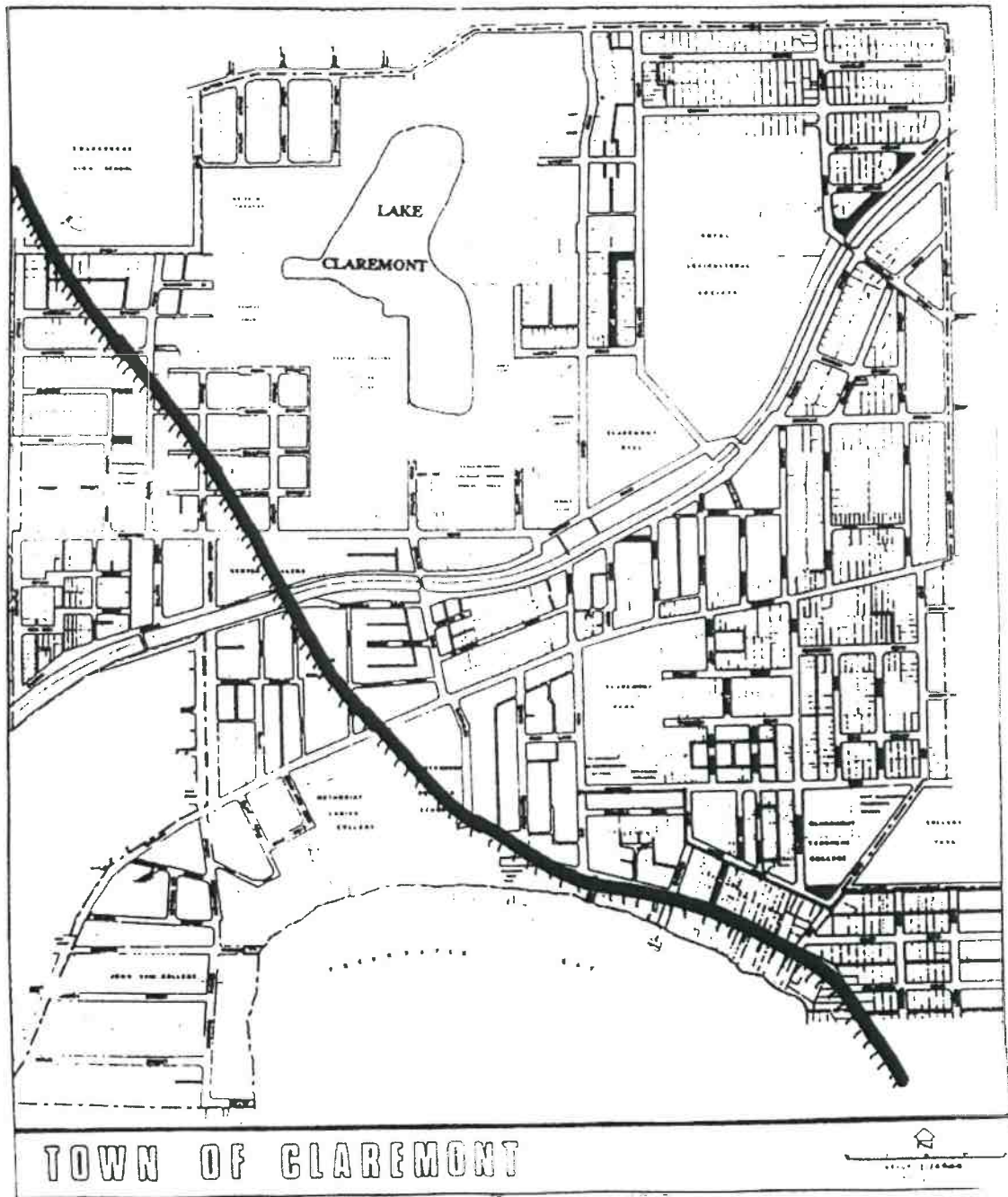
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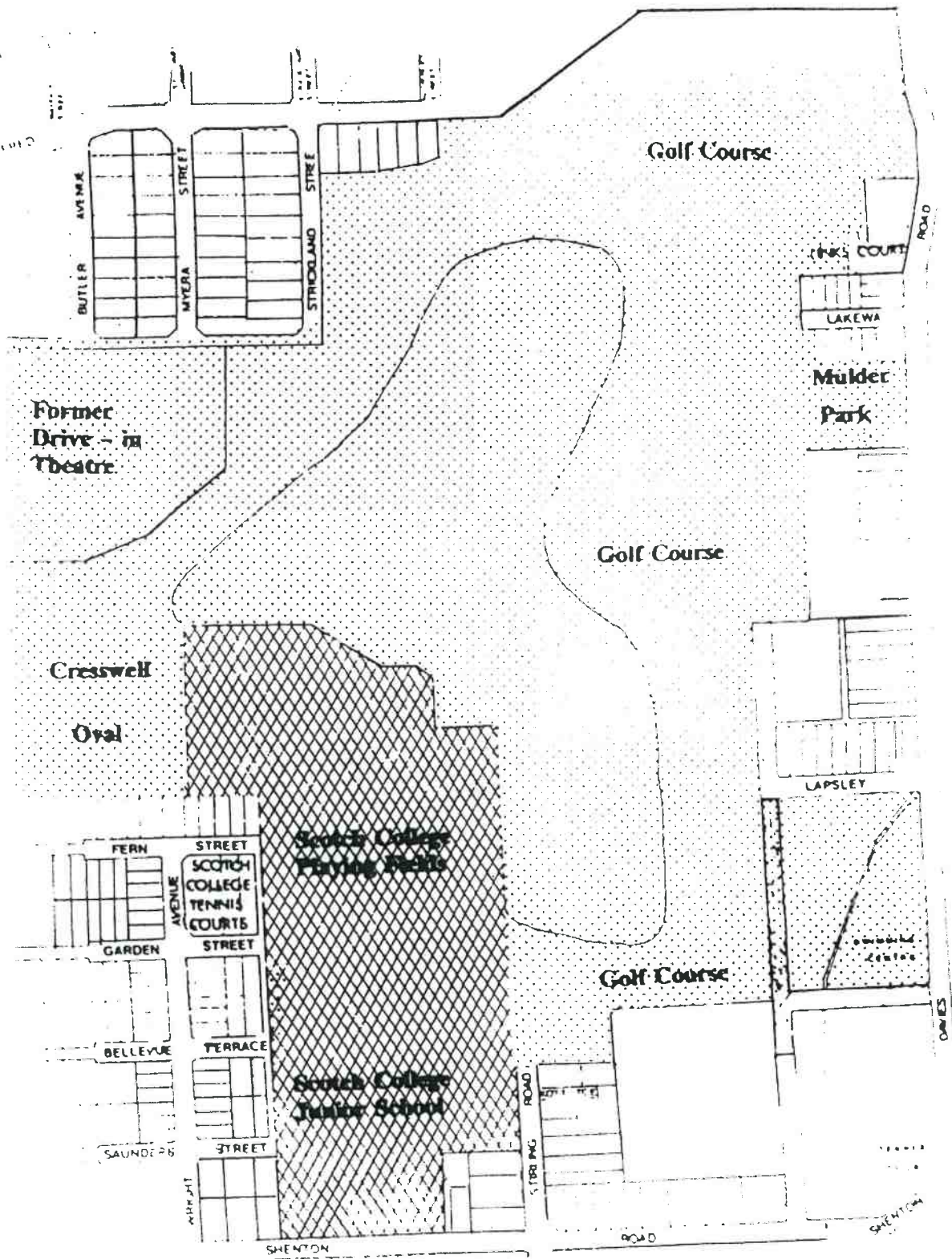
Dr. Ian Hamilton
Mr. Peter Sandilands





 Limit of area
 subject to salt water
 intrusion
 (1985)

LOCALITY PLAN

Figure 1

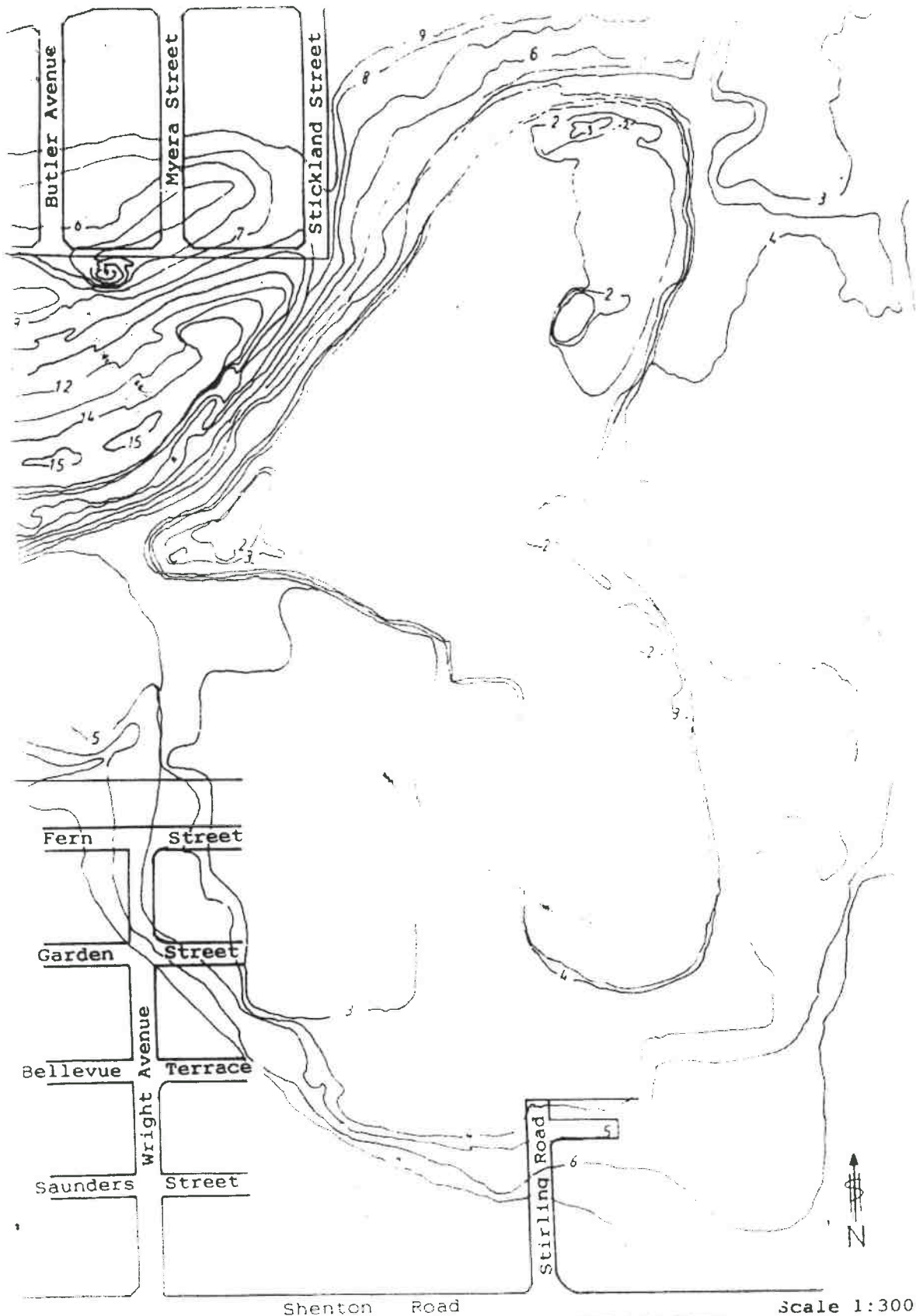


Legend

South College land 

Land Owners

Figure



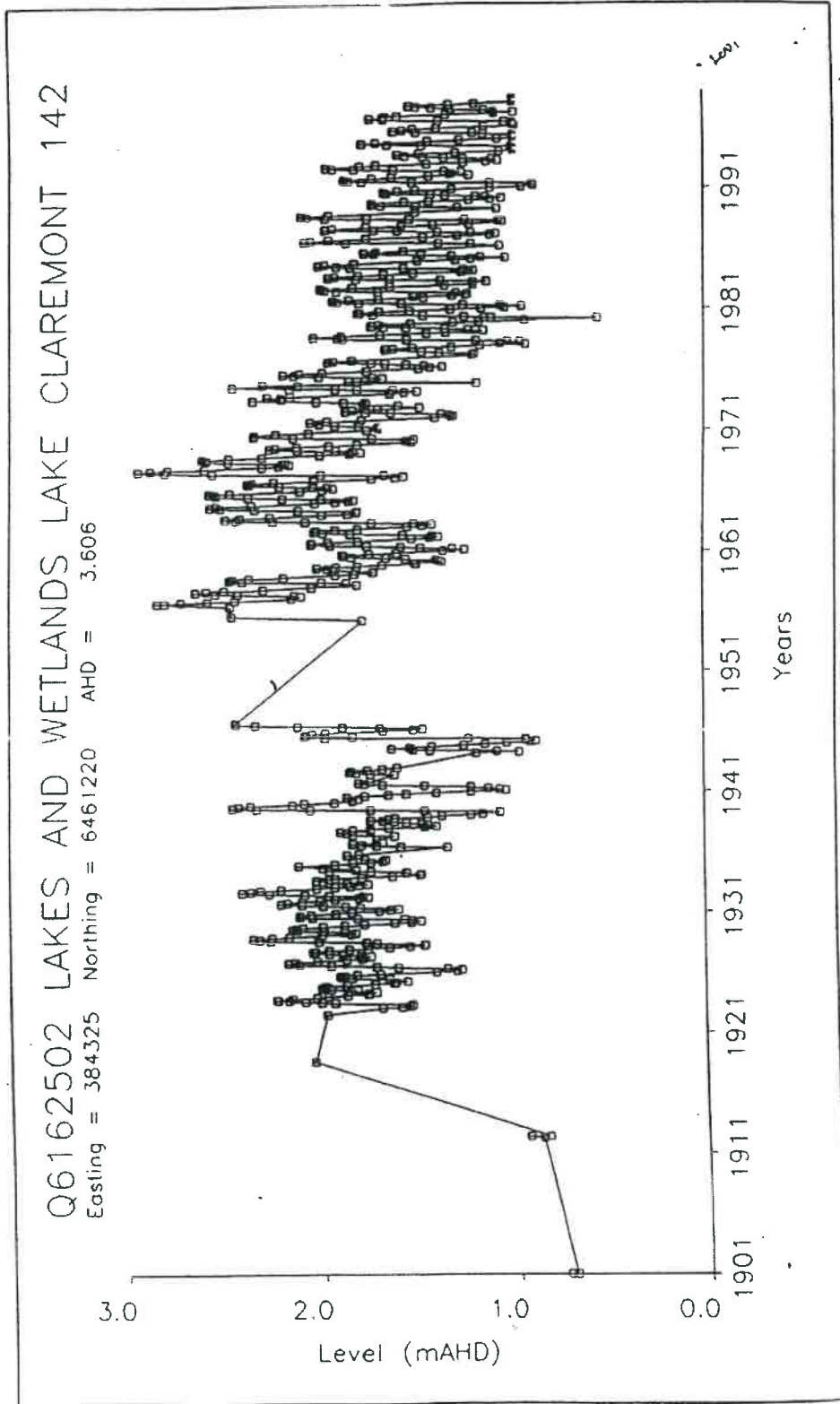
Contour Plan
Values to A.H.D.

Scale 1:3000

Figure 2

SOURCE: Department of

LAKE WATER LEVELS



10:45 07/01/98

Figure 4

Source: Waters and Rivers Commission