CONSULTATIVE ENVIRONMENTAL REVIEW FOR THE FUNCTIONAL REPLACEMENT OF THE CEDRIC STREET WETLAND

Prepared for: Department of Planning and Urban Development, City of Stirling and Private Landowners

Prepared by: BSD Consultants Pty Ltd

July 1992

HOW TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites persons and organisations to make submissions on this proposal.

The Consultative Environmental Review (CER) has been prepared to assess the potential impacts and management for the proposal to replace the Cedric Street Wetland on a functional basis on behalf of the Department of Planning and Urban Development, City of Stirling and private landowners in accordance with Western Australian Government procedures. The CER will be available for comment for four (4) weeks, beginning on August 10, 1992 and finishing on September 7, 1992.

Comments from Government agencies and from the public will assist the EPA in preparing an assessment report, in which it will make a recommendation to Government.

WHY WRITE A SUBMISSION

A submission is a way to provide information, express your opinion and put forward your suggested course of action including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree with or comment on the general issues or specific proposals discussed in the CER. It helps if you give reasons for your conclusions, supported by relevant data.

You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific proposals in the CER.

- clearly state your point of view.
- indicate the source of your information or argument if this is possible.
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

It will be easier to analyse your submission if you keep in mind the following points:

- Attempt to list points so that the issues raised are clear. A summary of your submission is helpful.
- Refer each point to the appropriate section, chapter or recommendation in the CER.
- If you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering.
- Attach factual information you wish to provide and give details of the source. Make sure your information is accurate.
- Please indicate whether your submission can be quoted, in part or in full, by the EPA in its assessment report.

Copies of the CER can be obtained from BSD Consultants, 1 Sleat Road, Applecross at a cost of $5.00 including packaging and postage.

Remember to include:

- name
- address
- date

The closing date for submissions is September 14, 1992.

Submissions should be address to :

The Chairman
Environmental Protection Authority
38 Mounts Bay Road
Perth WA 6000

Attention: Mr G Bott

TABLE OF CONTENTS

List of Tables

page

List of Plans

List of Appendices

CEDRIC STREET WETLAND FUNCTIONAL REPLACEMENT PROPOSAL

1.0 INTRODUCTION

1.1 Purpose of Document

The purpose of this CER document is to undertake a detailed environmental assessment of the potential environmental impacts of the proposed functional replacement of the Cedric Street Wetland and to present comprehensive management strategies and commitments to mitigate these impacts. Included in this assessment is the evaluation of the downstream benefits of improved water quality to the receiving environment of Herdsman Lake.

1.2 Background

1.2.1 Location and Setting

The Cedric Street Wetland is a remnant of a series of wetlands and damplands persisting in a low lying area to the north-east of the Innaloo Shipping Centre. The wetland, bounded by Cedric Street, Oswald Street and the Mitchell Freeway, was once part of a larger system previously filled for the Hertha Road Sanitary Landfill site, Innaloo residential development, Mitchell Freeway, Stephenson Highway and the Osborne Park Industrial Area. A site plan of the extent and location of the wetland is given on Plan 1.

The Cedric Street Wetland is peat based, forming a perched water table which is maintained by the underlying groundwater, surface inflow from a flood control drain and from rainfall recharge. An open drain extends along the eastern side of the wetland running in a north-south direction. The drain, known as the Osborne Park Branch Drain, comprises a network of open channels that link the Balcatta Swamps and Herdsman Lake. The drain is separated from the subject wetland by embankments associated with the construction of the Stephenson Highway and, due to the surrounding land uses, experiences poor water quality. Excessive nutrients, pesticides and heavy metals were evident from water quality data collected from mid 1990 to date. These contaminants derive from the drain's catchments and are transported into the Herdsman Lake environment.

1.2.2 Surrounding land use

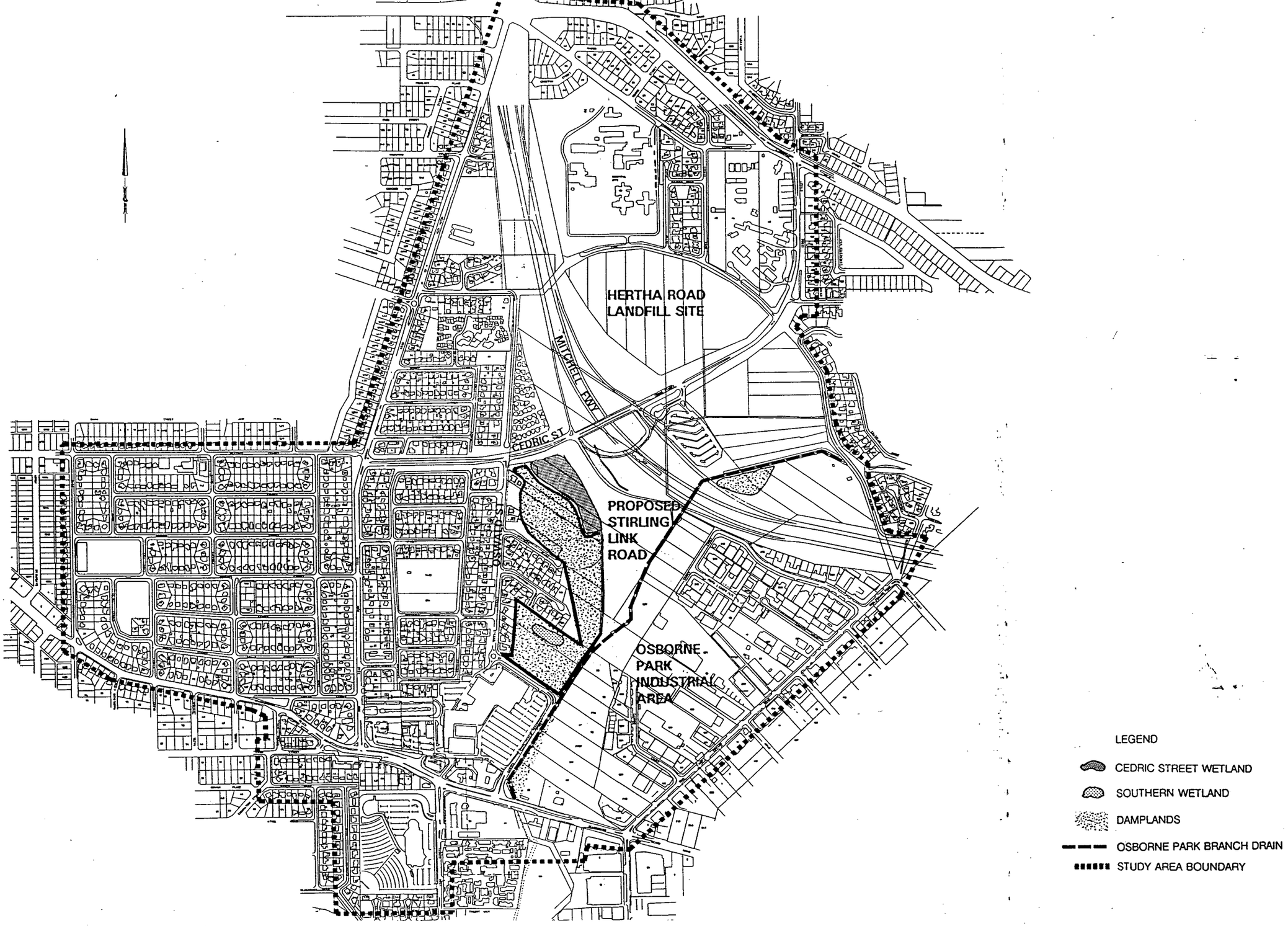
Past and present land uses around the wetland's perimeter have resulted in its current degraded state. These include market gardening, residential development, Freeway and road construction, industrial land uses and grazing by horses. Sections of the surrounding catchment are being used as a dumping ground for building materials, car bodies and domestic refuse. The invasion of introduced vegetation has limited the species diversity of native flora.

1.2.3 Environmental Protection (Swan Coastal Plain Lakes) Policy 1992

Wetland environments are now recognised as biologically rich ecosystems under pressure by surrounding suburban sprawl and other land uses. Almost two thirds of wetlands of the Swan Coastal Plain have been filled or severely degraded since European Settlement. This scenario has culminated in the recent release of the EPA's Draft Environmental Protection (Swan Coastal Plain Lakes) Policy, 1992 "(EPP Lake's).

Previous to the "EPP Lakes", the Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy, 1991 (EPP Wetlands) was released which listed those wetlands identified as worthy of protection. The purpose of both policies was to protect listed wetlands against activities such as filling, draining, mining and polluting.

The Draft EPP (Wetlands) was released in March 1992 for public comment and it became apparent to the EPA that the primary source of information (aerial photography and satellite imagery) was in some instances inaccurate and more precise determination of wetland mapping was necessary. In December 1991 the EPA surveyed presently listed wetlands and also considered unlisted wetlands of the Swan Coastal Plain. The purpose of the survey was to verify the validity of listed wetlands and investigate the possibility of including previously omitted wetlands (such as the Cedric Street Wetland) which had been brought to the EPA's attention in this case by a local community group. The main criteria for the inclusion of wetlands into the revised EPP (Lakes) 1992 was that the lake surface consist of areas of standing water of 1,000 square metres or more as at the first week of summer, as delineated and shown on the Land Administration Miscellaneous Plan 1700 (ie EPP Lakes 1992 Map).



PRINCIPAL

DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

TITLE

WETLANDS IDENTIFIED IN THE STIRLING REGIONAL CENTRE STUDY AREA

PROJECT

STIRLING REGIONAL
CENTRE PLAN

ARCHITECTS URBAN DESIGN PLANNING INTERIOR DESIGN
WOODHEAD AUSTRALIA

BSD CONSULTANTS
CONSULTING ENGINEERS, TOWN PLANNERS & PROJECT MANAGERS
BSD HOUSE, 1 SLEAT ROAD, APPLECROSS. PHONE No 316 2988

N W E S

DATE: MAY 92
JOB No.: P9232
SCALE: NTS

PLAN No. 1

The Cedric Street Wetland was surveyed by the EPA in the first week of December 1991, met the water permanency criteria and was subsequently listed for inclusion into the EPP (Lakes). Discussions with local residents, one of which has lived adjacent to the Cedric Street Wetland for over 30 years, reveals that the wetland area now covered with water was previously not subject to inundation and was generally dry throughout the year. It is apparent that development associated with the Mitchell Freeway and nearby construction of residential units has artificially increased the water balance of the local environment as a result of stormwater drainage discharge entering the wetland. The existence of water in the Cedric Street Wetland at the time of the EPA Survey was further assisted by unseasonal rainfall for the preceding month (November 1991) which amounted to over three times the mean monthly average (Bureau of Meteorology). These prevailing conditions were responsible for the Cedric Street Wetland containing the EPP (Lakes) criteria of "1,000m^2 or more as at the first week of summer for that year. According to EPP (Lakes) Maps, the area at the Cedric Street Wetland protected from polluting activities is given on Plan 2.

1.2.4 Stirling Regional Centre

The major development precinct associated with the Stirling Regional Centre is proposed at the site of the Cedric Street Wetland. The proposal involves the establishment of office and residential developments, retail outlets and entertainment centres which take advantage of the nearby Stirling Transfer (Bus and Rail) Station. The retention of the unmanaged degraded wetland in its present site and condition clearly conflicts with development of the Stirling Regional Centre. The Draft Indicative Development Plan (IDP) is given on Plan 3.

1.3 Scope of Assessment

The scope of the CER is to assess the environmental impacts of the proposed replacement of the Cedric Street Wetland on a local (Stirling Regional Centre) and regional (Herdsman Lake) scale. This formal level of environmental impact assessment (EIA) has been initiated by the Building Better Cities Program - Stirling Regional Centre, the listing of the Cedric Street Wetland in the EPP (Lakes) 1992 and is consistent with requirements of the EPA's "Guide to Wetland Management in Perth", 1990, Bulletin 374 which states that any development or land use change affecting a wetland in all management categories will require an environmental report. Environmental assessments at this level are usually

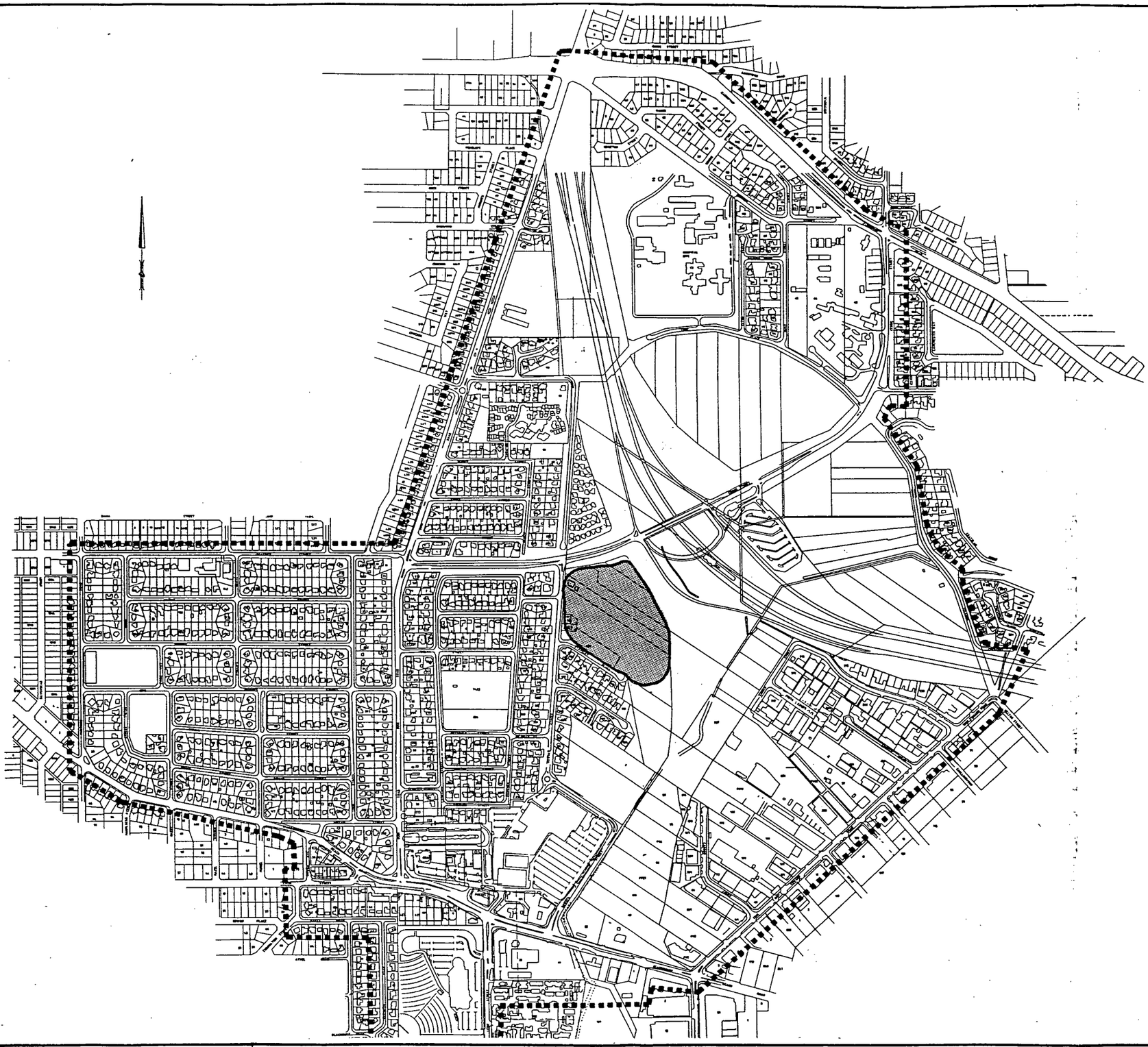
undertaken when the development proposal design is finalised and the environmental impacts of the proposal can be quantified by consideration of the development proposal construction details. This EIA approach was not applicable in the assessment of the Cedric Street Wetland replacement proposal as the development plan and indeed the final land use associated with the Stirling Regional Centre are presently at the concept stage and will not be known in the near future.

These circumstances have led this CER to concentrate on the Cedric Street Wetland replacement issue (as outlined in the EPA guidelines - Appendix 2) and not specifically assess the range of environmental impacts associated with the construction of the Stirling Regional Centre.

1.4 The Proponents

The proponents of the Cedric Street Wetland replacement proposal are DPUD, City of Stirling and the following private landowners:

- Westpoint Properties
- JK Geneff Nominees
- Mr P Baltovich
- Fabray Pty Ltd
- Mr Furfaro



LEGEND

AREA OF CEDRIC STREET WETLAND PROTECTED UNDER THE EPA'S DRAFT EPP (LAKES), 1992

PRINCIPAL

DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

TITLE

WETLAND AREA PROTECTED UNDER THE DRAFT ENVIRONMENTAL PROTECTION (SWAN COASTAL PLAIN LAKES) POLICY, 1992.

PROJECT

STIRLING REGIONAL CENTRE PLAN

ARCHITECTS URBAN DESIGN PLANNING INTERIOR DESIGN
WOODHEAD AUSTRALIA

BSD CONSULTANTS
CONSULTING ENGINEERS, TOWN PLANNERS & PROJECT MANAGERS
BSD HOUSE, 1 SLEAT ROAD, APPLECROSS. PHONE No 316 2988

N W E S

DATE: MAY 92
JOB No.: P9232
SCALE: NTS
PLAN No.: 2

2.0 NEED FOR THE PROPOSAL

The need for the proposed functional replacement of the Stirling wetland arises from;

- The strategic location of the wetland with respect to the Stirling Regional Centre and Stirling Transfer Station;

- The provision of a managed wetland alternative which can be appreciated for its improved environmental and social attributes;

- The downstream water quality benefits of incorporating a series of pollution stripping basins into the contaminated branch drain system; and,

3.0 ENVIRONMENTAL PLANNING CONSIDERATION

In the context of the Stirling Regional Centres early stages of evolvement and the environmental implications of this proposal, there is a need for decisive environmental goals, pertinent management objectives and a clear definition of the approach and timing of the Cedric Street Wetland replacement proposal at the planning level.

3.1 Environmental Goals

The environmental goals of the wetland replacement assessment are outlined below. The order of the goals do not reflect the importance of each individual goal but represent achievable environmental benchmarks.

- To upgrade and enhance the existing natural and human use values of the wetland.

- To provide a sustainable wetland environment which has the ability to fulfil and improve upon the ecological, social and hydrological functions currently operating in the Cedric St Wetland.

- To determine the design parameters of the replacement wetland series into the existing Osborne Park Branch Drain in order to enable the successful incorporation of wetland functions and features into the proposed Stirling Regional Centre.

- To improve the water quality of the Branch Drain to the benefit of the local environment and downstream users (ie Herdsman Lake).

- To identify a management body responsible for the long term management and maintenance of the created wetlands.

- To develop environmental management and monitoring commitments which would be detailed in a future Environment Management Plan should the proposal receive environmental approval.

Water quality is an important parameter of a wetland system which largely determines the integrity and sustainability of the ecological components of the wetland environment. As a

guide to establishing a replacement wetland, water quality objectives have been adopted which are consistent with those proposed in the Herdsman Lake Water Quality Study (Davis et al, 1990)

Proposed Objectives:

a. pH - 6.5-8.5

b. Salinity

(i) <1.5ppt (equivalent to a TDS of 1500mg/1 or conductivity of 250mS/m) in deepened waterbodies.

(ii) no restriction on levels in central shallow mere areas when drying out is proceeding during summer.

c. Dissolved Oxygen

(i) >6mg/1 for fully mixed conditions

(ii) no limits set where stratification occurs

d. Nutrients

Integrated water colomn

- Total phosphorous should not exceed 0.10mg/1 (filtered sample)
- Total nitrogen should not exceed 2.00mg/1 except in the hypolimnion during stratification. Levels exceeding these values have resulted in water quality problems in other wetlands on the Swan Coastal Plain.

f. Chlorophyll 'a' - should not exceed 0.10mg/1 (maximum levels). Levels exceeding these values appear to have promoted excessive midge swarms around other wetlands on the Swan Coastal Plain.

g. Pesticides in surface waters -

Chlordane	≤0.004ug/1
DDT	≤0.0005ug/1
Dieldrin	≤0.003ug/1
Heptachlor	≤0.001ug/1
Chloropyrifos	≤0.01ug/1
Temephos	≤0.01ug/1

h. Heavy Metals

Arsenic	50 ug/1
Cadmium	0.2ug/1
Chromium	10ug/1
Copper	5ug/1
Lead	5ug/1
Mercury	0.1ug/1
Nickel	25ug/1
Selenium	10ug/1
Zinc	50ug/1

i. Oil and petrochemicals - Spills and road runoff leaving surface films are unacceptable

j. Other - Floating debris (other than which occurs naturally, for example windblown vegetation. leaves, sedges, branches, etc) is unacceptable.

The criteria was proposed as water quality objectives for the protection and integrity of the aquatic ecosystem at Herdsman Lake. The close proximity of Herdsman Lake to the Stirling Regional Centre development site and the fact that the Osborne Park Branch Drain discharges into the Herdsman Lake environment supports the adoption of such objectives as the relevant standards to achieve the environmental goals of the Cedric Street Wetland replacement proposal.

3.2 Management Objectives

The Management Objectives of the Cedric Street Wetland functional replacement has been formulated according to the ecological, social and hydrological functions of the replacement wetlands environments.

3.2.1 Ecological

- To design a wetland system which improves upon the ecological, social and hydrological values of the existing wetland, as well as the conservation values of the proposed development site.

- To create and rehabilitate a range of self sustaining wetland habitats (aquatic and terrestrial) to increase the biodiversity in the local environment.

- Encourage increased usage by waterbirds with the provision of valuable feeding, roosting and breeding.

- Provide the necessary environmental monitoring infrastructure in order to evaluate the ongoing ecological performance of the wetland.

3.2.2 Social

- Create the opportunity for increased human use of the wetland environment.

- Formulate a viable management solution to a currently unmanaged and degraded wetland.

- Provide a publicly accessible wetland system with a variety of habitats to improve the aesthetics, landscape amenity and passive recreation of the area.

- Increase public awareness on the rehabilitation, recreation and conservation of newly created wetlands and the role of wetland managers in the health and long term sustainability of the wetland environment.

3.2.3 Hydrological

- Maintain as much as possible the existing water level regimes (ground and surface) operating in the Stirling Regional Centre Development site.

- Improve the water quality of the Osborne Park Branch Drain.

- Provide a wetland system which adequately manages the existing and proposed drainage of the Osborne Park Branch Drain.

3.3 Approach and Timing

The retention of the Cedric Street Wetland in the EPA's Environmental Protection (Swan Coastal Plain Lakes) Policy, 1992, clearly constitutes an impediment to the fundamental land use and development design of the Stirling Regional Centre.

The approach of this CER is to determine grounds for the exemption of the Cedric Street Wetland from the EPP (Lakes) and to demonstrate that properly managed and designed wetland/s can be constructed so as to exhibit greater environmental values than the existing wetland complex.

The timing of the wetland replacement proposal is largely determined by the progress of the Stirling Regional Centre and Stirling Transfer Station. The wetland replacement

proposal is expected to follow a staged approach which is designed to create replacement wetland habitat at the same rate that the existing wetland habitat is lost. The staging will commence during the end of spring when the site is beginning to dry out and is generally accessible to earthmoving equipment. This will also allow for the identification and translocation of wetland flora and fauna.

The waterbird breeding season begins in early summer and it is expected that the creation of adequate waterbird breeding habitat (based on existing and projected waterbird usage), will be possible within this timeframe at the replacement wetlands. This will be achieved by the transfer of biological material (peat substrate, reed beds, emergent and fringing vegetation), resulting in rapid establishment of a variety of wetland habitats. In conjunction with the newly created wetland habitats, it is proposed that areas of the existing wetland most significant, in terms of waterbird breeding habitat, will be temporarily retained during the waterbird breeding season to ensure that on balance, sufficient habitat exists within the proposed Stirling Regional Centre site.

The continual wetland loss/wetland creation approach of the proposal allows access and movement of machinery and is considered to have the least environmental impact on the wetland system.

4.0 DESCRIPTION OF PROPOSAL

4.1 Relevant Statutory Requirements

The Cedric Street Wetland replacement proposal firstly requires the exemption of the wetland from the EPA's Draft Environmental Protection (Swan Coastal Plain Lakes) Policy 1992. This will be achieved by formally assessing the environmental impacts and subsequent management consistent with a Consultative Environmental Review (CER) as outlined in Part IV of the Environmental Protection Act (1986).

Provided sufficient information is presented, the EPA releases the CER for public comment. The Public Review period for a CER is usually 4 weeks, beginning from the first date of advertisement. The public submissions received are forwarded by the EPA to the proponent whom then comments accordingly to those issues raised during the public review period. The EPA considers the proposal based on its own experience, the information presented in the CER and concerns raised during the public review period. The EPA then formulates its "Report and Recommendations" to be forwarded to the Minister for final approval.

4.2 Location of the Cedric Street Wetland and Implications for the Stirling Regional Centre

The Cedric Street Wetland is strategically situated within an area designated on the Draft Indicative Development Plan as Precinct 1 - Core Precinct (see Plan 3). This precinct is a key area in terms of the success of the Stirling Regional Centre and the integration of the Stirling Rail Transfer Station which is currently under construction.

To ensure maximum development potential on appropriate land within reasonable walking and cycling distance of railway stations and to promote the best possible integration of land use within the suburban rail system, the Department of Planning and Urban Development (DPUD) has recently formulated a planning policy. Policy No DC 1.6 "Development Near Metropolitan Railway Stations" recognises the need for residential and commercial development to concentrate within a 800m radius from the suburban railway station. A distance of 800m represents a 10 minute walk, 2 minute cycle or very convenient car passenger transfer trip for suburban rail passengers.

This area of high accessibility therefore needs to be planned to allow as many people as a possible to benefit from the rail service and to maximise patronage of the system. The area is referred to in DPUD Policy No DC 1.6 as the "Station Precinct".

Key components of Precinct 1 as outlined in the Draft Indicative Development Plan include the construction of a new link road from Cedric Street to Scarborough Beach Road (utilising a portion of the existing Oswald Street alignment), expansion of the Innaloo Shopping Centre northward (with appropriate landscape buffers) and development of a major high rise office park, focal entertainment node and business hotel immediately west of the Railway Station. Additional options for this precinct include retail outlets, restaurants and mixed use/residential development adjoining the existing residential enclave near Stavely Place.

4.3 Area of Wetland to be Lost

In determination of the area of the Cedric Street Wetland to be filled and recreated elsewhere within the Stirling Regional Centre development site, the following factors were considered:

- Results from flora and fauna surveys of the Cedric Street Wetland;
- The degraded state of the existing wetland;
- The lack of a current management body for Cedric Street Wetland;
- The unlikelihood of identifying an appropriate management body or gaining funds to rehabilitate the Cedric Street Wetland in its present location;
- The logistics of rehabilitating the Cedric Street Wetland in its present location;
- DPUD policy;
- The potential of the Cedric Street Wetland site for development which utilises the opportunities and environmental advantages of the proposed upgraded public transport system.

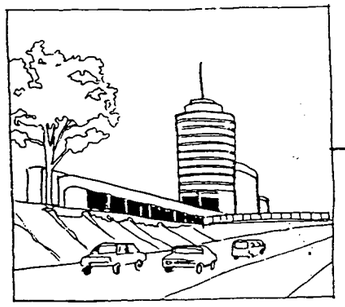
Based on careful examination of these factors, it is considered the most appropriate option is to fill the Cedric Street Wetland and recreate additional wetland habitats which have the potential to greatly improve the natural and human use than those currently operating at the present Cedric Street Wetland.

Business Park

Separate buildings in a landscaped setting.

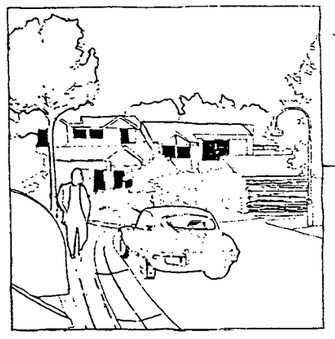
Landmark Point Building

Recognisable landmark building at the focus of the freeway system.



Residential

Medium density housing.



Civic Precinct

New civic building in a parkland setting with a plaza to commercial and retail elements on a podium over the existing "park and ride" station.

Civic Connections

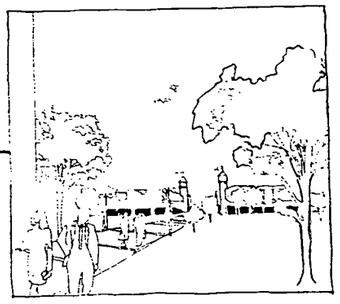
Longterm scope for a landscaped plate over the freeway system, linking the major civic and commercial elements.

Public Square

Pedestrian urban square enclosed by public entertainment and service elements.

Pedestrian Axis

Primary pedestrian axis, through the Centre connecting the major elements.



DEPARTMENT OF PLANNING AND URBAN DEVELOPMENT

City of Stirling

PERTH URBAN RAIL DEVELOPMENT

N

0 100 300 500m

DRAFT INDICATIVE DEVELOPMENT PLAN

STIRLING REGIONAL CENTRE

STIRLING REGIONAL CENTRE URBAN DESIGN

4.4 Area of Wetland to be Recreated

The objective of this proposal is to recreate a series of interconnected wetlands to be incorporated into the existing Osborne Park Branch Drain. It is considered that the wetland series will replace, and in most cases, greatly improve, upon the ecological, hydrological and social functions currently associated with the Cedric Street Wetland.

Conceptually this will be achieved by the creation of 6 or 7 wetlands which will all be capable of sustaining a viable wetland ecosystem. The water surface area expressed by each wetland will be at least 1,000m^2 as at the first week of summer of any year. This is consistent with wetland criteria proposed in the EPA's Draft Environmental Protection (Swan Coastal Plain Lakes) Policy, 1992.

The proposed replacement wetlands have the potential to possess the following natural and human use benefits.

a) A greater diversity of wetland vegetation types;
b) Providing a variety of waterbird habitats (open water roosting, feeding, breeding and loafing sites);
c) Creating landscape features which can be utilised for public enjoyment; and
d) Nutrient stripping sites which will improve the water quality of the Osborne Park Branch Drain.

5.0 EXISTING WETLAND ENVIRONMENT

5.1 Site Description

The Cedric Street Wetland may generally be described as a shallow peat-based wetland basin dominated by extensive in-lake beds of bulrushes. The northern portion of the wetland contains thickets of *Melaleuca* (paperbarks) with occasional occurrence of *Eucalyptus rudis* (flooded gums) around the wetland fringe.

The site is used as a dumping ground for rubbish and building materials which generally reflects the degraded nature of the wetland and its surrounds. The invasion of introduced flora (blackberry, castor oil plants, pampas grass) further detracts from the aesthetics of the local environment.

The soils associated with the Cedric Street Wetland belong to the Herdsman unit which are characterised by black peat swamp deposits being mainly saturated fibrous organic soil (DCE, 1980). The peat base varies in thickness from 0.0 to 3.6 metres deep and is mostly concentrated in the northern portion of the wetland. The peat overlies pale, coarse grained Karrakatta sands of the Spearwood Dune System which show some organic darkening at the surface and become paler with depth. Significant amounts of introduced fill (clays, yellow sands, lime sands) associated with Freeway, house and road construction is evident around the wetland perimeter.

A raised bank overgrown with kikuyu grass separates the Cedric Street Wetland from the wetland complex to the south. A small permanent lake (Southern Wetland) and associated damplands (see Plan 1) persist in the low lying areas in close proximity to the nearby residential development.

The permanent lake possesses in lake beds of bulrushes which, along with flooded gums and caster oil plants, fringe the wetland. Mature flooded gums have been previously felled with resultant epicormic and seedling regeneration. Alongside the drainage channel on the upper eastern and southern part of the dampland are several significant stands of mature flooded gums. The entire wetland/dampland system is covered with kikuyu grass which form thick mats in moist, low lying areas.

The Southern Wetland possesses a similar morphological characteristic to the Cedric Street Wetland and probably played a more interconnected role with the larger wetland prior to the surrounding land use modifications.

5.2 Delineation of Cedric Street Wetland

In order to determine the feasibility of translocating the various functions of the Cedric Street Wetland, it is necessary to delineate the wetland boundary. This was accomplished by on-site inspection, examination of recent aerial photography and investigation into the existing water level regimes. Plan 4 shows the maximum and minimum areas expressed by the wetland water body. The maximum water area expressed by the Cedric Street Wetland during winter 1992 is calculated at approximately 13,500m^2, whilst minimum water area probably fell below 3,000m^2 during the 1991/1992 summer period.

The calculated wetland area also represents a considerably smaller area than the 6.5 hectare area delineated in the Draft EPP (Lakes) Map (See Plan 2) which takes into account the proposed wetland water body, fringing vegetation as well as surrounding areas protected from polluting activities.

5.3 Ecological Values

5.3.1 Summary

The Cedric Street Wetland is bounded by Cedric Street, the Mitchell Freeway, Oswald Street and Staveley Place in Innaloo. It is approximately 1 hectare in size and is composed of a large disturbed area of weeds and grasses and a section fringing wetland vegetation with the waterbody itself filled with a dense stand of Typha orientalis mixed with Baumea articulata (see Plan 5).

The site was surveyed on July 25, 1992 and flora, fauna (vertebrate and macroinvertebrate) species present were recorded.

5.3.2 Flora

Floral diversity was low with a total of 36 species recorded, of which 11 were native. The low diversity is due to the disturbance of the site and the domination of Typha throughout the wetland. According to the Department of Conservation and Land

Management (CALM) Rare Flora Database, there are no rare or endangered species or species with restricted distributions recorded within the study site, however, a student undertaking a study of the Cedric Street Wetland apparently recorded a rare sedge species. This was not recorded during the survey associated with this proposal but will require verification during the summer months when sedges generally flower and identification is possible. Transplantation of sedge species is considered a viable management option.

5.3.3 Fauna

Vertebrates

Faunal diversity was also low with only 11 species of vertebrates (1 fish species, 6 bird species and 4 frog species) recorded as present and a further 15 expected to occur at the site. The possible utilisation of the Cedric Street Wetland by the Southern Brown Bandicoot was also indicated. This species is listed on the rare and endangered species list (Department of Conservation and Land Management - Wildlife Branch) and appropriate measures in determination of its existence and relocation will require further investigation.

Macroinvertebrates

Macroinvertebrates refer to small animals without a backbone or possess an exoskeleton. Macroinvertebrates are generally not easily detectable with the naked eye and require identification with magnifying equipment. For the purpose of this assessment, a survey of aquatic macroinvertebrate species was undertaken. Macroinvertebrates are an essential component of wetland food webs, are responsible for a significant proportion of the secondary production occurring in wetlands and act as biological indicators for the assessment of water quality (Davis et al, 1987). Macroinvertebrate samples of the Cedric Street Wetland identified approximately 20 species of aquatic macroinvertebrates . Although most functional feeding groups were present, the low diversity is most likely a result of disturbance and poor water quality.

No rare or endangered species or species with restricted distributions were recorded within the study site and the generally degraded nature of the wetland indicates its low conservation value. Detailed results on the biological survey of flora and fauna in the Cedric Street Wetland is given in Appendix 1.

LEGEND

MINIMUM WATER AREA EXPRESSED

MAXIMUM WATER AREA EXPRESSED

PRINCIPAL

DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

TITLE

CEDRIC STREET WETLAND WATER LEVEL REGIMES

PROJECT

STIRLING REGIONAL CENTRE PLAN

ARCHITECTS URBAN DESIGN PLANNING INTERIOR DESIGN
WOODHEAD AUSTRALIA

BSD CONSULTANTS
CONSULTING ENGINEERS, TOWN PLANNERS & PROJECT MANAGERS
BSD HOUSE, 1 SLEAT ROAD, APPLECROSS. PHONE No 316 2988

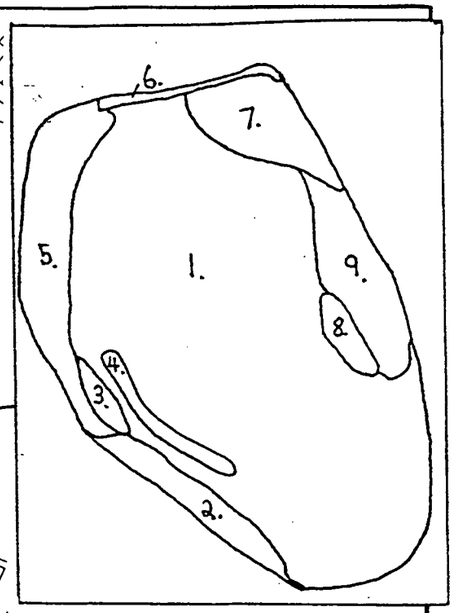
N W E S

DATE MAY 92

JOB No. P9232

SCALE 1:8000

PLAN No. 4



1. WATERBODY CONTAINING *TYPHA* AND *BAUMEA*
2. SLOPE DOMINATED BY *PTERIDIUM*
3. REGENERATING *EUCALYPTUS RUDIS* STAND
4. SUBMERGED *ISOLEPIS* BAND
5. WEED CHOKED MARSH WITH *CORTADERIA* AND GRASSES
6. OPEN DRAIN
7. *MELALEUCA RHAPHIOPHYLLA* SWAMP
8. *E. RUDIS / M. RHAPHIOPHYLLA* STAND
9. DISTURBED BOGGY GROUND DOMINATED BY WEEDS

PRINCIPAL

DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

TITLE

VEGETATION TYPES ASSOCIATED WITH THE CEDRIC STREET WETLAND AS IDENTIFIED IN FLORA SURVEY.

PROJECT

STIRLING REGIONAL
CENTRE PLAN

ARCHITECTS URBAN DESIGN PLANNING INTERIOR DESIGN
WOODHEAD AUSTRALIA

BSD CONSULTANTS
CONSULTING ENGINEERS, TOWN PLANNERS & PROJECT MANAGERS
BSD HOUSE, 1 SLEAT ROAD, APPLECROSS. PHONE No 316 2988

N W E S

DATE MAY 92
JOB No. P9232
SCALE 1:8000

PLAN No. 5

5.3.4 Ecosystem and Habitat

The Cedric Street Wetland possesses a simple ecosystem structure. The extensive Typha reed beds dominate the ecosystem, recycle nutrients and provide a source of primary production to the wetland system upon decomposition. The low diversity of macroinvertebrate and vertebrate fauna communities indicate that higher order consumers of the ecosystem are fairly limited.

The Cedric Street Wetland however is a component of a larger remnant wetland system which includes the Southern Wetland and surrounding damplands. It is proposed that the wetland replacements will also encompass the values of these wetlands as part of the overall proposal. This will enable the proposed recreated wetland system to replace and improve upon the functions performed by all the wetlands within the Stirling Regional Centre site. This will be achieved by creating a greater diversity of habitats than presently exist and providing a long term management solution to a currently unmanaged, degraded environment.

According to habitat classification for wetlands of the Darling System (Semeniuk, 1987), the Cedric Street Wetland is a lake - permanently inundated basin (Full classification: Microscale, elongate, fresh, poikilohaline lake). The Southern Wetland is also a lake (Full classification: microscale, ovoid, fresh, poikilohaline, lake) Semeniuk's classification is based on a geomorphic approach related fundamentally to landform development and water maintenance.

5.4 Social Values

The social values of a wetland may be determined using the Human Use questionnaire outlined in the EPA's "Guide to Wetland Management in Perth, 1990" Bulletin 374. Further investigation into various components of the human use aspects of the wetland provide the background on how the wetland is perceived and utilised by the local and broader community. After completion of the questionnaire it is apparent that the Cedric Street Wetland has little human use attributes which corresponds to its M Category or "Multiple Use" classification. (See Appendix 4). The Southern Wetland was also assessed using Bulletin 374, resulting in a "Multiple Use" management category (Appendix 5).

5.4.1 Wetland Management Objectives

According to Bulletin 374, wetlands in M category are significantly degraded, possessing few natural attributes and limited human use interest.

These management objectives should be considered in context of catchment and land use planning (especially drainage nutrient enrichment, surface and groundwater pollution) and in terms of the current value of the wetland and the potential value to the community if recreated.

5.4.2 Landscape and Amenity Values

The invasion of introduced vegetation, present and past utilisation of wetland surrounds for the dumping of rubbish, inaccessibility and lack of native plant species diversity limit the landscape and amenity values of the Cedric Street Wetland.

An area of planted *Eucalyptus rudis* (flooded gums) on higher ground to the north of the Cedric Street Wetland provide a vegetation buffer and screen the wetland from Cedric Street traffic. Thickets of *Melaleuca preissii* (paperbarks) provide a degree of landscape value, as does the significant stands of naturally occurring flooded gums scattered along either side of the Osborne Park Branch Drain in the southern section of the Stirling Regional Centre site.

5.4.3 Existing Land Use

The existing land use surrounding the Cedric Street Wetland (see Plan 6), is mainly responsible for the water quantity and quality within the wetland area.

Residential

Established low density (R20) urban development to the north-west, west and south-west of the Cedric Street Wetland. In addition to recently established medium density (R30) residential development directly north of the wetland is the predominant land use in the vicinity.

Roads and Freeways

The Cedric Street Wetland is bounded by Oswald Street (west) Cedric Street (north) and the Mitchell Freeway and proposed Stephenson Highway (east). The construction and

RESIDENTIAL

HERTHA ROAD
LANDFILL SITE

MITCHELL FREEWAY

PROPOSED STEPHENSON HIGHWAY

RESIDENTIAL

SHOPPING CENTRE

INDUSTRIAL

LOTS COVERED BY
PEAT EXTRACTION LICENSE

PRINCIPAL

DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

TITLE

EXISTING LANDUSE

PROJECT

STIRLING REGIONAL
CENTRE PLAN

ARCHITECTS URBAN DESIGN PLANNING INTERIOR DESIGN
WOODHEAD AUSTRALIA

BSD CONSULTANTS
CONSULTING ENGINEERS, TOWN PLANNERS & PROJECT MANAGERS
BSD HOUSE, 1 SLEAT ROAD, APPLECROSS. PHONE No 316 2988

N W E S

DATE MAY 92
JOB No. P9232
SCALE 1:8000

PLAN No. 6

preliminary roadworks associated with these service corridors have restricted the potential extent of the wetland and have resulted in the filling in the north-eastern section of the wetland.

Peat Extraction Licence

A peat extraction licence administered by the City of Stirling exists over those lots as shown in Plan 6. Peat mining is expected to be undertaken in the future as development plans for the Stirling Regional Centre become further advanced. The peat associated with the Cedric Street wetland is to be used to recreate the substrate of the replacement wetlands.

5.4.4 Existing Management of Wetland

The Cedric Street Wetland is currently an unmanaged wetland at the risk of further degradation. There has been no attempt to actively rehabilitate the wetland or take responsibility for the future control and maintenance of the wetland surrounds.

The City of Stirling, many years previously, undertook a series of pesticide applications to control mosquitoes. This was discontinued when it became apparent that the relatively small advantages of such practices did not compensate the potential adverse effects with respect to human and ecosystem health.

In order to secure the long term viability of the Cedric Street Wetland, significant rehabilitation would need to commence. Without a management body to provide guidance and funding for such an enormous tasks, it is probable that the Cedric Street wetland will not improve beyond its degraded state.

It is also unlikely that the Cedric Street Wetland will be earmarked for rehabilitation in its present position due to the impending development associated with the Stirling Regional Centre, lack of government funds available and retention of the wetland is against landowners whom recognise the degraded nature of the wetland and realise the potential to financially and socially benefit from the proposed development.

5.5 Hydrological Values

Wetlands on the Swan Coastal Plain are generally surface expressions of groundwater or locally perched water table (such as the Cedric Street Wetland) when an impermeable (rock) or less permeable (peat/clay) layer impedes the infiltration of surface orientated drainage. The Cedric Street Wetland plays a role in the local surface drainage system by mitigating storm surge from local catchment areas.

5.5.1 Existing Water Level Regimes

The present water level of the Cedric Street Wetland is largely a result of development associated with the construction of the Mitchell Freeway and drainage requirements for a recent medium density housing development of the north of the wetland.

During winter when the surface water area is greatest (approximately 1.35ha) the Cedric Street Wetland has a maximum depth of 0.75m, however, the maximum water levels over the majority of the wetland basin range from 0.1-0.5m. This is reflected by the proliferation and relative density of Typha (bulrushes) which dominate the wetland.

The minimum surface water area (summer) is predicted between 0.2-0.3ha and may attain a maximum depth of 0.25m. Precise determination of minimum water levels for the Cedric Street Wetland was not possible in the context of this report due to the limited time available to assess seasonal changes and the lack of available information on this relatively unknown and unstudied wetland environment.

5.5.2 Water Quality

Wetland water quality is an important determinant of the health and status of a wetland environment and has important implications for the diversity and sustainability of wetland dependent flora and fauna. Table 1 records the data for a range of water quality parameters collected during a water sampling survey of the Cedric Street Wetland conducted on the 21st July, 1992.

Table 1
Cedric Street Wetland Water Quality Data

Parameter	Cedric Street Wetland
Depth	0.45m
pH	7.12 units
Conductivity (TDS)	318
Temperature	14.03
Dissolved Oxygen	13.3
Total Phosphorous	0.45
Total Nitrogen	9.8
Total Kjeldahl Nitrogen	4.2
Nitrate/Nitrite	5.6
Chromium	<0.002
Copper	0.018
Lead	0.006
Nickel	<0.05
Zinc	0.12
Dieldrin	0.010 ug/1
Heptachlor	0.007 ug/1
Phaeophytins	<3.9
Cholorphylla	15

Note: a) Units in mg/1 unless otherwise stated.
b) Samples analysed by professional analytical laboratories were collected at random, filtered and prepared in the appropriate manner.

The dominant features of the baseline data indicate the Cedric Street Wetland is a freshwater basin, well mixed with elevated levels of phosphorous, nitrogen, chlorophyll 'a', heavy metals and pesticides. The lake is classified as mesotrophic-eutrophic according to OECD boundaries (OECD, 1982).

These water quality values, particularly nutrients, heavy metals and pesticides are significantly greater than criteria proposed in the Herdsman Lake Water Quality Study which has been adopted as environmental goals for the replacement wetlands (see section 3.1)

It should also be pointed out that sampling during winter months generally results in significant dilution of water contaminates which suggests a negative relationship with water level and a positive relationship with water quality parameters, particularly nutrients (Congdon, 1986).

5.5.3 Role in Local Flood Control

The Cedric Street Wetland is currently utilised for flood control and stormwater drainage purposes from a drain situated on the northern edge of the wetland. The drain services residential developments to the north and north east of the wetland.

The wetland capacity increases as the addition of stormwater drainage is contained by the surrounding embankments associated with nearby road and house construction. The underlying peat layer impedes the infiltration of water into the underlying superficial aquifer and eventually as stormwater flows decline, the Cedric Street Wetland releases water back into the drainage channel. This situation further supports the perched watertable theory and suggestions that the present water level regimes are largely due to development within the catchment.

5.5.4 Pollutant Trapping

Pollutants entering urban wetlands are generally derived from surface runoff rather than groundwater inflows. Nutrients, heavy metals and other pollutants tend to be predominantly particulate in nature (insoluble) and are transported into the wetland via stormwater drainage. The particulates settle out and are retained within the wetland.

Urban wetlands in the Perth Metropolitan area are also commonly used for local flood control. Wetlands are very resilient and can tolerate significant nutrient loads until such time as the assimilative capacity of the wetland is reached. Beyond this point, the wetland may produce water quality problems associated with nutrient enrichment(eutrophication)

such as algal blooms, deoxygenation of the wetland sediments and water column and subsequent alteration of the balance of wetland ecosystem components.

5.6 Osborne Park Branch Drain

The Osborne Park Branch Drain is predominantly an open channel type drain which assists in local flood control by providing a rapid transport route for the collection and diversion of surface to runoff and areas subject to high water tables. The surface catchment area of the Osborne Park Branch Drain upstream of the Cedric Street Wetland amounts to 13.662km^2 (WAWA).

5.6.1 Flow Rates

According to WAWA information the flow rates for the Osborne Park Branch Drain in the vicinity of the Cedric Street Wetland ranges from 5.0m-5.2m^3/s (1 in 10 year or 6 hour storm) to 6.7-7.4m^3/s (1 in 100 year or 36 hour storm). These flows are for ultimate development of the catchment but may change in the future with proposed changes to compensating basins associated with development proposal upstream.

5.6.2 Water Quality

Due to the extensive catchment area, variety of land uses in that area (eg industrial, residential, market gardens etc) the Osborne Park Branch Drain experiences fairly poor water quality throughout most of the year. Water quality data taken by WAWA between 30/5/90 and 14/10/91 and results from a water sampling survey taken by BSD Consultants on 21/7/92 are shown on Tables 2 and 3 respectively.

Table 2
OSBORNE PARK BRANCH DRAIN - WATER QUALITY DATA
(30/05/90 - 14/10/91)

Parameter	30/05/90	13/11/90	13/05/91	14/10/91
pH	7.05	7.40	7.50	6.90
Conductivity (mSm^{-1})	66	77	46	80
Total Phosphorous	-	-	0.039	0.076
Total Nitrogen	5.25	-	-	-
Total Kjeldahl nitrogen	1.05	1.90	1.40	3.85
Nitrate and Nitrate as nitrogen	4.15	5.40	-	6.65
Nitrite as nitrogen	0.027	-	0.007	-
Nitrate as nitrogen	-	-	0.165	-
Ammonia as nitrogen	0.50	2.15	0.037	2.15
Chromium	0.0015	<0.04	<0.002	<0.02
Copper	<0.05	<0.05	0.0110	<0.02
Lead	0.0070	<0.2	0.0090	<0.1
Nickel	<0.100	<0.2	<0.05	<0.2
Zinc	<0.04	<0.002	0.10	0.06

Source: WAWA

Note: All concentrations are expressed in mg/l with the exception of pH (units).

Table 3
OSBORNE PARK BRANCH DRAIN - WATER QUALITY DATA

Parameter	21/07/92
Depth	0.45m
pH	6.99
Conductivity (TDS)	431
Temperature	14.03
Dissolved oxygen	13.3
Total Phosphorous	0.10
Total Nitrogen	7.6
Total Kjeldahl nitrogen	2.7
Nitrate/Nitrite	4.9
Chromium	<0.002
Copper	0.006
Lead	0.003
Nickel	<0.05
Zinc	0.24
Dieldrin	0.014 ug/l
Heptachlor	0.004 ug/l

Note: All values in mg/L unless otherwise stated

Note: Water quality results for Table 3 are averages and composite sample measurements taken at random within the drain waterbody.

It is clear from both Table 2 and Table 3 that the Osborne Park Branch Drain has poor water quality similar to Cedric Street Wetland. Excessive nutrients, pesticides and heavy metals are similar, although generally slightly less than water quality data for the Cedric Street Wetland. The Osborne Park Branch Drain may be classified as mesotrophic-eutrophic according to OECD criteria.

6. POTENTIAL ENVIRONMENTAL IMPACTS AND MANAGEMENT

6.1 Introduction

The Cedric Street Wetland replacement proposal has the potential to cause environmental impacts which require management. The primary mitigating measures for the loss of wetland habitat will be offset and enhanced by the re-creation of multiple wetland habitats into the existing aquatic environment of the Osborne Park Branch Drain.

The overall objective of this section of the report is to demonstrate the feasibility of creating a series of wetlands which replace the ecological, social and hydrological functions of the Cedric Street Wetland.

6.2 Ecological Environment

6.2.1 Functional Objectives

The functional objectives for the ecological environment are as follows:

- retain an area of the *Melaleuca* woodland existing at the Cedric Street Wetland;
- minimise impacts associated with the loss of the Cedric Street Wetland habitat by using relocation techniques which ensure the success of rehabilitating the newly created wetlands;
- provide a peat based wetland with sections of shallow water which allow optimum emergent native plant growth for wetland series;
- increase species diversity in the area by creating a wide range of beneficial fauna and flora habitats;
- recolonise newly created wetlands with dense native fringing vegetation in an expedient manner to discourage the domination of *Typha*;
- encourage waterbird activity in the local wetland environment (eg feeding and breeding habitat, breeding boxes etc).

6.2.2 Wetland Flora

Impacts

The impacts on wetland flora from the filling of the majority of the Cedric Street Wetland are mainly associated with the loss of existing fringing and in-lake vegetation. Vegetation types of the Cedric Street Wetland identified as possessing conservation value include the *Melaleuca* thickets in the north-east section of the wetland, native sedges *(Baumea articulata*, etc) and pockets of flooded gums scattered along the southern fringes of the wetland.

Management

Prior to construction works that may impact upon the Cedric Street Wetland, an intensive vegetation relocation programme will be undertaken. The aim of the programme is to locate and transplant vegetation species of the Cedric Street Wetland which have conservation value and re-establish these to newly created wetlands.

Native sedges and rushes such as *Juncus pallidus* and *Baumea articulata* can be transplanted quite successfully (Godfrey et al, 1991). Other important fringing vegetation species such as *Melaleuca priessii* (paperbarks) and *Eucalyptus rudis* (flooded gums) can be readily grown from seed months prior to the planned wetland re-creation. In this way seedlings can be introduced in conjunction with direct seeding to ensure the rapid colonisation of desirable wetland species.

In order to increase the species diversity for the newly created wetland series, a range of tree, shrub and groundcover species which naturally occur on Swan Coastal Plan wetlands can be established. Suitable species, their description and suitable sites are given in Appendix 3 (Godfrey et al, 1991).

6.2.3 Wetland Fauna

Impacts

The impacts on wetland fauna are mainly due to excavation and subsequent filling of the Cedric Street Wetland. Of concern is the potential loss of frog species which inhabit the rush and sedge plant communities and the possibility that the habitat of any Southern Brown Bandicoots in the vicinity may be affected.

Management

The retention of the *Melaleuca* thicket in the residual wetland will provide a habitat for frogs and other fauna as well as native wetland vegetation types.

The vegetation relocation programme involves the transplantation of vegetation types which wetland fauna have evolved with as a preferred habitat. The relocation of closed rush and sedge plant communities also has the potential to relocate faunal species attached to the soil and root zone of the vegetation clumps. A thorough investigation and possible trapping exercise will be detailed in the Environmental Management Plan in an effort to verify and/or successfully relocate the Southern Brown Bandicoot. Following the flora and fauna relocation programme will be the removal of sections of the Cedric Street Wetland's existing peat substrate. The peat must be excavated (under a licence administered by the City of Stirling). It is proposed that the peat will be directly transferred to the newly created wetland basins to avoid stockpiling of peat and possible nutrient release from decomposition of material. Additional peat will be won from surrounding areas if required.

The peat will be transported to the excavated wetland sites and be incorporated as a 1-2m thick lining for the newly created wetland series. It is considered that some translocation of faunal species will occur during this phase and, based on the similarity of wetland characteristics (ie. extensive areas of shallow water) will be able to survive and re-establish in their new environment.

The provision of a diverse range of habitats is expected to encourage a greater diversity of fauna to the newly created wetlands.

6.2.4 Ecosystem and Habitat

Impacts

Detailed botanical and zoological surveys have indicated that the ecosystem and habitat types of the Cedric Street Wetland are extremely limited. The ecosystem is almost entirely dominated by *Typha* which hinders the diversity of plant and animal species with little opportunity for species recruitment without extensive rehabilitation.

Habitat types presently existing in the Cedric Street Wetland consist mainly of shallow seasonally inundated rush and sedge communities and thickets of mature paperbarks in the north-eastern fringe of the wetland.

The filling and subsequent development of the Cedric Street Wetland site will result in the loss of the present ecosystem and habitat types in their present location.

Management

As previously mentioned, methods for the transplantation and relocation of wetland flora and fauna will be employed prior to construction associated with the Cedric Street Wetland. Investigations indicate that transplanting mature paperbarks is possible providing access for the removal and transport of specimens is assured, although the transplantation of juvenile specimens and introduction by seed is generally the preferred option.

The loss of the Cedric Street Wetland ecosystem and habitat types will be compensated by the re-creation of a greater variety of habitat types capable of supporting an ecosystem of increased species diversity. The range of habitat types will be based on the natural succession of Swan Coastal Plan wetlands and include:

1. Permanent open water with a minimum of 0.5m depth;
2. Shallow wetland basins with extensive areas of seasonally inundated banks containing native rushes and sedges;
3. Thickets of *Melaleuca preissiana* and *M. rhaphiophylla*;
4. Mixed open forest of *Eucalyptus rudis* (flooded gums), *Banksia littoralis* (river banksia) and *Allocasuarina obesa* (swamp oak) supported by a variety of shrub species adapted to waterlogged soils such as *Melaleuca, Agonis* and *Astartea.*
5. Dry land forest consisting of a variety of *Banksia, Eucalypt* and *Allocasuarina* species with associated understorey backing the wetter areas.
6. Islands suitable for waterbird breeding.

The open water of minimum permanent depth of 0.5m discourages the establishment of *Typha,* provides feeding and loafing sites for waterbirds and creates a suitable habitat

which favours the establishment of aquatic species such as macro-invertebrates, long-necked tortoises, freshwater crustaceans and native fish populations. These species may colonise from the Osborne Park Branch Drain or nearby environment or alternatively be introduced from nearby wetlands.

The shallow, seasonally inundated wetland basins provide a habitat for frogs and macro-invertebrates which refuge in the rush and sedge plant communities. The vegetation also aerates the benthic substrate, assimilates and stores nutrients, is a valuable primary producer for the ecosystem food web, and provides stability for the wetland basin.

The thickets of mixed *Melaleucas* create a natural refuge for native animals, particularly waterbirds where nesting and roosting sites may be utilised. The paperbarks also carry out oxygenation, nutrient cycling and other functions as described for the seasonally inundated basin area.

The mixed open forest of flooded gums, banksias and swamp oak also provides refuge, nesting and roosting sites in addition to screening the wetland environment from the surrounding land use.

Dry land forest and associated understorey may be revegetated in areas where the appropriate habitat conditions can be provided. Public Open Space adjoining the wetlands may be utilised for the establishment of these vegetation types.

Fencing will be incorporated into the design of the wetlands and public amenities (dual use paths, Public Open Space etc) in order to offer some protection and safety for the proposed wetland system and its communities.

6.3 Social Environment

6.3.1 Functional Objectives

The objectives for the replacement of the Cedric Street Wetland are to create a wetland series which provides for:

- active management;
- recreation (eg bike riding, walking, bird watching);
- nature study;
- education;

- access to wildlife; and
- aesthetically appealing environment.

As mentioned earlier, the Cedric Street Wetland possesses little social value. There is currently no management body responsible for the rehabilitation and maintenance of the Cedric Street Wetland. Due to the multiplicity of private landowners, substantial economic outlays involved in rehabilitating the wetland at its present site and the recognised development potential of the site, it is unlikely that a management body will emerge in the foreseeable future.

6.3.2 Visual Aesthetics

Impacts

The main component of the social environment to be potentially adversely affected by the Cedric Street Wetland replacement proposal relates to visual impacts through physical modification and subsequent development of the existing wetland environment.

From the transport routes surrounding the Cedric Street Wetland it is not obvious to the casual observer that a wetland exists. The degraded nature of the wetland and the extent of numerous rubbish dumping sites detracts from the visual appeal of the site. The *Melaleuca* thickets along the north-eastern perimeter of the Cedric Street Wetland do provide a form of scenery that may be described as aesthetically pleasing.

Management

The proposed creation of additional wetlands along the Osborne Park Branch Drain will have obvious aesthetic appeal. The provision of dual use pathways, public open space and landscaping will be incorporated into the overall design of the wetland system and take advantage of the natural and human use attributes of the urban wetland environment.

6.3.3 Future Land Use

The Cedric Street Wetland occupies Precinct 1 - Core Precinct of the Stirling Regional Centre. Plan 3 shows the Draft Indicative Development Plan (IDP) for the Stirling Regional Centre with Section 4.2 of the CER providing additional text on the proposed future land use of the site.

It is proposed that some of the replacement wetlands will occur further upstream of the Osborne Park Branch Drain and fall within Precinct 3 which immediately adjoins the Stirling Railway Station.

The southern part of Precinct 3 will accommodate the translocated wetland and be adjoined by medium density (R40) housing and a retirement village.

6.3.4 Future Management

As part of the City of Stirling's involvement in the Regional Centre, the Parks and Gardens section of the Council has committed its resources to the long-term management of the proposed artificial wetland system. This is a marked improvement on the unmanaged situation which currently prevails at the Cedric Street Wetland which is an outstanding example of the need to properly manage these environments.

6.4 Hydrological Environment

6.4.1 Functional Objectives

The hydrological objectives for the proposed wetlands will have a bearing on the design and dimensions of the replacement wetlands. It is intended that the newly created wetland series will perform the following hydrological functions:

- Replacement and improvement of the hydrological functions currently performed by the Cedric Street Wetland;

- Maintain the current drainage and flood control functions of the Osborne Park Branch Drain whilst providing additional storage to accommodate run-off associated with the proposed Stirling Regional Development;

- Provide a combination of permanent open water and shallow, seasonally inundated wetland banks to provide a diversity of ecosystem habitats;

- Enhance nutrient/pollutant removal; and

- Design wetlands to maintain a water level regime which optimises the establishment of wetland fringing vegetation, provides access and passive

recreational opportunities for the public, and improves water quality of the Osborne Park Branch Drain.

6.4.2 Wetland Design

Typical cross-sections of the proposed replacement wetlands are given in Plan 7. The wetlands will have a floor level 0.5m below the minimum groundwater level to provide permanent water in the basin. The slope of the banks between the groundwater level and the 1 in 5 year flood level will be 1 in 15, to provide conditions suitable for the establishment and maintenance of emergent wetland fringing vegetation.

Generally the water levels in the wetland basins will range from a minimum depth of 0.5m in summer to a maximum depth of 2.0m in winter.

A peat base of thickness ranging from 1-2m will be constructed within each basin. Peat would be won from the reclaimed wetlands. A surface sand layer would be placed in the seasonally inundated zone to provide a base for the growth of emergent vegetation.

The inlet pipe will be designed to balance the water level between the main drain and each individual wetland. A flap valve will prevent outflow from the pond through the inlet pipe when the water level in the main drain falls after a storm event.

The outlet pipe's size and invert level will be designed to provide an average retention of 4 days for a 1 in 10 year Average Recurrence Interval storm. It is anticipated that a lower permanent water level and spillway level will be required for wetlands which receive stormwater from local catchments in addition to inflow from the main drain. This will provide additional temporary storage and minimise stormwater surcharge in the local stormwater system.

It is possible to control sediment entering the wetlands from stormwater drainage discharging directly into the wetlands from local catchments by the employment of sediment traps or basins. The traps would be placed preferably in the last stormwater pit in each contributing catchment whilst the basins could be located adjacent to the wetland site.

A spillway providing an overland overflow path to the main drain will be constructed at the 1 in 5 year flood level for wetlands which receive stormwater from local catchments adjacent to residential areas and at the 1 in 10 year level for wetlands which only receive inflow from the main drain. The spillway would be constructed of erosion-resistant material (eg mortared stone) to prevent scour.

Islands may be incorporated into the basins to encourage wildlife and provide protection from predation and human disturbance. The slopes of the banks may be increased in sections of the wetland to provide greater public access to the water's edge and also match the existing surface level where space is limited or where wetlands abut the Freeway reserve.

The final design of the wetland basins including the groundwater and hydraulic levels will require detailed investigation to ascertain the most suitable and effective basin geometry.

6.4.3 Water Quality

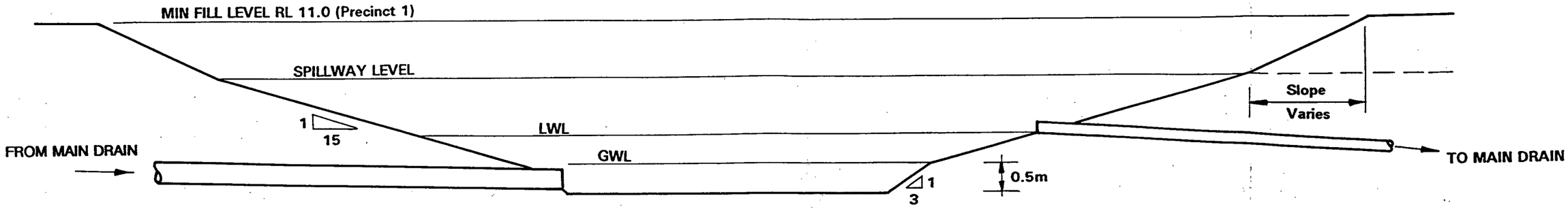
The newly created wetlands will provide permanent pollutant-stripping sites which will benefit the local and downstream environment.

The area of sand and peat based substrate will be optimised for improving water quality with the provision of extensive shallows, low flow rates and average 4 day retention times. The establishment of emergent vegetation will also play an important role in the water quality function of the wetlands.

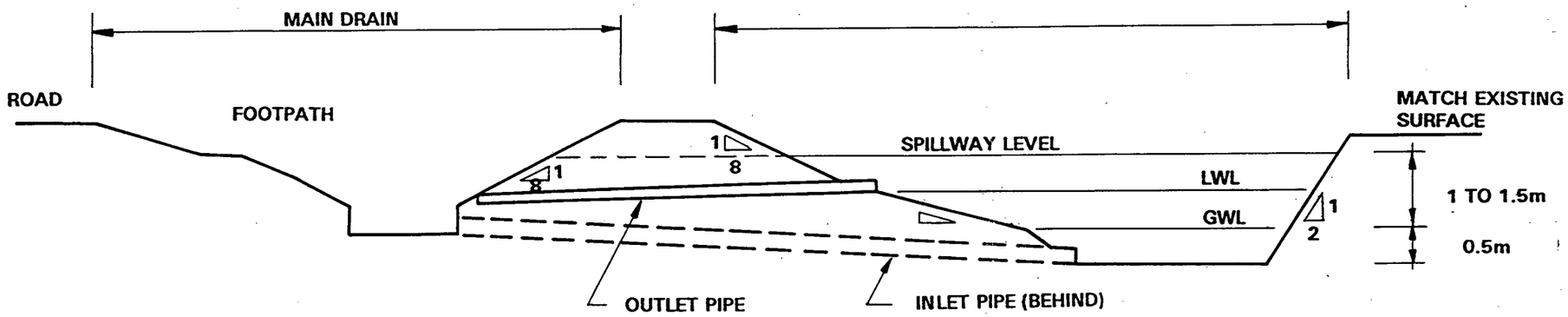
6.4.4 Osborne Park Branch Drain

The potential exists to modify the Osborne Park Branch Drain in a manner that improves its ecological and hydrological values whilst maintaining its drainage function. The extent to which the drain may be modified is largely dependent upon the area constraints imposed by the surrounding land use.

The drain is currently a formalised "U" shaped channel which diverts drainage waters downstream using the most direct method (ie in a straight line). In conjunction with the proposed replacement wetlands, there is an opportunity to provide additional wetland habitats along the branch drain itself. Excavation of a floodplain section on either side



TYPICAL LONGITUDINAL & CROSS SECTION FOR WETLAND BASIN
(NOT TO SCALE)



TYPICAL CROSS SECTION FOR WETLAND BASIN CONSTRAINED BY SURROUNDING LANDUSE
(NOT TO SCALE)

NOTE: CROSS SECTION FOR WETLAND BASIN WITH LIMITED SPACE IS SIMILAR.

GENERAL NOTE: FINAL DIMENSIONS, SLOPES AND LEVELS SUBJECT TO DESIGN CONSTRAINTS.

PRINCIPAL

DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

TITLE

TYPICAL CROSS SECTION OF PROPOSED REPLACEMENT WETLAND

PROJECT

STIRLING REGIONAL CENTRE PLAN

ARCHITECTS URBAN DESIGN PLANNING INTERIOR DESIGN
WOODHEAD AUSTRALIA

BSD CONSULTANTS
CONSULTING ENGINEERS, TOWN PLANNERS & PROJECT MANAGERS
BSD HOUSE, 1 SLEAT ROAD, APPLECROSS. PHONE No 316 2988

N W E S

DATE MAY 92
JOB No. P9232
SCALE NTS

PLAN No. 7

of the formalised channel can improve the pollutant stripping ability of the drain by trapping particulate material and increasing the residence time within the floodplain zone. Plan 8 illustrates the engineering and ecological design features involved in channel (or stream) modifications in the upstream and downstream sections of the Osborne Park Branch Drain.

The drain has improved its function as a biological filter without adversely affecting the existing drainage function it performs. These floodplain and embankment characteristics are already evident along the drain in the southern section of the proposed Stirling Regional Centre site (near Scarborough Beach Road) where a mature stand of flooded gums occur. These areas may only require minor alterations to improve the efficiency of this biological filter role.

The drain modification and function improvement in this manner can be further enhanced by "informalising" the drain route to reflect a meandering channel which more accurately represents a natural stream channel. This can create deeper pools and backwaters which increase the pollutant stripping sites and contribute to the improved function of the wetland system.

6.5 Feasibility of Translocating Functions

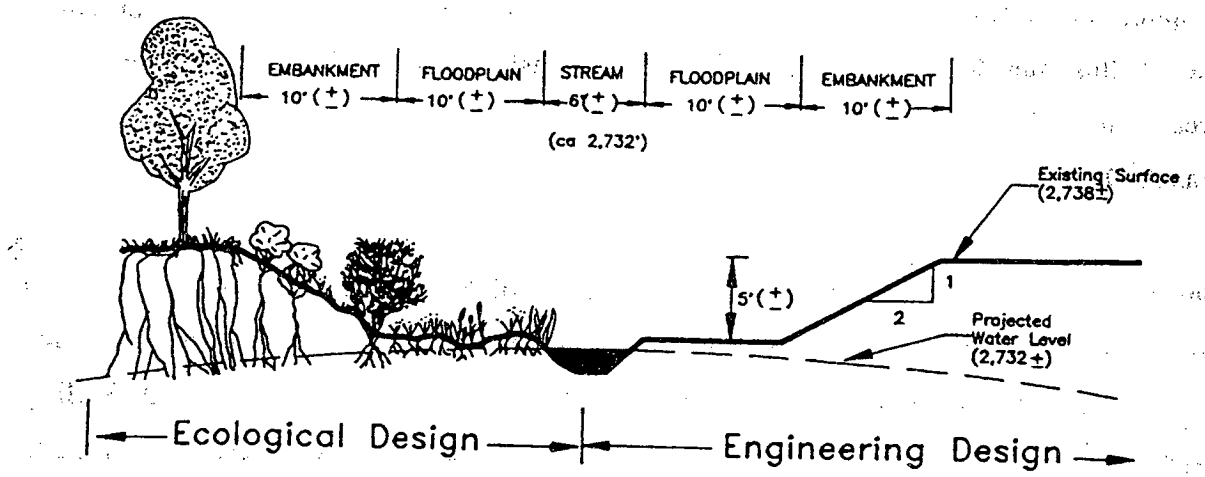
The success of the proposed wetland functional replacement proposal is closely linked to the rate of floral and faunal recruitment to the re-created wetlands.

Factors to be taken into account include:

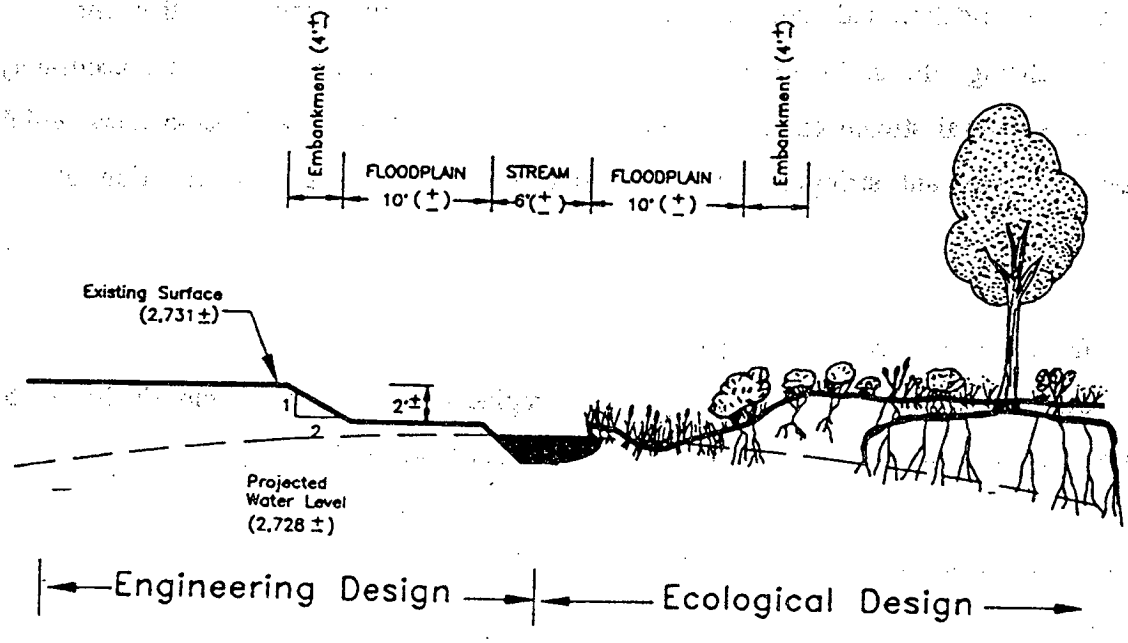
- seasonal considerations;
- maturation of new habitat;
- likely success rates.

6.5.1 Seasonal Considerations

The ability of earthmoving equipment to undertake necessary works to reclaim and re-create the proposed wetlands depends largely on the physical constraints operating in this low-lying environment (boggy soils, inundation, etc). Ideally, the end of summer



A. Upstream Segment



B. Downstream Segment

SOURCE: Kusler & Kentula(1990)

DRAWING TITLE
GENERAL VEGETATION LAYOUT RELATIVE TO ENGINEERING DESIGN IN UPSTREAM AND DOWNSTREAM SEGMENTS OF THE OSBORNE PARK BRANCH DRAIN.

PROJECT
STIRLING REGIONAL CENTRE PLAN

PRINCIPAL
DPUD
CITY OF STIRLING
URBAN RAIL OFFICE

BSD CONSULTANTS PTY LTD
CONSULTING ENGINEERS ⊕ TOWN PLANNERS ⊕ PROJECT MANAGERS
650 HOUSE, 1 SLEAT ROAD, APPLECROSS, W.A. 6153
TEL: (09) 316 2988 FAX: (09) 364 2640

SCALE: NTS
DATE: MAY'92
JOB NUMBER: P9232
DRAWING NUMBER: 8

provides the optimum conditions for such earthworks, as the area is considerably drier and more stable at this time of year.

In terms of wetland vegetation re-establishment, which is an important determinant on the overall success of this proposal, the most beneficial period of the year for transplantation and propagation of wetland vegetation species is during winter and spring when water availability is adequate and seed germination is likely to occur.

Creating wetlands "off line" to the main drain ensures that maximum flows in the drain will produce minimal impacts for vegetation establishment. The management of water levels, as outlined previously, will make it possible to control the levels in the wetlands to a degree which allows the vegetation to adapt to water level regimes. Upon completion of the structural characteristics of the wetlands, an intensive planting and seeding operation will be undertaken to provide rapid establishment of native vegetation and discourage the invasion of less desirable introduced vegetation (eg *Typha*).

A typical schedule outline may be as follows:

- October-April - identification and translocation of flora and fauna, excavation of peat earthworks associated with replacement wetlands, gradual filling of existing wetland.
- November-July - establishment of vegetation through transplantation, planting and seeding, creation of habitat types (waterbird breeding and feeding sites).

At this stage of the Stirling Regional Centre proposal it is difficult to ascertain with any precision the exact timing of the proposed wetland replacement. The above general schedule however can be incorporated into the project planning to allow for the most appropriate conditions for wetland ecosystem establishment.

It is important to note that an Environmental Management Plan will be formulated, to the satisfaction of the EPA, prior to any construction works regarding the filling in or recreation of wetlands associated with the Stirling Regional Centre.

6.5.2 Maturation of New Habitat

It is expected that the maturation of the new habitat to a point where the ecosystem becomes self-sustaining ranges from 2-10 years. Rushes and sedges establish readily, paperbarks require a few years to establish and produce seed, while longer-lived species such as *Eucalypts* and *Banskias* require an establishment period toward the upper scale of the maturation range.

6.5.3 Likely Success Rates

Based on the information and experience of numerous wetland creation and rehabilitation projects such as:

• Wellard Wetlands	(Alcoa of Australia)
• Capel Wetlands	(AMC Mineral Sands Ltd)
• The Spectacles Wetland Project	(Alcoa of Australia)
• Lake Booragoon, Frederick Baldwin Park	(City of Melville)
• Lake Gwelup, Star Swamp	(City of Stirling)
• Big Swamp, Bunbury	(South West Development Authority)
• Wetlands at Capel	(Westralian Sands Ltd)
• North Lake, Lake Yangebup, South Lake	(Wetlands Conservation Society/ DPUD)
• Lake Joondalup, Herdsman Lake	(DPUD)

It is apparent that there is considerable collective knowledge on similar wetland projects and that a high rate of success can be achieved, providing the application of appropriate principles of which many have been outlined in this CER.

6.6 Monitoring Programme

An Environmental Monitoring Programme will assess the performance of wetland habitat establishment and give indications on the likely remedial measures needed to achieve successful function of the wetlands.

A detailed Monitoring Programme will be incorporated into the Environmental Management Plan to be formulated at a date closer to the proposed development. Factors that will be taken into account for the monitoring of wetland performance include flora

and fauna criteria such as species diversity, composition, recruitment and rehabilitation success. Other parameters include hydrological parameters such as water level regime, nutrient retention performance and pollution assimilation estimates.

7. PUBLIC PARTICIPATION

Throughout the compilation of this CER, contact with various government departments, interest groups and the general public was undertaken.

Input was sought and gratefully received from:

- EPA
- Water Authority of Western Australia
- CALM
- City of Stirling
- Department of Planning and Urban Development
- Main Roads Department
- Murdoch University
- Alcoa of Australia
- Wetlands Conservation Society

A display of the Draft Indicative Development Plan for the Stirling Regional Centre (conducted at Innaloo Shopping Centre) also provided an opportunity to discuss relevant environmental matters with members of the public. It was apparent that most concern with respect to the Cedric Street Wetland related to its removal. Most local residents feel the area encompassing the wetland is degraded and the opportunities offered by the Stirling Regional Centre to upgrade the environment are welcomed.

8. ENVIRONMENTAL COMMITMENTS

8.1 Environmental Management Plan (EMP)

The EMP will formulate the specific construction details of the wetland replacement proposal and identify the responsibilities and obligations of the proponent and long term wetland managers. The EMP will incorporate an extensive environmental monitoring programme designed to assess the ongoing performance of the wetland series system in terms of ecological, social and hydrological functions.

The environmental goals and objectives outlined in this CER will be incorporated into the EMP and provide the fundamental framework for its compilation.

8.2 Rationale and Objectives of Environmental Commitments

The rationale behind the formulation of environmental commitments for the proposed functional replacement of the Cedric Street Wetland is to provide necessary guidance on the management of potential environmental impacts. These commitments will feature strongly in a Environmental Management Plan (EMP) which will be compiled at a later date when the development parameters have been ascertained. The environmental commitments have been categorised into

- Pre-operational Environment;
- Operational Environment; and
- Post-operational Environment.

8.3 Pre-operational Environment

1. An extensive Environmental Management Plan (EMP) will be formulated when the development details and wetland construction variables have been rationalised. Important aspects of the EMP include:
   (i) Wetland design;
   (ii) Precise siting of wetlands;
   (iii) Performance criteria;
   (iv) Performance monitoring;
   (v) Management and maintenance of replacement wetlands; and
   (vi) Corrections/contingency plans

The preparation of the Environmental Management Plan will be the responsibility of the proponents with final approval of the EMP by the EPA.

2. Detailed engineering surveys to assess groundwater and hydraulic levels.

3. Identification of vegetation species to be relocated from Cedric Street Wetland and investigations into feasible transplanting methods.

4. A detailed survey and trapping exercise to be undertaken in order to determine the possibility of the Southern Brown Bandicoot or other native mammals utilising the wetland environment.

5. Quantitative analysis on the adequacy of peat reserves necessary for wetland to be created.

6. Precise determination of most beneficial timing of earthworks and vegetation relocation/establishment as part of the wetland replacement proposal.

7. Clear definition of the number, siting, area and other aspects of wetland design.

8. Gain initial background information to assist in the formulation of the environmental monitoring programme.

9. Assess the flow rates and water levels of the Osborne Park Branch Drain which are expected to vary according to final land use proposed upstream.

10. Utilise cleared, low lying sites for wetland recreation which possess minimal potential impacts on remnant vegetation types such as the mature flooded gums in the southern portion of the development site.

11. Undertake necessary precautions that maximise the potential for environmental goals and functional objectives to be achieved.

12. Educate prospective companies, contractors and subcontractors involved in the construction and establishment of wetlands on the environmental goals and objectives of the proposal as outlined in the CER.

13. Undertake a public education process (newspapers, displays etc) to inform the community of the impending proposal and the regional role of the new wetlands in the environment. Public input regarding the design of the wetlands within the parameters and environmental goals will be considered.

14. Landscape Plans for those developments impacting upon the existing and proposed wetlands will be formulated. Implementation of the Landscape Plans will be the responsibility of the proponent. The Landscape Plans will be incorporated into the Environmental Management Plan and therefore will require satisfactory approval by the EPA.

15. The proponents to negotiate the siting of replacement wetlands within the Stirling Regional Centre.

16. Negotiate with MRD the location of replacement wetlands within the Freeway Reserve.

17. A water sensitive design approach will be encouraged for all development design which has the potential to impact on the proposed wetlands.

18. The proponents will be responsible for the management and maintenance of the proposed wetland series during the construction phase and for a further 2 years after practical completion of the wetland project. After this period, the City of Stirling will undertake the role of long term managers of the wetland system.

19. The functions performed by the Southern Wetland/dampland complex shall also be incorporated into the replacement functions of the wetland creation proposal.

8.4 Operational Environment

20. Construction of wetlands and establishment of habitats to be undertaken at most beneficial time taking into account seasonal influences.

21. Adopt excavation, engineering and revegetation practises that enhance the establishment of the newly created wetlands.

22. Monitor earthworks, drainage provisions and wetland storage capacities to ensure the Osborne Park Branch Drain will not be adversely affected by the proposal.

23. Segregate wetland excavation activities from the water course of the Osborne Park Branch Drain to mitigate water quality impacts such as increased turbidity and siltation of main drainage channel.

24. Maximise the establishment of native vegetation by adopting an intensive transplanting/planting/seeding operation for each wetland. This will minimise areas of open ground where Typha are likely to invade.

25. Further development ecosystem performance criteria to be incorporated into the environmental monitoring programme.

26. Restrict access to newly created wetlands by the provision of fencing. Where appropriate the fencing may become a permanent fixture providing it does not impede upon the various functional objectives contained in this CER.

27. Monitoring the water quality of the Osborne Park Branch Drain to assist in the effectiveness of nutrient/pollutant stripping functions of wetlands.

28. Ensure the long term managers of the wetland system (City of Stirling) are well informed on the environmental goals of the wetlands. Their active involvement in initial stages of wetland creation will greatly assist in the future management of the wetland environment.

29. Conduct an education campaign and help community groups and school become involved with planting exercises and other activities which contribute to public involvement in the wetland project.

30. Sediment basins will be constructed alongside replacement wetlands to settle out particulates/sediments associated with stormwater drainage prior to entry into the wetland waterbody.

8.5 Post-operational Environment

31. Finalise the environmental monitoring programme for parameters to be monitored based on the collection of baseline data, experience obtained during wetland creation and future performance goals for the ecological, social and hydrological environments. The monitoring programme will form an integral part of the Environmental Management Plan. The proponents will be responsible for the monitoring programme.

32. Educate the managers of the wetlands (City of Stirling) and local community groups on land management practices that contribute to the long term sustainability of the wetland environment (eg conservative fertiliser and water usage etc).

33. Maintain the balance of native vegetation types (sedges, rushes, paperbarks, flooded gums) and use environmentally sensible methods to control the proliferation of undesirable vegetation types (ie manual removal of Typha, Castor Oil plants, pampas grass, blackberry).

34. Encourage the use of native fauna, particularly waterbirds with the establishment of habitat types consistent with the range of waterbird activities. The introduction of hollow logs, nesting boxes, and effective screening are methods to enhance these activities in those wetlands where adequate space and screening is offered.

35. Periodic maintenance of the proposed sediment basins shall be undertaken by the Proponents.

36. The City of Stirling shall employ the use of street sweepers on wetland surface catchment roads in order to reduce sediments prior to the first flush of winter rains (eg March-April).

9. CONCLUSION

The Cedric Street Wetland replacement proposal provides an opportunity to upgrade and utilise an existing degraded site presently possessing minimal human use or natural attributes.

The environmental impacts associated with the proposal can be adequately managed and in most cases shown to produce positive long term consequences. Inappropriate land use planning and a lack of active management has resulted in many of Perth's wetlands becoming eutrophic with subsequent water quality problems. It is considered that the Cedric Street Street Wetland replacement proposal offers a managed, well planned solution for urban wetland environments.

The proposed creation of a wetland series has the potential to valuably contribute toward the role of these threatened environments in a local and regional perspective. It also offers an opportunity to demonstrate that the incremental loss and degradation of suburban wetlands on the Swan Coastal Plain is capable of being curtailed and reversed.

REFERENCES

- Congdon, RA 1986. Nutrient Loading and Phytoplankton Blooms in Lake Joondalup, Wanneroo, Western Australia.
  Technical Series 6, Department of Conservation and Environment, Perth, Western Australia.

- Davis, JA and Rolls, SW 1987. A Baseline Biological Monitoring Programme for the Urban Wetlands of the Swan Coastal Plain, Western Australia.
  Bulletin No 265. Environmental Protection Authority, Perth, Western Australia.

- Davis, JA, Clark, K and Murray, F 1990. Herdsman Lake Water Quality Study.
  Report to Department of Conservation and Land Management, Western Australia.

- Department of Conservation and Environment, 1980. Atlas of Natural Resources - Darling System, Western Australia.
  Department of Conservation and Environment, Perth, Western Australia.

- Environmental Protection Authority, 1992. Draft Environmental Protection (Swan Coastal Plain Lakes) Policy.
  Environmental Protection Authority, Perth, Western Australia.

- Environmental Protection Authority, 1990. A Guide to Wetland Management in Perth, Bulletin 374, Environmental Protection Authority, Perth, Western Australia.

- Godfrey, N, Jennings, P and Nichols O, (Ed) 1991. Draft - A Guide to Wetland Management on the Swan Coastal Plain.
  Wetlands Conservation Society, Perth Western Australia.

- Kusler and Kentula (Ed), 1990. Wetland Creation and Restoration.
  Island Press, USA.

- OECD, 1982. Eutrophication of Waters, Monitoring Assessment and Control. Final Report of the OECD Cooperative Programme on Monitoring of Inland Waters.
  Environmental Directorate, OECD, Pans.

- Semeniuk, CA 1987. Wetlands of the Darling System. A Geomorphic Approach to Habitat Classification.
  Journal of the Royal Society of Western Australia, Vol 69, Part 3, 1987, pg 95-112.

APPENDIX 1

Biological Survey of Flora and Fauna
in the Cedric Street Wetland
(Woodman and Associates)

BIOLOGICAL SURVEY OF FLORA AND FAUNA IN THE CEDRIC STREET WETLAND

Performed by **Woodman and Associates**
Environmental Consultants

Produced for **BSD Consultants Pty Ltd**
July 1992

CONTENTS

SUMMARY

The Cedric Street Wetland is bounded by Cedric Street, the Mitchell Freeway, Oswald Street and Staveley Place in Innaloo. It is approximately 1 hectare in size and is composed of a large disturbed area of weeds and grasses and a section of fringing wetland vegetation with the waterbody itself filled with a dense stand of *Typha orientalis* mixed with *Baumea articulata*.

The site was surveyed on July 25th 1992 and flora, fauna and macroinvertebrate species present were recorded. Floral diversity was low with a total of 36 species recorded of which 11 were native. Faunal diversity was also low with only 11 species of vertebrates recorded as present and a further 15 expected to occur at the site. Macroinvertebrate sampling identified 22 species of aquatic invertebrates in a variety of habitat types, including the Osborne Park Drain. This low diversity is most likely a result of disturbance and poor water quality.

No rare or endangered species or species with restricted distributions were recorded within the study site and the generally degraded nature of the wetland indicates it's low conservation value.

1.0 INTRODUCTION AND SITE DESCRIPTION

This survey was commissioned by BSD Consultants and designed to describe the flora , vertebrate and invertebrate fauna of a small metropolitan wetland bounded by Cedric Street, the Mitchell Freeway, Oswald Street and Staveley Place, Innaloo.

The wetland consists of a low lying area approximately 1 hectare in size. This is bounded by a large disturbed zone, characterized by introduced weed on the Western and Southern edges of the water body itself. Water depth varied between 10cm and 70cm although during summer it is possible that little or no surface water is present. However, the presence of stands of aquatic vegetation, including Bulrush (*Typha orientalis*), indicates that the wetland contains some water throughout the year.

Soil outside the wetland fringe consists of grey sands while the wetland itself has a thick layer (approximately 40cm to 50cm deep) of decaying organic matter on top of a hard red clay layer. Peaty layers are also likely to be present in some of the submerged areas of the wetland (Trudgeon, 1992). The wetland itself is also bounded on the Cedric Street side by an open drain up to 1m wide with a sandy base.

Two sections of the Osborne Park Drain were also included in this survey as it is proposed that artificial (replacement) wetlands be placed in these areas if development on the site of the existing wetland is approved. These sites are indicated in Figure 1. Drain Site 1 was surrounded by the light industrial area of Osborne Park. At this site the drain was approximately 1.5m wide with depths varying from 10cm to 40cm. Substrate consisted of a silty layer (50cm deep), with sand and peat layers also present. Water flow was quite rapid with some slower areas where the channel curved slightly.

Drain Site 2 is situated adjacent to a large oval in the suburb of Stirling on the site of the old Stirling tip. The drain here was approximately 2m wide and 50cm to 60cm deep. The channel itself was straighter here than at Site 1 and as a result water flow was faster

2.0 METHOD

The main site was surveyed on July 25th 1992 by two experienced field personnel. The entire wetland was traversed on foot and vegetation species and types recorded. During this field assessment all vertebrate activity was recorded, including bird and frog movements, and the tape-recording of calls for later identification was also performed

The area was inspected for the scats and diggings of larger vertebrates. Due to the cool weather no reptile activity was evident although a list of species likely to be present is included (Appendix B)

Macroinvertebrate samples were also taken in each distinctive area of the wetland. These consisted of sweep samples using a 500 micron mesh size net. The thick organic layers in most areas prevented sweep samples of definite lengths being taken and therefore only qualitative analysis could be performed. Six sweep samples were taken from the main wetland with four samples being taken from each drain site.

Botanical samples were identified using Marchant *et al* (1987). During the fauna survey actual records were gathered during the field inspection and provisional records (species likely to be present but not recorded during the survey) were drawn from a variety of sources including: Kitchener and Vicker (1978 and 1981), Storr *et al* (1978, 1981, 1986 and 1990), Tyler *et al* (1984) and Blakers *et al* (1984). Macroinvertebrate samples were identified using Williams

(1980).

3.0 BOTANICAL COMPONENT

The flora of the Cedric Street Wetland is typical of other degraded water collecting areas of this size abutting both light industry and suburbia. This survey identified 36 plant species of which 11 were native. A full species list including all native species and the majority of introduced species is included in the report (Appendix A). As this survey was undertaken in Winter some native annuals may be missing from this list.

The native species persisting in this wetland in significant numbers include *Eucalyptus rudis*, *Melaleuca rhaphiophylla*, *Baumea articulata*, *Juncus pallidus*, *Centella asiatica* and *Pteridium esculentum*.

3.1 VEGETATION

The waterbody was almost totally covered by a dense stand of the introduced Bulrush *Typha orientalis* mixed with *Baumea articulata* (a tall native sedge) which was more commonly found at the margins. This stand was approximately 2m tall and included large patches of senescent and dead *Typha*. The margins of the waterbody typically contained an understorey of *Isolepis prolifera* and introduced grasses. *I. prolifera* dominated a distinct open band approximately 3m from the bank and extending for about 70m along the edge in what appeared to be a deeper channel in the waterbody.

This bank (parallel to Staveley Place) also contained a large dense belt of *Pteridium esculentum* (Bracken fern) with no overstorey and a stand of coppicing *Eucalyptus rudis* (Flooded gum) approximately 2m to 3m tall which had been felled at some point in the last 3 years and was regenerating. Isolated individuals of *Melaleuca rhaphiophylla*, *Jacksonia furcellata* and *Acacia saligna* also occurred here with some patches of *Juncus pallidus*, *Epilobium*

nirtigerum and *Centella asiatica* present lower on the slope.

Introduced grasses, sedges and weeds formed the dominant understorey components with some dense patches of Blackberry (*Rubus* Sp.) and large growths of *Cortaderia selloana* (Pampas grass) becoming more common along the Northern margins of the wetland.

A slow flowing drain marked the Northern border of the wetland parallel to Cedric Street. This open drain contained *J. prolifera* with occasional clumps of *B. articulata* and *T. orientalis* on the edges along with *M. rhaphiophylla* saplings and some *Acacia pulchella* and *Kennedia prostrata* which had invaded from a previously revegetated road verge. This drain also contained the green alga *Cladophora* Sp.

A swamp of *M. rhaphiophylla* fringed the North-eastern corner of the wetland and extended westward along the Northern edge. The area consisted of a 20m wide strip of open water under a 100 percent cover of *M. rhaphiophylla*. *E. rudis* saplings bordered this area with discrete clumps of both *T. orientalis* and *B. articulata* occurring on the outer margins. Isolated stands of *C. selloana* were scattered along the edges of the bank. Some weeds had invaded the outer edges of the swamp including *Sonchus* Sp (Thistle). Another small stand of *E. rudis* and *M. rhaphiophylla* was located on the Eastern margin of the wetland.

An open bog characterized by red clay and pools of stagnant water stretched from the North-eastern edge of the waterbody to the area affected by the construction of the express railway. This area had occasional individuals of *C. selloana* and clumps of *J. pallidus* though the dominant vegetation consisted of introduced weeds, including *Phytolacca octandra* , *Asphodelus fistulosus* and introduced grasses.

The sections of the Osborne Park Drain included in the study

area contained no aquatic or fringing vegetation other than weeds and introduced grasses. A map of the various vegetation types is included (Figure 1).

4.0 FAUNA COMPONENT

The entire area surveyed was divided into 4 distinct habitat types. Vertebrate and invertebrate activities were recorded separately for each area. A description of each habitat type is given below:

HABITAT 1 - Submerged area containing dense stands of Bulrush and *B. articulata* with a fringe of Budding club-rush (*I. prolifera*).

HABITAT 2 - Swamp paperbark (*M. rhaphiophylla*) covered area situated in the North-eastern corner of the survey area.

HABITAT 3 - Open degraded bog of stagnant water characterized by introduced weeds and Bulrush.

HABITAT 4 - Fringing non-aquatic vegetation consisting of Flooded Gum (*E. rudis*) and Bracken fern (*P. esculentum*)

4.1 VERTEBRATE FAUNA

Overall 1 fish species, 6 bird species and 4 frog species were recorded. It is expected that other bird and frog species utilize the wetland but were not seen. These are included in the full species list (Appendix 2). Reptiles and mammals that are also likely to inhabit the wetland but were not recorded during the field assessment are also listed. The table below indicates vertebrate species richness for all four habitat types, including species likely to be present but not actually recorded.

TABLE 1: NUMBER OF VERTEBRATE SPECIES LIKELY TO UTILIZE THE FOUR HABITAT TYPES

HABITAT 1	11 Species
HABITAT 2	18 Species
HABITAT 3	14 Species
HABITAT 4	11 Species

4.2 INVERTEBRATE FAUNA

During the sweep sampling a total of 22 invertebrate species were recorded. As mentioned previously the area was quite difficult to sample due to the thick organic layer therefore it is possible that other species were present but not recorded Generally diversity was low in all areas. The following table outlines the number of species recorded in each of the 3 aquatic habitat types outlined previously. Also shown are the number of invertebrate species collected From the Osborne Park Drain and the drain on the Northern border of the main wetland. A full species list is included (Appendix C).

TABLE 2: NUMBER OF MACROINVERTEBRATE SPECIES RECORDED IN EACH SAMPLING AREA

HABITAT 1	6 Species
HABITAT 2	9 Species
HABITAT 3	3 Species
DRAIN SITE 1	11 Species
DRAIN SITE 2	9 Species
NORTHERN DRAIN	15 Species

5.0 DISCUSSION AND CONCLUSIONS

5.1 BOTANICAL COMPONENT

The Cedric Street Wetland is severely degraded with respect to native floral composition. Introduced weeds and grasses have invaded all vegetation types present due to the level of disturbance at this site. Possible high nutrient and pollutant inputs from surrounding industry and suburban drains has resulted in the waterbody being dominated by the introduced Bulrush *T. orientalis* which has left very little open water.

No rare and endangered species or species with restricted distributions were identified in this area and the residual wetland vegetation types were extremely reduced or weed choked.

5.2 FAUNA COMPONENT

Overall vertebrate fauna usage of the this wetland was found to be low with no rare or endangered species present. This is most likely due to the degraded state of the area. Large sections contain suburban and building refuse. Activity relating to the construction of the express railway has also disturbed the Eastern side of the wetland.

The number of frog species recorded was average for a metropolitan wetland of this size although the number of bird species was low, again probably the result of noise associated with the railway construction. Water-bird usage was very low with only the common Black Duck (*Anas superciliosa*) present. Generally water-fowl require areas of open water for feeding which are not present at this site due to excessive *T. orientalis* growth.

These reed beds and *M. rhaphiophylla* swamp area are suitable as breeding habitat but are not likely to be utilized due to the lack of feeding areas. Replacement wetlands must provide all types of habitat if water-bird usage is desired. The preferred wildlife

habitat types for replacement wetlands are listed below:

- Deep unvegetated water as resting areas for ducks and swans and feeding areas for cormorants, grebes and diving ducks.
- Water 1m to 2m in depth containing submerged aquatic plants which provide food for water-birds and habitat for aquatic fauna.
- Areas of shallow water 0.5m to 1.5m deep containing rushes and sedges. These should be gently sloped and extensive with maximum variation in topography. These littoral areas are important in that they will provide feeding grounds for water-birds and are also the most productive with regard to invertebrates and algae due to increased light levels and an abundance of oxygen.
- Boggy areas of seasonal inundation with water depth between 0.5m and 0.7m. These areas provide a feeding and resting place for water-birds.
- Islands suitable for water-bird breeding.

(Kirby, 1992)

Also necessary are areas of fringing vegetation suitable for habitation by birds, reptiles and mammals.

No mammal or reptile species were recorded with only a few possibly occurring (Appendix 2). This is due to the lack of fringing vegetation which, where present, is weed-infested. This fringing vegetation is required for both food and shelter. It should be noted that as the wetland is connected to other vegetated areas via vegetated drains some other transient vertebrate species may pass through the area at different times of the year.

Also, whereas signs of this species were not evident, the Southern Brown Bandicoot (*Isoodon obesulus*) has been recorded at other metropolitan wetlands of this size and therefore may possibly utilize this area.

Diversity with regard to macroinvertebrates, was low throughout the main wetland. This is most likely a result of disturbance, poor water quality and lack of areas of open water. The drain entering the wetland and the Osborne Park Drain were healthier with respect to macroinvertebrates, reflecting their open nature. Samples taken from the Osborne Park Drain at Site 1 contained more species than Site 2 due to the slower water flow rate present at Site 1. Surprisingly a juvenile crustacean (*Cherax* Sp.) was present in the drain at Site 2 which indicates that the drain is relatively healthy. Overall, the number of macroinvertebrate species present in the Osborne Park Drain is high enough to provide a good starting point for replacement wetlands.

The drain on the Northern side of the main wetland produced the highest number of macroinvertebrate species due to the sandy substrate, good water quality and presence of algae (*Cladophora* Sp), a valuable food source.

6.0 CONSERVATION VALUE

The area contains few native flora species, none of which are listed as rare and endangered or have restricted distributions. All of the remaining natural vegetation types cover very small areas and are becoming heavily populated by introduced species. The only possible exception to this would be the *Melaleuca rhaphiophylla* swamp in the North-eastern corner of the wetland which remains relatively natural

There is also little evidence of utilization of this wetland by native fauna excepting some birds and a few frog species. It is the conclusion of this company that the Cedric Street Wetland has little conservation value.

REFERENCES

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). *The Atlas of Austalian Birds.* Melbourne University Press.

Kirby, D (1992). *A management plan for construction of replacement wetlands as part of the Roe Highway extension.* Unpublished Main Roads (WA) Report, Perth.

Kitchener, D.J., Chapman, A. and Barron, G. (1978). Mammals of the Northern Swan Coastal Plain. In: *Faunal Studies of the Northern Swan Coastal Plain. A consideration of past and future changes.* West. Aust. Museum, Perth.

Kitchener, D.J. and Vicker, E. (1981). *Catalogue of modern mammals in the Western Australiam Museum 1895-1981* West Aust.Museum, Perth.

Marchant, N.G., Wheeler, J.R., Rye, B.L., Bennett, E.M., Lander, N.S. and Macfarlane, T.D. (1987). *Flora of the Perth Region*. Western Australian Herbarium. Department of Agriculture, WA.

Storr, G.M., Harold, G. and Barron, G. (1978). The amphibians and reptiles of the Northern Swan Coastal Plain. In: *Faunal Studies of the Northern Swan Coastal Plain. A consideration of past and future changes*. West. Aust. Museum, Perth.

Storr, G.M., Johnstone, R.E. and Harold, G. (1978). Birds of the Northern Swan Coastal Plain. In: *Faunal Studies of the Northern Swan Coastal Plain. A consideration of past and future changes* West Aust. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1981). *Lizards of Western Australia. Vol. I Skinks*. Univ. West. Aust. Press with West. Aust. Museum, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1990) *Lizards of Western Australia. Vol. III. Geckos and Pygopods.* West. Aust. Museum, Perth.

Storr, G.M., Smith, L.A. And Johnstone, R.E. (1986). *Snakes of Western Australia* West. Aust. Museum, Perth.

Trudgeon, M. (1992). *Flora survey of a wetland at Oswald Street Innaloo*. Unpublished Report for Fini Group.

Western Australian Museum (1978). *Faunal Studies of the Northern Swan Coastal Plain A consideration of past and future changes* West. Aust. Museum, Perth.

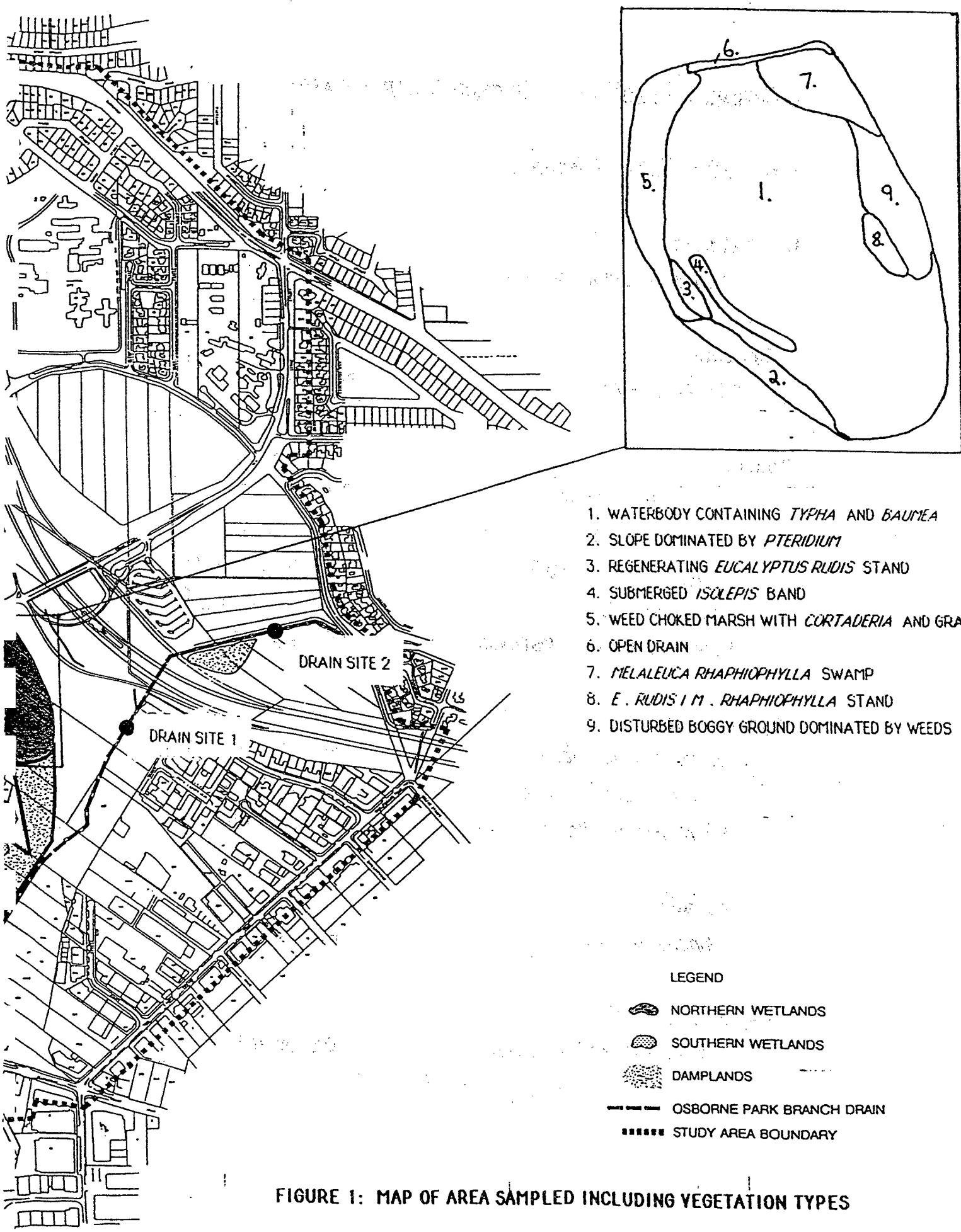


FIGURE 1: MAP OF AREA SAMPLED INCLUDING VEGETATION TYPES

APPENDIX A: FLORA OF THE CEDRIC STREET WETLAND

* denotes introduced species

Dennstaedtiaceae	
Pteridium esculentum	Bracken fern
Typhaceae	
* *Typha orientalis*	Bulrush
Poaceae	
* *Cortaderia selloana*	Pampas grass
* *Cynodon dactylon*	Couch grass
* *Eragrostis curvula*	African love grass
* *Paspalum* Sp.	Paspalum grass
* *Pennisetum clandestinum*	Kikuyu grass
Cyperaceae	
Baumea articulata	Jointed twig-rush
* *Cyperus congestus*	Dense flat-sedge
* *Isolepis prolifera*	Budding club-rush
Juncaceae	
Juncus pallidus	Pale rush
Asphodelaceae	
* *Asphodelus fistulosus*	Onionweed

Polygonaceae

* *Polygonum* Sp.	
* *Rumex crispus*	Curled dock

Phytolaccaceae

* *Phytolacca octandra*	Inkweed

Rosaceae

* *Rubus Sp*	Blackberry

Mimosaceae

Acacia pulchella	Prickly moses
Acacia saligna	Orange wattle

Papilionaceae

Jacksonia furcellata	
Kennedia prostrata	Scarlet runner
* *Lupinus angustifolius*	Narrow-leafed lupin
* *Lupinus* Sp.	

Anacardiaceae

* *Schinus terebrinthifolia*	Chinese pepper

Geraniaceae

* *Pelargonium capitatum*	

Myrtaceae

Eucalyptus rudis	Flooded gum
Melaleuca rhaphiophylla	Swamp paper-bark

Onagraceae

Epilobium hirtigerum

Apiaceae

Centella asiatica

* *Foeniculum vulgare* Fennel

Solanaceae

* *Solanum nigrum* Black berry nightshade

Plantaginaceae

* *Plantago major* Greater plantain

Asteraceae

* *Aster supulatus* Bushy starwort

* *Hypochaeris glabra* Smooth cats-ear

* *Sonchus* Sp. Thistle

Crop Species

* *Musa* Sp. Banana palm

Chlorophyceae

Cladophora Sp. Green algae

APPENDIX B: VERTEBRATES RECORDED OR EXPECTED TO OCCUR AT THE CEDRIC STREET WETLAND

* denotes not recorded but expected to occur

	HABITAT TYPE
BIRD SPECIES	
Anatidae	
Anas superciliosa - Black duck	1 only
Columbidae	
* *Columba livia* - Feral pigeon	2 and 4
Streptopelia senegalensis - Laughing turtle dove	2, 3 and 4
Platycercidae	
* *Barnardius zonarius* - Port Lincoln ringneck	4 only
Muscicapidae	
Rhipidura leucophrys - Willie Wagtail	2 and 3
Maluridae	
Serocornis maculatos - Scrub wren	2 only
Meliphagidae	
* *Anthochaera caronculata* - Red wattlebird	4 only
Lichmera indistincta - Brown honeyeater	2 only
Zosteropidae	
Zosterops lateralis - Silvereye	2 only
Cracticidae	
* *Gymnorhina tibicen* - Magpie	4 only

Corvidae

* *Corvus coronoides* - Australian raven 4 only

MAMMAL SPECIES

Peramelidae

* *Isoodon obesulus* - Southern brown Bandicoot 4 only

Muridae

* *Rattus rattus* - Black rat 2 and 4

* *Mus musculus* - House mouse 4 only

AMPHIBIAN AND REPTILE SPECIES

Leptodactylidae Frogs

Crinea Sp. 1, 2 and 3

* *Crinea georgiana* 1, 2 and 3

Crinea glauerti 1, 2 and 3

* *Heleioporus eyrei* 1, 2 and 3

Letoria adelaidensis 2 only

* *Letoria morrei* 2 only

Limnodynastes dorsalis 1, 2 and 3

* *Myobatrachus gouldii* 1, 2 and 3

Gekkonidae Geckos

* *Phyllodactylus marmoratus* 2 and 4

Scincidae Skinks

* *Tiliqua rugosa* - Bobtail 4 only

Elapidae Elapid snakes

* *Pseudonaja affinis* - Dugite 2 and 4

TELEOST FISH

Gambusia holbrooki - Mosquitofish 1 and 2

APPENDIX C: MACROINVERTEBRATE SPECIES RECORDED THROUGHOUT THE ENTIRE STUDY AREA

Turbellaria	Flat-worm
Turbellaria Sp.	
Oligochaeta	Segmented worm
Tubificidae Sp.	
Gastropoda	Aquatic snails
Physastra Sp. 1	
Physastra Sp. 2	
Arachnida	
Aranae Sp	Aquatic spider
Hydracarina	
Acercella falcipes	Water mite
Crustacea	
Cyclopoida	Copepods
Microcyclops Sp.	
Amphipoda	Side-swimmers
Paramphisopus palustris	
Parastacidae	
Cherax Sp. (Juvenile)	Yabbie/Gilgie

Odonata

Anisoptera	Dragon-fly larvae
Hemicordulia australiae	
Hemicordulia tau	
Zygoptera	Damsel-fly larvae
Coenagrionidae Sp.	

Hemiptera

Corixidae	Water boatmen
Micronecta robusta	
Notonectidae	Backswimmers
Anisops Sp.	

Diptera

Culicidae	Mosquito larvae
Psorophora Sp.	
Chironomidae	Midge larvae
Chironomus griseidorsum	
Dicrotendipes conjunctus	
Polypedilum nubifer	
Procladius villosimanus	

Coleoptera Water beetles

Dytiscidae

Antiporus Sp. (Adults)

Rhantus Sp. (Larvae)

Helodidae

Cyphon Sp. (Adult)

APPENDIX 2

EPA Guidelines for the Consultative Environmental Review
for the Proposed Replacement of the
Cedric Street Wetland

GUIDELINES FOR CONSULTATIVE ENVIRONMENTAL REVIEW

Proposed relocation of Cedric St wetland (bounded by Cedric St & Mitchell Freeway)

These guidelines are prepared for the Consultative Environmental Review (CER) for the proposal by the City of Stirling to relocate the above wetland. Other relevant wetland issues may arise during the preparation of the document or public consultation phases.

The proposal is based on several distinct parts - the need to translocate the wetland, the social, hydrological and ecological values of the wetland, the extent of the wetland, the feasibility of translocating these functions and the long-term management, performance monitoring and maintenance of new and residual wetland areas. The CER will need to provide sufficient information to allow the EPA to undertake an assessment of these aspects.

The extent of the wetland should be determined on a geomorphic/hydrological basis (according to C A Semeniuk, 1987 - Wetlands of the Darling System - A Geomorphic Approach to Habitat Classification, J. Roy. Soc. W.A., 69, 95-112). The area under consideration for translocation should be clearly defined, as should the entire wetland, and the CER should include details of the social, hydrological and ecological values of the entire wetland.

The document should include:

- The need for wetland translocation, include reference to the Stirling Regional Centre draft Structure Plan and Metropolitan Regional Scheme;
- Grounds for exemption from the regulations pertaining to the draft Swan Coastal Plain Lakes Environmental Protection Policy;
- Delineation, functions and values of the Cedric St wetland and the area that is proposed for translocation;
- Likely timing of wetland loss (including seasonal considerations);
- Proposed timing for replacement of wetland functions (including projected time for maturation of new habitat and adjustments for likely success rates and seasonal considerations);
- Commitments relating to the translocation of the wetland - including design parameters, functions, area, transfer of biological material, timing and environmental goals of the wetland to be constructed (specific details will be required in a subsequent Environmental Management Programme);
- The likely ecological values of any residual wetland area;
- Plans to ameliorate any decline in water quality in drainage entering Herdsmans Lake as a result of the proposed wetland translocation; and
- Arrangements to ensure ongoing funding, management and performance monitoring of both the translocated and residual wetlands; and
- Desirable effects, such as erection of fox-proof fencing, enhancement of wetland functions and identification of organizations/individuals responsible for the long-term management of the wetland should also be cited.

EXISTING WETLAND

A description of the ecological values should include:

- wetland flora;
- identification and occurrence of wetland dependent fauna;

- rare, endangered and geographically restricted flora and fauna;
- distribution of dieback disease;
- introduced pests;
- ecosystems and habitats;
- other representation of this wetland system (uniqueness); and
- wetland function, with specific reference to waterbird breeding and feeding habitat

A description of the social values should include:

- overall wetland management objectives, refer to "A guide to wetland management in Perth" (EPA, Bulletin 374);
- landscape and amenity values;
- existing landuse, including location and general impacts of peat mining; and
- existing management of the wetland.

A description of the hydrological values should include:

- role in local flood control;
- pollutant trapping; and
- existing water level regimes.

The purpose of the overall document should be to demonstrate the effectiveness of translocating the wetland functions. Therefore, functional objectives, environmental goals and management strategies for the wetland should be cross-referenced to future monitoring results.

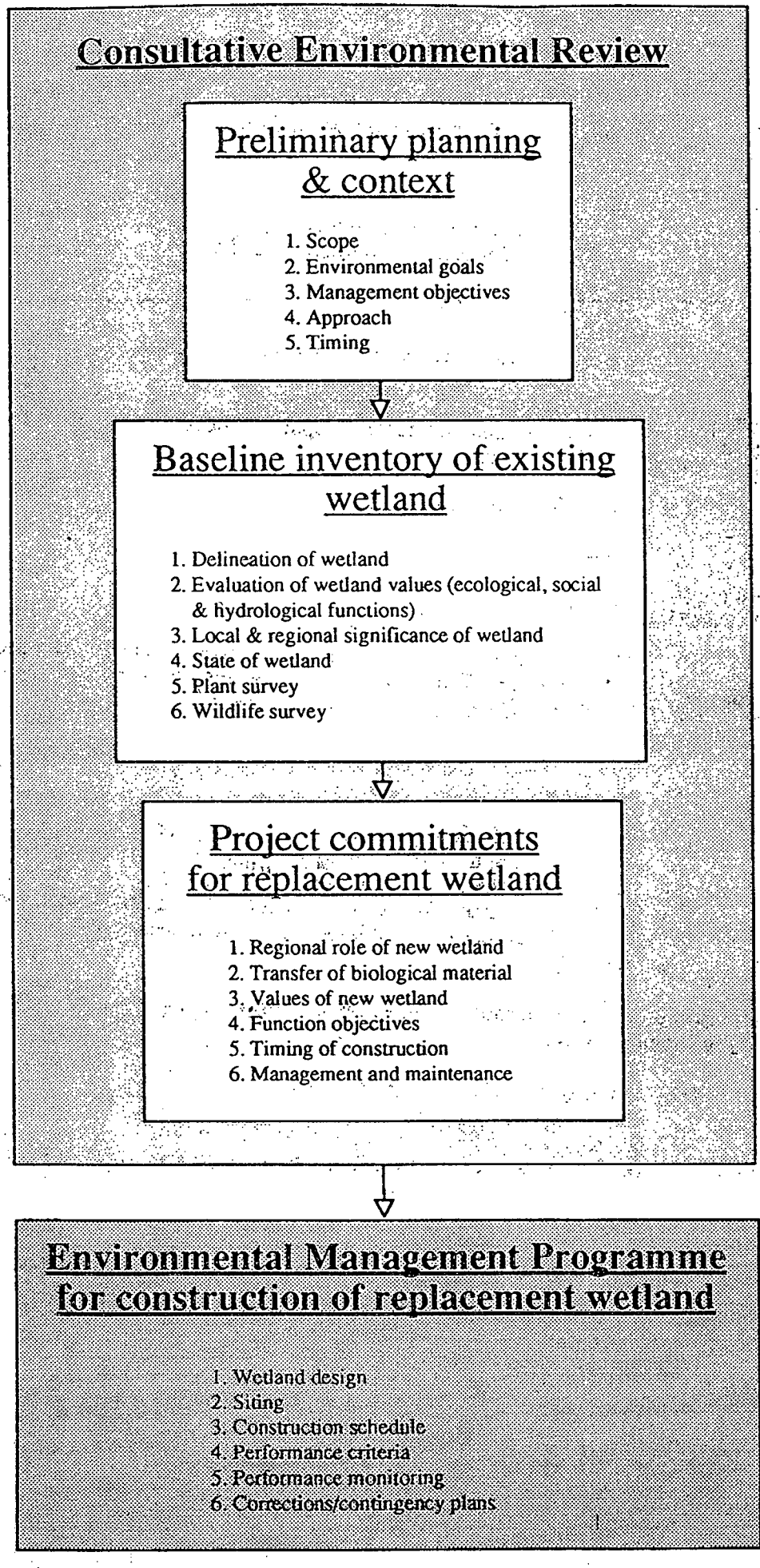
PUBLIC PARTICIPATION AND CONSULTATION

A brief description should be provided of public participation and consultation activities undertaken by the proponent in preparing the CER. This should outline the activities undertaken, the timetable for activities, the groups or individuals involved and the objectives of the activities. A summary of concerns raised should be documented. This discussion should be cross referenced with environmental management issues and should clearly indicate how each concern has been addressed.

Procedures for reporting the results of monitoring and management to appropriate authorities and the community should be given.

COMMITMENTS BY PROPONENT

Commitments made by the proponent should include: (a) who will do the work, (b) what the work is, (c) when the work will be carried out and (d) to whose satisfaction the work will be carried out.


Consultative Environmental Review
Preliminary planning & context
1. Scope
2. Environmental goals
3. Management objectives
4. Approach
5. Timing
Baseline inventory of existing wetland
1. Delineation of wetland
2. Evaluation of wetland values (ecological, social & hydrological functions)
3. Local & regional significance of wetland
4. State of wetland
5. Plant survey
6. Wildlife survey
Project commitments for replacement wetland
1. Regional role of new wetland
2. Transfer of biological material
3. Values of new wetland
4. Function objectives
5. Timing of construction
6. Management and maintenance
Environmental Management Programme for construction of replacement wetland
1. Wetland design
2. Siting
3. Construction schedule
4. Performance criteria
5. Performance monitoring
6. Corrections/contingency plans

APPENDIX 3

Species Suited to Wetland Regeneration Programmes
(Wetland Conservation Society)

SPECIES SUITED TO WETLAND REGENERATION PROGRAMS

SPECIES	DESCRIPTION	SUITABLE SITE	EASE OF ESTABLISHMENT*	COMMENTS (D = SUSCEPTIBLE TO DIEBACK)
* 5 = EASIEST 1 = MORE DIFFICULT				
1.0 Plants for Woodlands and Low Lying Areas Not Waterlogged				
1.1 Trees				
Acacia salinga (Orange Wattle)	Dense spreading tree to 6m.	Low lying areas but not waterlogged.	5	Widespread on land near seasonally waterlogged areas. Seed shed each year
Agonis flexuosa (WA Peppermint)	Tree to 18m, moderate growth rate. Dense weeping canopy.	Coastal (limestone) belt, above 2m from seasonal high water level.	5	Associated with Tuarts. Adaptable to other situations.
Allocasuarina fraseriana (Sheoak)	Erect tree to 15m. Slow growth rate. Drooping branchlets.	Well drained sands of all woodlands.	3	Widely scattered as individuals or small groups. Seed is retained.
Banksia attenuata (Slender Banksia)	Tree to 10m, moderate growth rate, open canopy.	Well drained sands.	4	Distribution similar to Firewood Banksia. Common on coastal plain. D.
Banksia grandis (Bull Banksia)	Tree to 10m, moderate growth rate, open canopy.	All well drained soils on the coastal plain.	4	Widely distributed throughout most woodlands. D.
Banksia ilicifolia (Holly Banksia)	Tree to 12m, slow growing, open habit.	Most soils, but prefers less well drained sites compared to other Banksias.	4	A primitive Banksia without a distinctive cone. Common throughout the coastal plain. D.
Banksia menzelsii (Firewood Banksia)	Tree to 10m,. moderate growth rate, open canopy.	Well drained sands.	4	Seed shed annually. Widespread distribution on coastal plain, associated with Jarrah. D.
Eucalyptus calophylla (Marri)	Tree, moderate growth rate to 30m. Dense canopy, erect habit.	All sites above 2m from seasonal high-water level. All soil types.	5	Widespread throughout the south-west. Large black seed shed February. Easily propagated. A pink flowered form is attractive.

Eucalyptus gomphocephala (Tuart)	Tree, fast growing to 25m. Upright habit.	Coastal (limestone) belt above 2m from seasonal high water level.	5	Common in the limestone belt to the west of most freshwater wetlands. Associated with Peppermint. Seed retained. D?
Eucalyptus marginata (Jarrah)	Tree, slow growing to 25m. Upright habit.	All sites above 2m from seasonal high water level	3	Commonly associated with Marri. Seed largely retained. D.
Eucalyptus todtiana (Coastal Blackbutt)	Tree, slow growing to 10m. Spreading habit, dense canopy.	Low-lying areas with high water table but not seasonally waterlogged.	4	Common in low-lying deep sands. Seeds retained in capsules. Propagates successfully.
Xylomelum occidentalis (Woody Pear)	Tree, grows to 10m.	Well drained sandy soils.	4	Common in suitable areas.
1.2 Shrubs				
Acacia cyclops (Coastal Wattle)	Dense shrub to 4m.	Sands over limestone preferred but adaptable.	3	Widespread near limestone ridges and Tuart woodlands. Seed is shed soon after set.
Acacia pulchella (Prickly Moses)	Dense shrub to 1.5m. Intense gold flowers.	Well drained sands of most woodlands.	5	Widespread. Hard seed shed soon after set.
Adenanthos cygnorum (Common Woollybush)	Shrub to 4m, flowers inconspicuous, grey-green leaves.	Deep sands.	4	Generally abundant on sandy rises.
Allocasuarina humilis (Dwarf Sheoak)	Shrub to 2m.	Well drained sands of all woodlands.	2	Widely distributed on coastal plain. Male and female plants.
Anigozanthus manglesii (Kangaroo Paw)	Small plant with spectacular green and red flowers in spring.	Common in Jarrah/Banksia woodlands.	5	Attractive, well known plant, useful for honey-eaters.
Bossiaea ericocarpa	Small shrub with pea flowers, grows to 0.5m.	Occurs in Jarrah/Banksia woodlands.	4	Useful hardy understorey plant.
Calothamnus quadrifidus (One-sided Bottlebrush)	Erect shrub to 2m. Open habit.	Well drained soils over limestone, adaptable.	5	Occurs naturally in Tuart formations and coastal limestone ridges. Seed retained.
Dryandra sessilis Parrot Bush)	Erect shrub to 5m.	Coastal limestone belt, well drained soils.	3	Common in Jarrah woodlands and over coastal limestone.

Hakea prostrata (Harsh Hakea)	Usually erect shrub or small tree to 4m.	Well drained soils over limestone.	4	Small along the coastal limestone ridge and taller in valleys. Seed retained.
Kunzea ericifolia	Erect shrub to 3m, drooping branches.	Low lying but not waterlogged.	5	Forms dense thickets near some wetlands.
Macrozamia reidlii (Zamia Palm)	Cycad palm to 1m high.	Common in Jarrah woodlands.	4 (if seed buried)	Occurs as male and female plants. Adds nitrogen to soil.
Melaleuca huegelii (Chenille Honeymyrtle)	Medium shrub to 3m, dense foliage, forms thickets, attractive flowers.	Limestone soils, well drained.	4	Commonly associated with Tuarts.
Phyllanthus calycinus	Small shrub to 30cm.	Common in Jarrah woodlands.	4	Useful as a small, common understorey plant.
Templetonia retusa (Cockies Tongues)	Erect shrub to 3.5m. Red pea-shaped flowers.	Well drained soils over limestone.	3	Found along the coastal limestone ridge. Seed shed after set.
1.3 Ground Cover				
Hardenbergia comptoniana (Native Wisteria)	Climbing shrub, flowers purple to pale mauve.	All free draining soil types.	3	Common in all bushlands. Hard seeded.
Hypocalymma robustrum (Swan River Myrtle)	Dense shrub to 0.5m, pink flowers.	Damp, sandy soils in seasonally waterlogged depressions.	5	Attractive plant which forms dense ground cover and helps bind soil.
Kennedia prostrata (Red Runner)	A prostrate shrub, red flowers.	All soil types, not waterlogged.	4	Common in all bushland areas especially after fire. Hard seeded.
2.0 Plants for Seasonally Waterlogged Soils and Wetland Fringes				
2.1 Trees				
Agonis linearifolia	Shrub to 2m, spreading habit.	Swamps, seasonally waterlogged, low lying damplands.	2	Frequents most swamps and seasonal wetlands.
Allocasuarina obesa (Swamp Oak)	Upright tree to 10m.	Fringing swamps and wetlands. Adapted to saline soils.	4	Associated with Salt-Water Paperbark especially near estuaries. Seed retained.
Banksia littoralis (River Banksia)	Medium bushy tree to 15m, moderate growth rate.	Seasonally waterlogged areas, margins of wetlands.	5	Often associated with Flooded Gum, and Fresh-Water Paperbark. D.

Eucalyptus rudis (Flooded Gum)	Tree, fast growing to 20m, spreading habit.	All soil types from high-water level to 2m above. Tolerates seasonal inundation of root zone.	5	Widespread, typically associated with wetlands. Readily propagates from seed. Some seed shed annually but much is retained.
Melaleuca cuticularis (Salt-Water Paperbark)	Small slow growing tree to 10m, upright habit, spreading canopy.	Saline soils fringing salty wetlands and estuaries.	3	Commonly forms a belt of low woodland between open water and Tuart associations.
Melaleuca preissiana	Small tree to 12m, slow growth rate.	To the edges of swamps and low-lying seasonally waterlogged soils.	3	Commonly forms closed-canopy formations in undisturbed situations. Originally widespread.
Melaleuca rhaphiophylla (Swamp Paperbark)	Small shrubby tree to 12m. Slow growing, dense foliage.	Swampy areas seasonally waterlogged or inundated.	4	Commonly forms dense thickets and closed-canopy formations in swamps, seasonal wetlands and fringing open fresh water.
2.2 Shrubs				
Astartea fascicularis	Small shrub to 1.5m.	Low lying land seasonally waterlogged.	2	Associated with *Melaleuca preissiana* formations.
Melaleuca lateritia	Small shrub to 1.5m, red 'bottlebrush' flowers.	Low-lying areas, seasonally waterlogged.	3	Rather sparsely distributed throughout its range. Attractive. Readily propagated.
Melaleuca polyaloides (Grey Honeymyrtle)	Spreading shrub to 1.5m. White flowers.	Low-lying areas, seasonally waterlogged.	4	Not uncommon in areas suited to *Melaleuca preissiana*.
3.0 Plants Suited to Permanent Inundation of the Root Zone				
Baumea articulata (Jointed Rush)	Tall growing rush, large pencil-like leaves.	Permanently inundated and waterlogged soils.	4	Common rush of freshwater wetlands, in shallow waters and near shoreline.
Juncus krausii	Rush which occurs in clumps to 1m high.	Permanently inundated and waterlogged soils.	4	Common rush of freshwater wetlands.
Melaleuca teretifolia	Medium shrub to 4m. Spreading habit, slow growth.	Waterlogged and seasonally inundated wetland areas.	4	Forms dense thickets in lakes and swamps. Can withstand permanent inundation of root zone.

APPENDIX 4

Cedric Street Wetland Assessment using the EPA's Bulletin 374
"A Guide to Wetland Management in Perth 1990"

Source: Environmental Protection Authority 1990. A Guide to Wetland Management in Perth. Bulletin No. 374, Environmental Protection Authority, Perth WA.

CEDRIC STREET WETLAND ASSESSMENT

2.2 The natural attributes questionnaire

2.2.1 Part 1A: Permanent and seasonal wetlands with well defined boundaries

For wetlands with poorly defined boundaries go to Part IB (Page 12)

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5	
(NO)	Score	1	
	Score		[1]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

(YES)	go to question iii		
NO	Score	3 — go to question (iv)	
	Score		[O]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3	
(NO)	Score	1	
	Score		[1]

Source: Refer to question (vi) for a listing of habitat types. Use aerial photos and field visits.

Management Notes: A high diversity of habitats is desirable from an ecological perspective. In some cases this diversity is not expressed in an individual wetland, but in a series of adjacent wetlands.

iv Drought refuge

What is the importance of the wetland as a drought refuge for birds?

MAJOR IMPORTANCE	Score	5	- Limited area of open water - Advice from CALM - Information from local residents
MINOR IMPORTANCE	Score	2	
(NO IMPORTANCE)	Score	0	
	Score		[O]

Source: Refer to Appendix 7 and local branch of RAOU.

Management Notes: Although waterbirds can move long distances to find suitable habitat when lakes dry out, it has been shown that Perth's wetlands provide a valuable drought refuge during the summer.

v Area of wetland

Estimate the area of the wetland:

>100ha	Score	5
50-100ha	Score	4
25-50ha	Score	3
10-25ha	Score	2
<10ha	Score	1
	Score	[1]

Source: Map of appropriate scale in conjunction with a grid overlay. The edge of the inundated area (often indicated by fringing vegetation or summer grass) should be used as the wetland perimeter for this calculation.

Management Notes: As a general rule large wetlands are capable of supporting a larger variety of species and have a greater capacity to absorb the detrimental impacts of nearby land uses than small wetlands. Where a wetland chain is severed by urban development, species diversity within individual lakes often declines due to a reduction in habitat diversity (see management notes Question (vi).

vi Habitat type

Using the list below score 1 for each habitat type represented.

a Vegetation over 0.1 hectare in area

- large paperbarks (> 2.5m tall) in dense clumps
- ✓ low thickets (ie < 2.5m tall). These are often *Melaleuca, Astartea* or *Kunzea* spp
- ✓ paperbark fringe 1
- fringing rushes and sedges (often *Baumea* and *Juncea* spp.)
- fringing *Typha* (bullrush)
- samphire or saltmarsh
- ✓ extensive inlake beds of sedges 1
- ✓ extensive inlake beds of *Typha* or other rushes 1
- scattered dense clumps of rushes or sedges

b Other habitats

- ✓ flooded grassland in winter/spring
- mud flats or seasonally dry open water
- ✓ islands — natural or human made
- ✓ fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- ✓ permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score 1/2 point for:

- ✓ scattered paperbarks
- scattered rushes

Score [3½]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations. The more complex the vegetation associations, the greater the habitat diversity.

vii Emergent vegetation

How much of the wetland is covered with emergent wetland vegetation?

If 40-60%			Score	5
If 30-40%	or	60-70%	Score	4
If 20-30%	or	70-80%	Score	3
If 10-20%	or	80-90%	Score	2
If <10%	or	(>90%)	Score	1

Score [1]

Source: Aerial photos and field visit.

Management Notes: A wetland which provides both open water and emergent vegetation is likely to fulfil the biological requirements of a greater range of species. For example, waterbirds need emergent vegetation for breeding and open water areas for feeding.

viii Adverse water quality

Has adverse water quality been reported in the last two years or observed on the current inspection? For example the presence of oil slicks, algal blooms or botulism in waterbirds.

No aspect observed or reported	Score	5
A single event/aspect observed or reported	Score	2
Several aspects observed or reported	Score	1
Three or more aspects observed or reported	Score	0

Elevated nutrient & pesticide levels

Score [1]

Source: Field survey, discussion with local residents, and local government authority.

Management Notes:

1 *Water quality varies significantly throughout the year with problems most evident in summer and often undetectable during winter.*

2 *The presence of macroalgae and/or large numbers of epiphytes is often an indication of poor water quality. An epiphyte is a non parasitic plant that relies on other plants for physical support.*

3 *Good water quality is important, particularly for invertebrates. If there is evidence of pollution (from heavy metals, pesticides and nutrients etc) measures should be taken to alleviate the problem.*

ix Drainage

a Are there drains directing water into or out of the wetland?

(YES) go to (b), (c) and (d)

NO Score 5 — go to question (x).

b If the drain(s) only directs water into a wetland, use the table below to determine the lake's susceptibility to nutrient pollution. This is achieved by:

i calculating the surface area of the wetland (refer to question v);

ii selecting the 'wetland surface area category' in the left hand side of the table* below that most closely approximates the lake being studied; and

iii note the 'drainage catchment area' value for that category (right hand side of table).

If the area of the catchment for the wetland being assessed exceeds the specified value in the right hand side of the table:

Score 1 — go to (c)

If the area is less than the catchment area value:

Score 4 — go to (c)

Wetland surface area category (ha)	Drainage catchment area (ha)
200	700
100	350
75	263
50	175
25	88
10	35

c If the drain(s) was constructed to maintain water levels in the lake or to support wetland vegetation

Score 3 — go to (d)

d If the drain(s) was constructed to dry out the wetland

Score 0

Score (a + b + c + d) [ ]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

x Adjacent nutrient sources

a Are there alternate nutrient sources that could affect the water quality in the wetland?

For example, rubbish tips or landfill, lawns and/or grazing property fertilised on a seasonal basis; septic tanks within 100m of the wetland; agricultural development with high nutrient output such as feedlots and sheep holding yards nearby etc.

If YES go to (b) and (c)

NO Score 5 — go to question (xi)

* The table was prepared on the basis of a phosphorus assimilative capacity of 0.35 grams of phosphorus per square metre of wetland water area per annum, and a runoff rate of 1kg of phosphorus per hectare of catchment per annum. Further details about the table can be obtained from the Environmental Protection Authority.

b If there is only one source?

Score 2

(c) If more than one source?

Score 0

Score [0]

Source: Field inspection and visit to the local government authority.

Management Notes: Recent research has demonstrated that large quantities of nutrients enter wetlands via surface water drains.

xi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10 %	Score	5
11 - 20%	Score	4
21 - 30 %	Score	3
31 - 40%	Score	2
(> 40%)	Score	1
	Score	[1]

Source: Aerial photos and maps.

Management Notes: See question (xiii)

xii Reserve area

Is the size of the (potential) reserve containing the wetland large enough to ensure that conservation values can be protected from the impacts of surrounding land uses. To determine this divide the area of the wetland by the area of the reserve surrounding the wetland. If the outcome of the computation is:

< 0.1	Score	5
0.1 - 0.25	Score	4
(0.25 - 0.5)	Score	3
0.5 - 0.75	Score	2
0.75 - 1.0	Score	1
	Score	[3]

Reserve generally less than 50 metres wide on northern & eastern areas of wetland

Area of Reserve = 4·25 ha
Area of Wetland = 1·35 ha

Source: Aerial photos and maps — If there are not formal boundaries around the wetland use fence lines, roads or natural features of the landscape for the calculation (see management notes below).

Management Notes: Wetlands with large buffer zones are less likely to be degraded by the impact of surrounding land uses than those with small buffer zones. The size of buffer zones should be determined according to the physical and ecological properties of the individual wetland and the purpose for which it is being managed. Property or reserve boundaries used in the above computation should be at least 50m from the wetland edge. If less than 50m make a note in the report.

xiii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90%	Score	10
89 - 80%	Score	8

89 - 70%	Score	6
69 - 60%	Score	4
59 - 50%	Score	2
(<50%)	Score	1
	Score	

Natural Attributes Total = 19½

[ ]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

2.2.2 Part 1B: Seasonal and episodic wetlands with poorly defined boundaries

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5
NO	Score	1
	Score	

[ ]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area, wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

YES	go to question iii	
NO	Score	3 — go to question (iv)
	Score	

[ ]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3
NO	Score	1
	Score	

[ ]

Source: Refer to question (iv) for a list of habitat types. Use aerial photos and field visits.

iv Habitat type

Using the list below score one for each habitat type represented (maximum score 10).

a Vegetation over 0.1 hectare in area.

- large paperbarks (>2.5m tall) in dense clumps
- low thickets (ie <2.5m tall). These are often *Melaleuca, Astartea* or *Kunzea* spp
- paperbark fringe
- fringing rushes and sedges (often *Baumea, Juncea* spp)

- fringing *Typha* (bullrush)
- samphire or saltmarsh
- extensive inlake beds of *Typha* or other rushes
- scattered dense clumps of rushes or sedges

b Other habitats

- flooded grassland in winter/spring
- mud flats or seasonally dry open water
- islands — natural or human made
- fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score ½ point for

- scattered paperbarks
- scattered rushes

Score [ ]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations. The more complex the vegetation associations, the greater the habitat diversity.

v Drainage

Are there drains directing water into or out of the wetland?

YES	Score	0
NO	Score	5
	Score	[ ]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

vi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10%	Score	5
11 - 20%	Score	4
21 - 30%	Score	3
31 - 40%	Score	2
> 40%	Score	1
	Score	[ ]

Source: Aerial photos and maps.

Management Notes: See question (vii)

vii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90%	Score	5
89 - 80%	Score	4
79 - 70%	Score	3
69 - 60%	Score	2

59 - 50%	Score	1	
< 50%	Score	0	
	Score		[ ]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

2.3 Human use questionnaire

i Aesthetics

Does the wetland possess any of the following attributes? (score appropriately)

Little, if any, artificial noise	Score	2	
Understorey mostly intact	Score	2	
Few, or no, roads or buildings obvious from wetland	Score	2	
Steep ridge visible as part of the scenery	Score	(1)	
Ridge accessible giving view of wetland	Score	(1)	
Wetland is a lake and open water easy to view	Score	1	
A section of wetland exists where few people visit	Score	1	
	Score (total of above)		[2]

Source: Field survey.

Management Notes: A management plan should try to ensure that these attributes are preserved or enhanced by proposed developments.

ii Historical and archaeological features

Does the wetland have any of the following historical or archaeological features?

- registered Aboriginal relics or sacred sites
- pioneer relics/operations
- National Estate/Trust listings

No sites of historical or archeological significance Search undertaken at Dept. of Aboriginal sites.

If two or more (of the above)	Score	5	
If one	Score	3	
Otherwise	Score	0	
	Score		[0]

Source: Field survey, local government authoritys, National Trust, WA Museum — Department of Aboriginal Sites.

Management Notes: Strategies for the protection and/or preservation of historical and archeological features should be clearly defined in the management plan for the wetland.

iii Security of wetland

What is the current vesting of the land containing the wetland ?

A Class Reserve for conservation and recreation or Metropolitan Region Scheme reserve for Parks and Recreation owned by the Department of Planning and Urban Development or local government authority	Score	5

Other class of reserve — vested System Six recommendation unvested or on private property	Score	3
Other class of reserve — unvested	Score	2
Other (eg private or vacant Crown land)	Score	(1)
	Score	[1]

Iv Protection groups

Does the wetland have active protection groups?

One or more	Score	5
(No groups)	Score	0
	Score	[0]

v Passive recreation

Is the wetland used for any of the following passive recreation activities?

If yes, score 1 for each

- nature study/bird watching
- education (school or other educational interest within 500m)
- picnic and /or barbecue facilities
- conservation of flora (refer to maps)
- conservation of fauna (refer to maps)
- protection and preservation of other attributes
- recognised research site
  - — biological
  - — archaeological
  - — other
- recognised tourist venue

Score [0]

Source: Field surveys, maps, road directories, State and local government department and residents.

Management Notes: Damage such as trampling, erosion and destruction of vegetation should be noted during the field visit.

vi Active recreation

Is the wetland used for any of the following active recreational activities? If yes, score 1 for each.

- walking/jogging or cycling
- horse riding
- trail bike riding
- playground
- sports grounds
- model boats
- golf course
- canoeing/rowing
- power boating/skiing
- swimming

Score [0]

Source: State and local government recreation departments.

Management Notes: Damage from current activities should be recorded during the field survey and reported to the appropriate authority/s.

vii Other human uses

Is the wetland used for any of the following purposes? (Score 1 for each)

- agricultural activities (grazing, horticulture etc)
- ⊙ mining (check for mining leases) — A Peat Extraction Licence exists over the majority of the site.
- ⊙ existing/proposed service corridors (SECWA, roads, etc)
- water supply
- ⊙ proposed urban/housing use
- private purposes other than described above

Human Use Total = 6

Score [3]

Source: Field survey, maps and State and local government departments.

Management Notes: The compatibility of the above activities with conservation values should be considered during the formulation of a management plan. It may not be practical to achieve all management objectives, and land use priorities will have to be decided.

Management Category M - Multiple Use

2.4 Supplementary questionnaire

This questionnaire is used to determine the most appropriate management category for a wetland where the natural attributes and human use score falls in the "transition zones" in the graph in Appendix 6.

If the answer is YES in question i (below) the wetland should be moved to the management category to the right.

If NO, move to left.

If the answer to either ii or iii is YES, move upwards; if NO move downwards.

i Species rarity

Are rare species of animals or plants present or are there communities represented which have a limited distribution?

Source: Department of Conservation and Land Management, local government authorities, conservation groups, literature searches.

Management Notes: Wetlands supporting rare and endangered species should be given priority when allocating resources for the formulation of management plans and implementation of field works.

ii Effect on land values

Does the wetland significantly enhance real estate values and land rates around it? ie, does the wetland add more than 10% to the value of nearby houses?

Source: local government authoritys, estate agents.

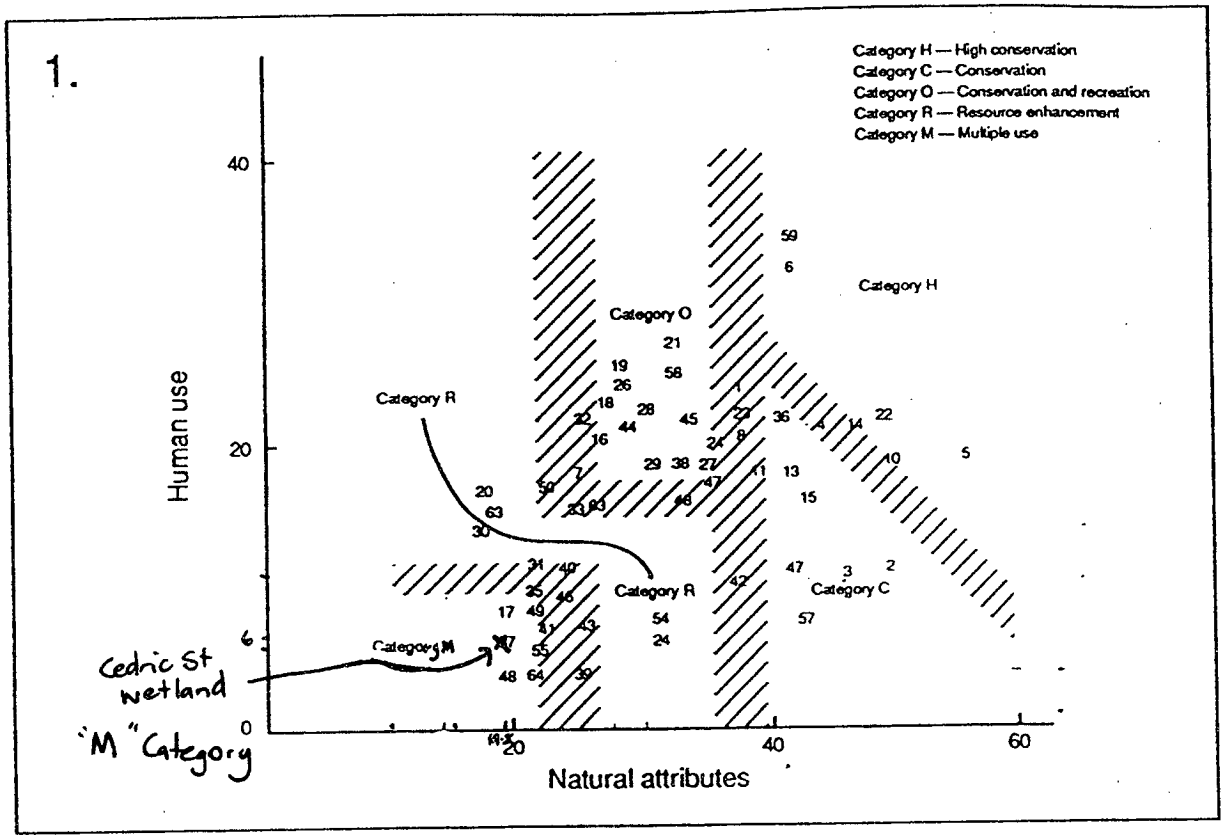
Management Notes: The enhancement of real estate values is a legitimate reason for increased expenditure on the active management of a wetland.

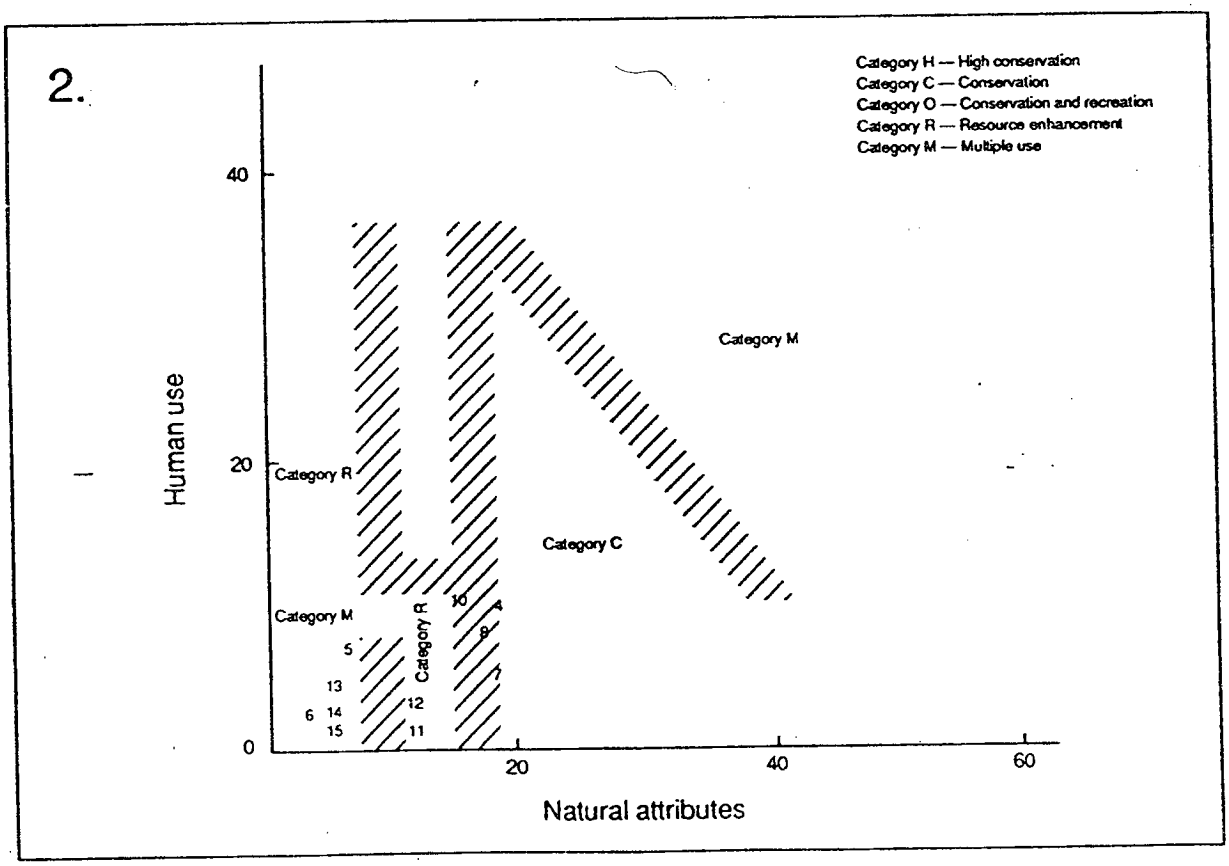
iii Human use

Do more than 100 people visit the wetland each week?

Source: Extended field surveys, State and local government recreation departments.

Management Notes: This question provides a good measure of the need for human use management.





Graph 1 : Management categories for permanent and seasonal wetlands with well defined boundaries.
Graph 2: Management categories for seasonal and episodic wetlands with poorly defined boundaries

APPENDIX 5

Southern Wetland Assessment using the EPA's Bulletin 374
"A Guide to Wetland Management in Perth", 1990

Source: Environmental Protection Authority 1990. A Guide to Wetland Management in Perth. Bulletin No. 374, Environmental Protection Authority, Perth WA.

SOUTHERN WETLAND ASSESSMENT

2.2 The natural attributes questionnaire

2.2.1 Part 1A: Permanent and seasonal wetlands with well defined boundaries

For wetlands with poorly defined boundaries go to Part IB (Page 12)

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5	
(NO)	Score	1	
	Score		[1]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

(YES)	go to question iii		
NO	Score	3 — go to question (iv)	
	Score		[0]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3	
(NO)	Score	1	
	Score		[1]

Source: Refer to question (vi) for a listing of habitat types. Use aerial photos and field visits.

Management Notes: A high diversity of habitats is desirable from an ecological perspective. In some cases this diversity is not expressed in an individual wetland, but in a series of adjacent wetlands.

iv Drought refuge

What is the importance of the wetland as a drought refuge for birds?

MAJOR IMPORTANCE	Score	5	
MINOR IMPORTANCE	Score	2	CALM, local residents
(NO IMPORTANCE)	Score	0	
	Score		[0]

Source: Refer to Appendix 7 and local branch of RAOU.

Management Notes: Although waterbirds can move long distances to find suitable habitat when lakes dry out, it has been shown that Perth's wetlands provide a valuable drought refuge during the summer.

v Area of wetland

Estimate the area of the wetland:

>100ha	Score	5
50-100ha	Score	4
25-50ha	Score	3
10-25ha	Score	2
<10ha	Score	1
	Score	[ ]

Source: Map of appropriate scale in conjunction with a grid overlay. The edge of the inundated area (often indicated by fringing vegetation or summer grass) should be used as the wetland perimeter for this calculation.

Management Notes: As a general rule large wetlands are capable of supporting a larger variety of species and have a greater capacity to absorb the detrimental impacts of nearby land uses than small wetlands. Where a wetland chain is severed by urban development, species diversity within individual lakes often declines due to a reduction in habitat diversity (see management notes Question (vi).

vi Habitat type

Using the list below score 1 for each habitat type represented.

a Vegetation over 0.1 hectare in area

- large paperbarks (> 2.5m tall) in dense clumps
- low thickets (ie < 2.5m tall). These are often *Melaleuca, Astartea* or *Kunzea* spp
- paperbark fringe
- ✓ fringing rushes and sedges (often *Baumea* and *Juncea* spp.)
- fringing *Typha* (bullrush)
- samphire or saltmarsh
- extensive inlake beds of sedges
- ✓ extensive inlake beds of *Typha* or other rushes
- scattered dense clumps of rushes or sedges

b Other habitats

- ✓ flooded grassland in winter/spring
- mud flats or seasonally dry open water
- ✓ islands — natural or human made
- fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- ✓ permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score 1/2 point for:

- scattered paperbarks
- scattered rushes

Score [5]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations. The more complex the vegetation associations, the greater the habitat diversity.

vii Emergent vegetation

How much of the wetland is covered with emergent wetland vegetation?

If 40-60%			Score	5
If 30-40%	or	60-70%	Score	4
If 20-30%	or	70-80%	Score	3
If 10-20%	or	80-90%	Score	2
If <10%	or	>90%	Score	1

Score [2]

Source: Aerial photos and field visit.

Management Notes: A wetland which provides both open water and emergent vegetation is likely to fulfil the biological requirements of a greater range of species. For example, waterbirds need emergent vegetation for breeding and open water areas for feeding.

viii Adverse water quality

Has adverse water quality been reported in the last two years or observed on the current inspection? For example the presence of oil slicks, algal blooms or botulism in waterbirds.

No aspect observed or reported	Score	5
A single event/aspect observed or reported	Score	2
Several aspects observed or reported	Score	1
Three or more aspects observed or reported	Score	0

oily slicks, midge larvae

Score [1]

Source: Field survey, discussion with local residents, and local government authority.

Management Notes:

1 *Water quality varies significantly throughout the year with problems most evident in summer and often undetectable during winter.*

2 *The presence of macroalgae and/or large numbers of epiphytes is often an indication of poor water quality. An epiphyte is a non parasitic plant that relies on other plants for physical support.*

3 *Good water quality is important, particularly for invertebrates. If there is evidence of pollution (from heavy metals, pesticides and nutrients etc) measures should be taken to alleviate the problem.*

ix Drainage

a Are there drains directing water into or out of the wetland?

YES go to (b), (c) and (d)

NO Score 5 — go to question (x).

b If the drain(s) only directs water into a wetland, use the table below to determine the lake's susceptibility to nutrient pollution. This is achieved by:

i calculating the surface area of the wetland (refer to question v);

ii selecting the 'wetland surface area category' in the left hand side of the table* below that most closely approximates the lake being studied; and

iii note the 'drainage catchment area' value for that category (right hand side of table).

If the area of the catchment for the wetland being assessed exceeds the specified value in the right hand side of the table:

Score 1 — go to (c)

If the area is less than the catchment area value:

Score 4 — go to (c)

Wetland surface area category (ha)	Drainage catchment area (ha)
200	700
100	350
75	263
50	175
25	88
10	35

c If the drain(s) was constructed to maintain water levels in the lake or to support wetland vegetation

Score 3 — go to (d)

d If the drain(s) was constructed to dry out the wetland

Score 0

Score (a + b + c + d) [5]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

x Adjacent nutrient sources

a Are there alternate nutrient sources that could affect the water quality in the wetland?

For example, rubbish tips or landfill; lawns and/or grazing property fertilised on a seasonal basis; septic tanks within 100m of the wetland; agricultural development with high nutrient output such as feedlots and sheep holding yards nearby etc.

(If YES) go to (b) and (c)

NO Score 5 — go to question (xi)

* The table was prepared on the basis of a phosphorus assimilative capacity of 0.35 grams of phosphorus per square metre of wetland water area per annum, and a runoff rate of 1kg of phosphorus per hectare of catchment per annum. Further details about the table can be obtained from the Environmental Protection Authority.

b If there is only one source?

Score 2

c If more than one source?

Score 0

Score [0]

Septic tanks, dumped rubbish

Source: Field inspection and visit to the local government authority.

Management Notes: Recent research has demonstrated that large quantities of nutrients enter wetlands via surface water drains.

xi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10 %	Score	5
11 - 20%	Score	4
21 - 30 %	Score	3
31 - 40%	Score	2
> 40%	Score	1
	Score	[1]

Source: Aerial photos and maps.

Management Notes: See question (xiii)

xii Reserve area

Is the size of the (potential) reserve containing the wetland large enough to ensure that conservation values can be protected from the impacts of surrounding land uses. To determine this divide the area of the wetland by the area of the reserve surrounding the wetland. If the outcome of the computation is:

< 0.1	Score	5
0.1 - 0.25	Score	4
0.25 - 0.5	Score	3
0.5 - 0.75	Score	2
0.75 - 1.0	Score	1
	Score	[3]

Source: Aerial photos and maps — If there are not formal boundaries around the wetland use fence lines, roads or natural features of the landscape for the calculation (see management notes below).

Management Notes: Wetlands with large buffer zones are less likely to be degraded by the impact of surrounding land uses than those with small buffer zones. The size of buffer zones should be determined according to the physical and ecological properties of the individual wetland and the purpose for which it is being managed. Property or reserve boundaries used in the above computation should be at least 50m from the wetland edge. If less than 50m make a note in the report.

xiii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90%	Score	10
89 - 80%	Score	8

89 - 70%	Score	6
69 - 60%	Score	4
59 - 50%	Score	2
<50%	Score	1
	Score	

Natural Attributes Total = 21

[1]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

2.2.2 Part 1B: Seasonal and episodic wetlands with poorly defined boundaries

i Environmental geology classification

Does the wetland occur on the Quindalup Dunes or on a geological unit confined to a river/estuary floodplain?

YES	Score	5
NO	Score	1
	Score	[ ]

Source: Refer to 1:50,000 Environmental Geology Series (see Gozzard 1982).

Management Notes: Geological origin is one of the bases for wetland classification systems. In the metropolitan area, wetlands within these geological units are rare.

ii Adjacent wetlands

Are there wetlands within a 2km radius?

YES	go to question iii	
NO	Score	3 — go to question (iv)
	Score	[ ]

Source : Aerial photos.

Management Notes: Refer to question (iii).

iii Habitat diversity

Is the composition and structure of the vegetation significantly different to that found at nearby wetlands?

YES	Score	3
NO	Score	1
	Score	[ ]

Source: Refer to question (iv) for a list of habitat types. Use aerial photos and field visits.

iv Habitat type

Using the list below score one for each habitat type represented (maximum score 10).

a Vegetation over 0.1 hectare in area.

- large paperbarks (>2.5m tall) in dense clumps
- low thickets (ie <2.5m tall). These are often *Melaleuca, Astartea* or *Kunzea* spp
- paperbark fringe
- fringing rushes and sedges (often *Baumea, Juncea* spp)

- fringing *Typha* (bullrush)
- samphire or saltmarsh
- extensive inlake beds of *Typha* or other rushes
- scattered dense clumps of rushes or sedges

b Other habitats

- flooded grassland in winter/spring
- mud flats or seasonally dry open water
- islands — natural or human made
- fringing woodland or heath (eg eucalyptus nodes or non-wetland species)
- permanent **shallow** open water < 50cm deep
- permanent **deep** open water > 50cm deep

Score ½ point for

- scattered paperbarks
- scattered rushes

Score [ ]

Source: Field visit and aerial photos.

Management Notes: The composition, density and structure of the vegetation around a wetland has a major influence on the size and diversity of bird and other animal populations. The more complex the vegetation associations, the greater the habitat diversity.

v Drainage

Are there drains directing water into or out of the wetland?

YES	Score	0
NO	Score	5
	Score	[ ]

Source: Field inspection and visit to local government authority.

Management Notes: Surface water run-off entering wetlands via drains is often polluted. Nutrient inputs from this source should ideally be monitored for several years before determining the most appropriate means of managing algal and insect problems.

vi Area of wetland modified

What proportion of the wetland, within boundaries taken as 50m from the edge of the inundated area, has been modified by landfill, paving, cultivated gardens/playing fields, irrigated agriculture, grazing, weed invasion, mining etc?

0 - 10%	Score	5
11 - 20%	Score	4
21 - 30%	Score	3
31 - 40%	Score	2
> 40%	Score	1
	Score	[ ]

Source: Aerial photos and maps.

Management Notes: See question (vii)

vii Native vegetation buffer

What percentage of the wetland perimeter has a buffer of native vegetation 50m or wider along it?

100 - 90%	Score	5
89 - 80%	Score	4
79 - 70%	Score	3
69 - 60%	Score	2

59 - 50%	Score	1	
< 50%	Score	0	
	Score		[ ]

Source: Aerial photos.

Management Notes: Native vegetation has a beneficial effect on water quality and aesthetics and is essential for wetland fauna. A clear management objective for all wetlands should be to ensure there is vegetation cover where it would normally occur. Limited clearing may be acceptable at some sites if management procedures ensure that weed invasion is controlled and applied nutrients are prevented from leaching into the ground water or reaching the wetland through surface flow.

2.3 Human use questionnaire

i Aesthetics

Does the wetland possess any of the following attributes? (score appropriately)

Little, if any, artificial noise	Score	2
Understorey mostly intact	Score	2
Few, or no, roads or buildings obvious from wetland	Score	2
✓ Steep ridge visible as part of the scenery	Score	1
✓ Ridge accessible giving view of wetland	Score	1
Wetland is a lake and open water easy to view	Score	1
A section of wetland exists where few people visit	Score	1
	Score (total of above)	[2]

Source: Field survey.

Management Notes: A management plan should try to ensure that these attributes are preserved or enhanced by proposed developments.

ii Historical and archaeological features

Does the wetland have any of the following historical or archaeological features?

- registered Aboriginal relics or sacred sites
- pioneer relics/operations
- National Estate/Trust listings

Dept of Aboriginal Sites.

If two or more (of the above)	Score	5
If one	Score	3
Otherwise	Score	0
	Score	[0]

Source: Field survey, local government authoritys, National Trust, WA Museum — Department of Aboriginal Sites.

Management Notes: Strategies for the protection and/or preservation of historical and archeological features should be clearly defined in the management plan for the wetland.

iii Security of wetland

What is the current vesting of the land containing the wetland ?

A Class Reserve for conservation and recreation or Metropolitan Region Scheme reserve for Parks and Recreation owned by the Department of Planning and Urban Development or local government authority	Score	5

Other class of reserve — vested System Six recommendation unvested or on private property	Score	3	
Other class of reserve — unvested	Score	2	
Other (eg private or vacant Crown land)	Score	1	
	Score		[1]

iv Protection groups

Does the wetland have active protection groups?

One or more	Score	5	
No groups	Score	0	
	Score		[0]

v Passive recreation

Is the wetland used for any of the following passive recreation activities?

If yes, score 1 for each

- nature study/bird watching
- education (school or other educational interest within 500m)
- picnic and /or barbecue facilities
- conservation of flora (refer to maps)
- conservation of fauna (refer to maps)
- protection and preservation of other attributes
- recognised research site
  - — biological
  - — archaeological
  - — other
- recognised tourist venue

Score [0]

Source: Field surveys, maps, road directories, State and local government department and residents.

Management Notes: Damage such as trampling, erosion and destruction of vegetation should be noted during the field visit.

vi Active recreation

Is the wetland used for any of the following active recreational activities? If yes, score 1 for each.

- walking/jogging or cycling
- horse riding
- trail bike riding
- playground
- sports grounds
- model boats
- golf course
- canoeing/rowing
- power boating/skiing
- swimming

Score [6]

Source: State and local government recreation departments.

Management Notes: Damage from current activities should be recorded during the field survey and reported to the appropriate authority/s.

vii Other human uses

Is the wetland used for any of the following purposes? (Score 1 for each)

- agricultural activities (grazing, horticulture etc)
- ✓ mining (check for mining leases)
- ✓ existing/proposed service corridors (SECWA, roads, etc)
- water supply
- ✓ proposed urban/housing use
- private purposes other than described above

peat licence

Human Use Total = 5

"M" Category

Score [3]

Source: Field survey, maps and State and local government departments.

Management Notes: The compatibility of the above activities with conservation values should be considered during the formulation of a management plan. It may not be practical to achieve all management objectives, and land use priorities will have to be decided.

2.4 Supplementary questionnaire

This questionnaire is used to determine the most appropriate management category for a wetland where the natural attributes and human use score falls in the "transition zones" in the graph in Appendix 6.

If the answer is YES in question i (below) the wetland should be moved to the management category to the right.

If NO, move to left.

If the answer to either ii or iii is YES, move upwards; if NO move downwards.

i Species rarity

Are rare species of animals or plants present or are there communities represented which have a limited distribution?

Source: Department of Conservation and Land Management, local government authorities, conservation groups, literature searches.

Management Notes: Wetlands supporting rare and endangered species should be given priority when allocating resources for the formulation of management plans and implementation of field works.

ii Effect on land values

Does the wetland significantly enhance real estate values and land rates around it? ie, does the wetland add more than 10% to the value of nearby houses?

Source: local government authoritys, estate agents.

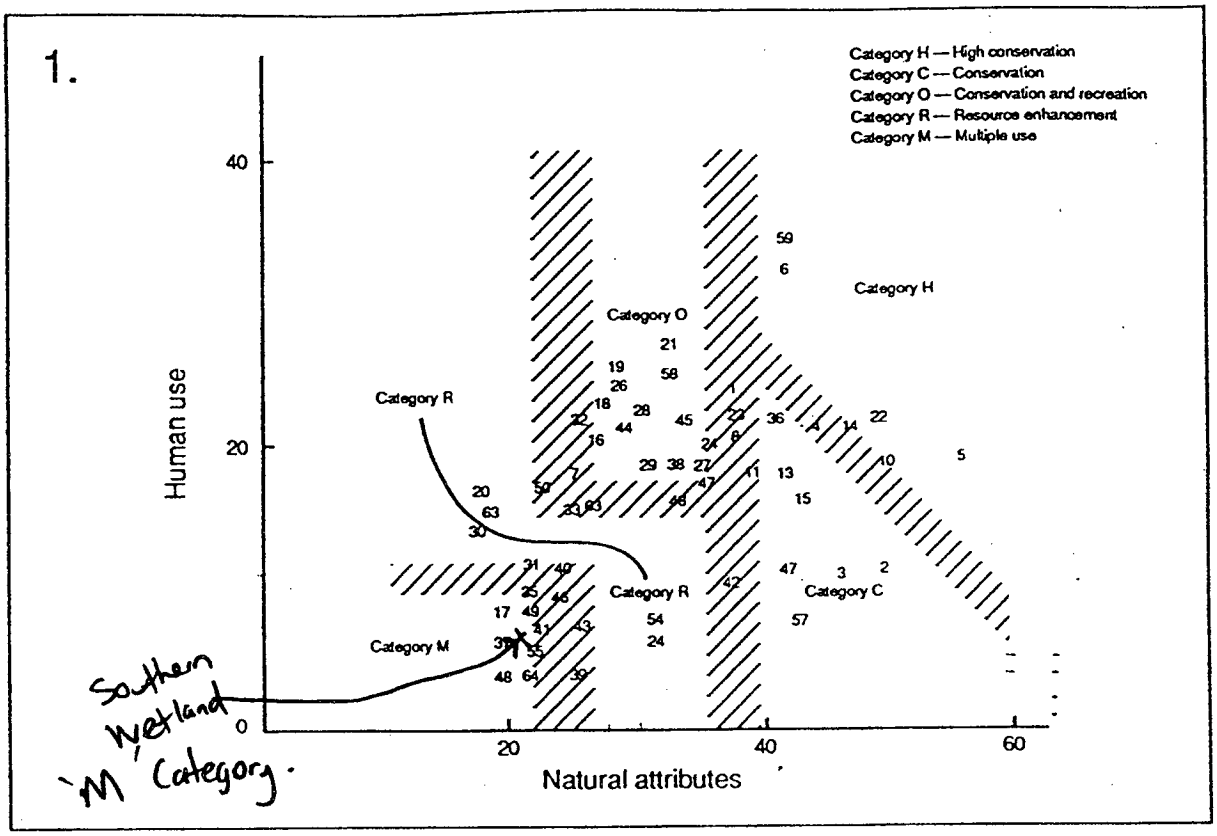
Management Notes: The enhancement of real estate values is a legitimate reason for increased expenditure on the active management of a wetland.

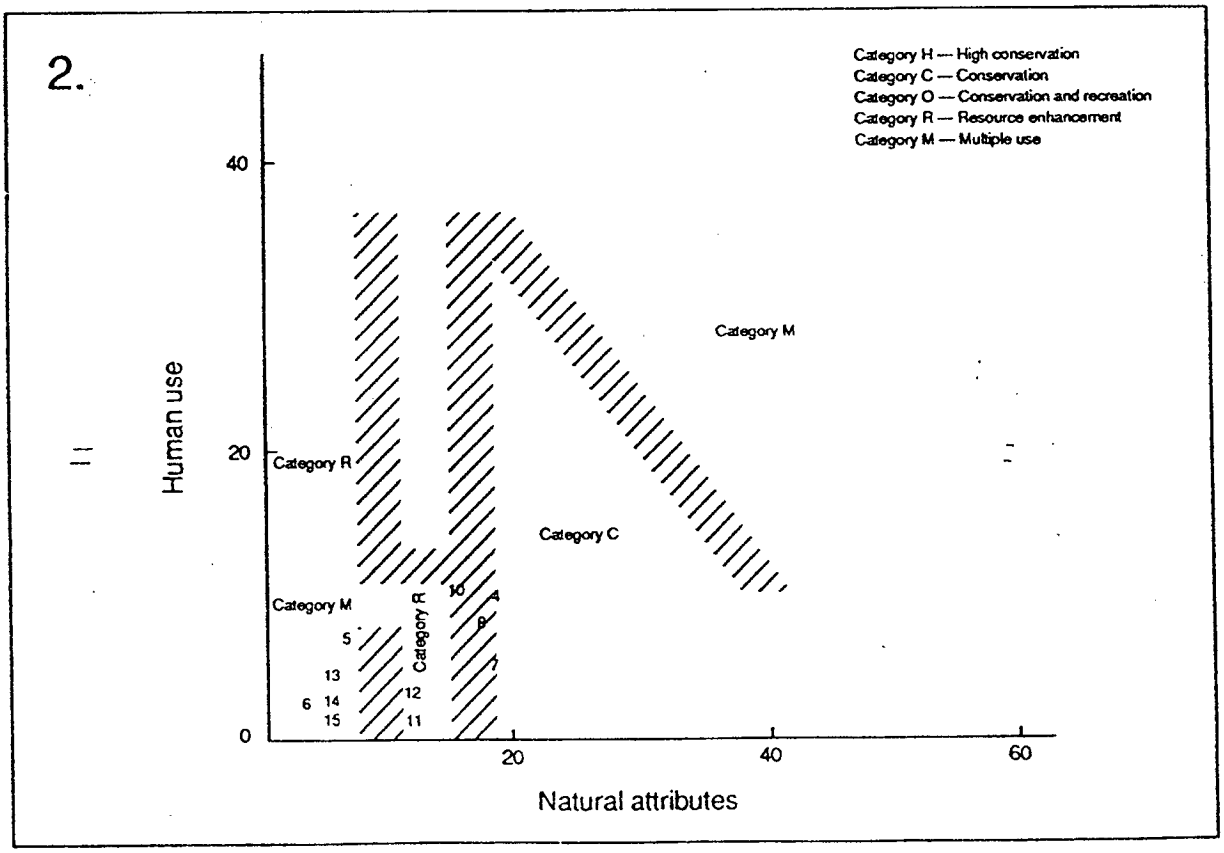
iii Human use

Do more than 100 people visit the wetland each week?

Source: Extended field surveys, State and local government recreation departments.

Management Notes: This question provides a good measure of the need for human use management.





Graph 1 : Management categories for permanent and seasonal wetlands with well defined boundaries.
Graph 2: Management categories for seasonal and episodic wetlands with poorly defined boundaries