DESIGN STANDARDS
for
URBAN INFRASTRUCTURE
16 URBAN WETLANDS LAKES AND PONDS

FOR THE QUEEN, THE LAW AND THE PEOPLE

URBAN SERVICES

Urban wetlands, lakes and ponds

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16.1 Introduction

The development of urban areas results in changes to the quantity and quality of stormwater runoff. Urbanisation increases the level of export of a variety of non-point source pollutants from the catchment.

In the ACT, a Water Policy Plan (*The Territory Plan Part C Section C2 Water Use and Catchment Policies.*) has been developed to protect urban lakes and the receiving waters system from degradation in water quality resulting from urban development. This plan gives a framework in which Water Quality Control Ponds must operate, and specifies the outcomes that must be achieved by the pond systems.

Ponds are an integral part of an overall strategy to protect water quality. A water quality master plan shall normally be prepared by the Operating Authority or other government agency to determine appropriate water quality objectives, standards, and measures to be adopted for a particular catchment.

The requirements and design parameters to be adopted for a pond shall normally be given in the Deed of Agreement for a development or a specific design brief. Where details are not provided, the Designer shall consult the Operating Authority prior to commencing preliminary design work.

Designers should ensure that ponds are not located where they will prevent Utility Authorities from gaining access to their mains or services.

16.2 Related codes of practice and guidelines

16.2.1 Policy and guidelines

Design Guidelines: Stormwater pollution control ponds and wetlands Ian Lawrence & Peter Breen, Co operative Research Centre for Freshwater Ecology, July 1998.

Sustainable water action management project (swamp) - strategy and action plan, Environment ACT, 2000

ACT Environmental Flow Guidelines, Environment ACT, 27 May 1999.

Water resources management plan, Environment ACT, 16 August 1999.

Canberra's urban lakes and ponds draft plan of management, Canberra Urban Parks and Places, May 2000.

ANZECC Guidelines for Fresh and Marine Waters, Environment Australia (2000).

16.2.2 Legislation

Environment Protection Act 1997 (ACT).

Water Resources ACT 1998 (ACT).

The Territory Plan Part C Section C2 Water Use and Catchment Policies.

16.3 Functions

16.3.1 Pollution Control

A primary function of ponds is to minimise the impact of certain pollutants on downstream waters.

The ACT Water Policy Plan designates the uses of streams and rivers and sets out the required water quality standards for those receiving waters. It is important that ponds do not give rise to environmental problems or be visually unattractive, either through poor design or poor management practices.

16.3.2 Flood Control

Often there will be a requirement to reduce flows to within acceptable levels for downstream trunk drainage and receiving water systems.

A secondary function of ponds is the provision of storage for flow retardation to minimise the environmental impact of flood flows on down-stream areas.

Retardation of stormwater flows, hence flood peaks and water velocities, reduces the erosion and damage potential of floodwaters. Also, flow retardation can lead to reduced floodway capacity requirements and hence reduced land take requirements for drainage reserves in downstream areas.

Wetlands must be off-line from the channel system to ensure that the macrophyte growth is not impeded by regular flows, which would flatten the macrophytes.

16.3.3 Environmental Amenity

Other secondary functions of ponds are related to the provision of enhanced environmental amenity. Ponds can provide the following benefits:

- habitats for nature conservation
- potential source of second class water as limited by the *Environmental Flow Guidelines*
- improved landscape values
- restricted recreational uses.

16.4 Design Requirements

16.4.1 Objectives

Ponds shall be designed to collect and retain urban runoff for sufficient time (hydraulic retention time) to allow self-purification processes to reduce some pollutant loads. The hydraulic retention time is a key variable in providing the desired percentage retention for the type of pollutants to be removed.

A pond shall normally be designed to provide a 70% retention of the total phosphorus export from the catchment. However, the retention required is determined on a total catchment management basis. Therefore, the requirement for a particular pond may vary if other ponds are provided in the catchment, especially if they are located in series.

16.4.2 Water Volume

The length of time water is retained in a pond is a key variable in determining how effective the pond will be in trapping certain pollutants. The greater the retention time the greater the opportunity for sedimentation of particulate material and the action of other purification mechanisms.

For initial planning or preliminary design, a pond water volume of not less than 400m^3/hectare of catchment area may be adopted. A further 20% volume should be added to allow for sedimentation.

For final design, the required pond water volume shall be calculated using the Co-operative Research Centre for Freshwater Ecology Pond Model to provide a much more rigorous estimate of pond size requirements.

This Model is widely used by Local government and consultants throughout Australia & New Zealand.

16.4.2.1 Daily runoff.

- Select daily rainfall for three years covering wet, average, and dry weather conditions.
- Calculate daily runoff using the Boughton (Water Balance) model or other calibrated rainfall-runoff model.
- Calculate the daily pollutant export using the relationships in Table 16.1 for suspended solids, total phosphorus, and e-coli.

Table 16.1

Pollutant Exports and Relationship to Runoff

Pollutant	Urban	Rural
Suspended Solids (kg/km^2)	200 R	20 R
Total Phosphorus (kg/km^2)	0.39 $R^{0.8}$	0.115 $R^{0.57}$
E-coli (Numbers)	30,000 $R^{0.9}$	500 $R^{0.9}$

R is Runoff in mm/day

- adopt a preliminary pond volume on the basis of not less than 400 m3/hectare of catchment area
- calculate the retention time by routing the water runoff through the pond on a daily basis
- calculate the required retention time to stay within the water quality objectives for the receiving water by comparing the pollutant loads leaving the pond with the required receiving water flow and quality
- adjust the pond size until the required retention time is achieved
- add a further 20% volume to allow for sedimentation

16.4.3 Pond Configuration

Ponds and wetlands should be long relative to their width. The length to width ratio should be in the range from 3 to 5 to provide better distribution of flows across the pond.

The pond design should incorporate three main zones as follows.

16.4.3.1 Inlet Zone

An inlet zone shall be provided on all floodways and pipelines discharging into a pond. This shall consist of a Gross Pollutant Trap (GPT) to remove litter, debris, and coarse sediment particles. Refer to Design Standard 1 Urban Stormwater for the design requirements for GPTs.

It is desirable that inlet structures be located as far from outlet structures as possible to maximise retention time and to ensure that the entire water body is utilised for pollution control.

From the point of view of in-lake processes, multiple inlets that disperse the total pollutant load around the upstream end of the pond are preferable to single inlets.

Islands should be provided in ponds with wide inflow reaches to distribute flow evenly across the reach and to prevent short circuiting. Islands will facilitate wind driven circulation and therefore should be aligned with respect to prevailing winds. Also, islands are especially beneficial as habitat since they protect birds from predators such as domestic cats and dogs.

No water contact sports should occur in this zone.

16.4.3.2 Macrophyte Zone

Macrophytes (aquatic plants either emergent or submergent) enhance the pollutant removal potential of ponds by filtering finer particles and taking up nutrients. They can also help to prevent scouring of the sediments during high flows and can reduce sediment mobilisation by wind generated waves.

The configuration and design of a pond should incorporate sufficient shallow areas to encourage the growth of beds of emergent and submergent aquatic macrophytes. As a general guide, between 10 and 30 percent of the total surface area of a pond should be set aside for macrophyte growth, particularly in the upper reaches.

Depths shallower than 2.4 m are likely to be colonised by submergent macrophytes while depths shallower than 0.6 m are likely to be colonised by emergent macrophytes.

16.4.3.3 Open Water Zone

A deeper area that allows time for fine particles to flocculate and settle, and allows sunlight to kill bacteria shall be provided. Water contact sports can occur in this zone.

The minimum depth should be greater than 2.4 m to minimise the growth of rooted macrophytes.

The maximum depth should not exceed 3.0 m because of the increased risk of temperature stratification beyond this depth.]

16.4.4 Edge Treatment

Natural soft edges should be used wherever possible to encourage a variety of shoreline plants. The shore line edge is to be free draining to discourage isolated pockets of water (potential breading area for mosquitos). The edge should be capable of withstanding wave action erosion.

Hard edge treatments such as timber and stone walls should only be used where required for adjacent land uses, and where it is desirable to discourage emergent macrophytes.

An edge side slope of 1 in 15 should be provided in areas where it is desirable to establish aquatic macrophytes to trap pollutants, provide bank stability, and provide habitat. This gentle slope, free from sudden drops will not present a safety hazard to children wading.

Where it is desired to limit the extent of macrophyte growth, an edge side slope of 1 in 8 should be provided to a minimum depth of 2 m below normal operating level. A coarse gravel substrate may also be used to reduce macrophyte colonisation.

16.4.5 Embankment and Spillway

The pond embankment and spillway design shall be based on the latest edition of the ANCOLD "Guidelines on Design Floods for Dams".

Full engineering investigation and design of dams will be required.

The primary spillway, secondary spillway, or limited (non-scouring) overtopping of the embankment must accommodate floods up to 1:10,000 AEP in high hazard areas.

The embankment and spillway design shall be submitted to the ACTEW Dam Safety Officer for consideration and endorsement prior to submission to the Operating Authority for acceptance.

Low flows up to at least 3 month ARI shall either bypass or be concentrated over the primary spillway to discharge directly into the downstream channel.

The pond shall be designed to avoid floodwaters, up to and including 100 Years ARI, from inundating upstream roadways and leases. Flood protection requirements for other adjacent land uses shall also be considered where appropriate.

Embankment slopes that require mowing should generally not exceed 1 in 6 although in some circumstances up to 1 in 4 may be accepted over small areas.

Suitable access shall be provided for maintenance machinery. Access ramps shall be at least 3.7 m wide (unobstructed) and have slopes no steeper than 1 in 6. Transitions shall be provided at the crest and toe of ramps. Adequate space to manoeuvre machinery on and off the ramps shall also be provided.

16.4.6 Emergency drainage facility

The pond design shall incorporate a drainage facility to enable at least 80% of the pond volume to be drained within 14 days.

Intakes to this facility must be screened to minimise the likelihood of blockage. Careful consideration must also be given to the effect of sediment build-up around the outlet. Stop logs should be provided at the upstream end of the low outlet to facilitate maintenance of the valve and pipe fittings. The stop logs should be such that they can be easily installed from the surface or by divers.

The drainage facility must be designed to be vandal resistant and secured to prevent unauthorised drawdown of the pond.

16.5 Water plants

16.5.1 Selection of species

Plant species for use in public open spaces managed by City Management should be chosen from the approved plant list (see Design Standard 23 Plant Species for Urban Landscape Projects). Designers should also consider the site conditions, maintenance requirements and design intent when selecting species. The following criteria must be considered when selecting plants for a particular pond site.

- There must be clear evidence that the proposed plants will be able to establish and grow in the site.
- A plant must be unlikely to colonise outside the proposed area, or to colonise downstream of the pond.
- The maximum height of the plants must be consistent with maintaining desirable visual characteristics around the pond.
- The over-wintering form of a plant must not cause degradation of the aesthetics of the area.
- Plants must not grow to a density that would provide habitats suitable for mosquito breeding.

16.5.2 Planting

In the ACT, planting between October and March is recommended for success. Later plantings make slower growth and are less robust before Winter. Given a choice, November is the optimum planting month.

The presence of a hard substrate due to cemented soils or rock shelves will slow the establishment of water plants. Other site conditions such as wave action and wind exposure will slow or prevent the spread of the existing species as well as making it difficult for seedlings or pieces to obtain a foothold.

One strong constraint to the establishment of certain species, such as *Schoenoplectus validus,* is the grazing of waterfowl on newly planted seedlings. This factor needs to be considered for each site, and protective netting used where necessary until plants are well developed.

Another constraint to establishment is the need to be certain that the water level of the pond or lake is unlikely to drop significantly during the initial few months after planting to ensure that the plant root system can develop before any drying out of that zone.

Ensure that seedlings are securely planted in the substrate. This is especially important in sites with a hard substrate and along sections exposed to large waves.

16.5.2.1 Planting density

In larger water bodies of the size of Lake Tuggeranong, for example, planting of the margin/open water plant species can occur in clumps of 20 to 40 metres long, with a gap of 20 metres between the clumps. These areas between the clumps can be planted with edge zone species (such as *Paspalum distichum, Crassula helmsii* and *Carex* species) or margin zone species (such as *Eleocharis acuta, Juncus usitatus*).

16.5.2.2 Growing into deeper water

Only five of the approved emergent plant species have the growth potential and robustness to grow successfully from the lake edge into deeper water of one metre or more. These are *Typha domingensis, Phragmites australis, Schoenoplectus validus, Eleocharis sphaceltata* and *Bolboschoenus fluviatilis*. The nature of the substrate is important.

For example, *Eleocharis sphacelata* thrives in water 1 to 1.5 metres deep, but only if the sediment is soft for the large rhizomes to expand. For this reason *Eleocharis sphacelata* is unlikely to thrive at sites with hard compacted substrate.

Most of these plant species such as *Schoenoplectus validus* grow well when planted in water 50–100 mm deep. *Phragmites australis* will also establish in the wet soil of the shoreline as well as in the shallow water.

16.5.3 Transplanting waterplants

Seedlings are usually preferable to pieces and generally cost less. However, rhizome pieces from sites that are to be destroyed or mechanically cleaned can be used. Taking plants from existing wetlands should be avoided. However, under some circumstances pieces obtained from farm dams, normally subject to cleaning, is permissible.

16.5.4 Propagation

In recent experience, seeds were germinated during Winter (June/July) in order that they will be robust and at least 250 mm tall in time for the November planting. It is best to seek advice from experienced propagators, as the germination requirements are not fully documented.

The water zone species will require specialised growing cultures (that is, water tanks). Apart from the water zone water plants, other species have grown well under general nursery conditions after the germination phase. Placing containerised plants in shallow water tanks may be used for longer-term storage of some species.

16.5.5 Other issues

16.5.5.1 Weediness of some waterplants

From time to time, native emergent and submerged plants may require control for management purposes. The reason for having a list of locally endemic waterplant species recommended for planting in the ACT is that many other waterplant species can be invasive under their optimum growing conditions or they may have other environmental impacts. Future asset management costs for water bodies are minimised by the selection of the correct species for the region and the particular site being developed.

16.5.5.2 Bird and animal habitat

Previous workers have identified land/water margins with shallow, still water and well developed macrophyte vegetation to be safe habitats for refuge, breeding and feeding by many aquatic and semi-aquatic animals.

16.5.5.3 Effect of overhanging trees

A survey carried out into the variety of waterplants found in lakes throughout the ACT has determined that the factor most limiting to the emergent waterplants in Lake Burley Griffin is the large trees, common on the lake edge. By contrast the range of species located in Lake Tuggeranong has been found to be more diverse than other lakes inspected in the ACT. The absence of shading trees is the main reason for the increased diversity

Introduced trees that overhang the edge of the lake reduce light and provide competition that prevents growth of the emergent and submerged waterplants.

16.5.5.4 Introduced plants and edge zone plants

At the edge of water bodies in urban areas, the fringe left after mowing may be considered to be untidy. This zone may support adventive plants such as *Festuca elatior, Rumex conglomeratus, Rumex crispus, Phararis aquatica* and *Cyperus eragrostis.* However, once a good stand of emergent waterplants establishes, the fringe of dry-land species tends to disappear or diminish. *Carex appressa* is a suitable semi-aquatic for the lake margin.

16.6 Water Reuse

Ponds can provide a supply of second class water for use on construction sites and for irrigation of open space areas and neighbourhood playing fields. However a major limitation on the use of second class water is the requirement to maintain an environmental flow. This can mean that there is no spare capacity to provide irrigation water at the time of peak demand.

For lakes and ponds in the ACT, the Environmental Flow Guidelines determine the limit of the surface level drawdown. For Urban Lakes and Point Hut Pond, the maximum drawdown is 100mm. For other ponds, the maximum drawdown is 200mm.

A Licence to abstract water from lakes, Ponds and wetlands is required under the Water Resources Act 1998.

16.7 Public safety

16.7.1 Advisory Signs

Water based recreation is generally inappropriate in small ponds and in the upstream parts of larger ponds (Inlet and macrophyte zones). Advisory signs shall be provided to warn the general public of the danger of shallow water and advise where swimming and other recreational activities is not permitted.

Figure 16. 1 Water Quality Control Pond Warning Sign

The sign shall be 300 mm x 450 mm with red lettering on a white light reflective plate. The signs shall be located at points where access to the pond edge is unobstructed and generally at intervals around the pond such that adjacent signs are visible from each other.

The signs shall be erected back to back on a 75 mm grey galvanised steel pole and be located 1.5 m above the ground. The blades shall be oriented at right angles to the water.

16.7.2 Power Line Warning Signs

Where lakes or ponds which are likely to be used for boating are constructed such that powerlines pass over either the water or the access to the water, appropriate warning signs must be erected to advise of the electrical hazard posed by the lines. Detail of type and location of signs are available from ActewAGL.

16.8 Emerging Issues

The benefits of extended detention based ponds/wetlands are substantial in terms of improved interception of pollutants, the promotion of greater diversity of edge plants, and the flow attenuation downstream. Extended detention based ponds or wetlands are now fairly universally adopted, rather than fixed level (broad spillway) based ponds.

The Co-operative Research Centre for Freshwater Ecology Pond Model includes an extended detention function in estimating pollution interception.

Research has established that where ponds are on-line and in series, the downstream pond may not intercept further pollutant loads except where the downstream pond is significantly larger than the upstream pond, or there are substantial additional sub-catchments discharging to a drain downstream of the upstream pond.

The location of ponds or wetlands off-line provides a number of benefits over on-line ponds or wetlands. Benefits include greater control over hydraulic & pollutant loading on pond or wetland, ease of maintenance, substantial cost savings in relation to reduced spillway requirements, and enhanced landscape visibility.

16.9 Further reading

Urban Surface Water Management, Walesh S. G**.** John Wiley & Sons Inc

Erosion and Sediment Control During Land Development, Environment *ACT, 1998.*

Peak Design Discharges for ARIs less than one year, ACT Electricity & Water, Hydrology & Water Resources Branch, HWR 92/679, Department of Urban Services**,** February 1993.

Integrated Urban Land & Water Management: Workshop Report, Lawrence, I (2000), Co-operative Research Centre for Freshwater Ecology & Institution of Engineers Australia (Newcastle Division).

Changing context of constructed wetlands, Ian Lawrence, Stormwater Industry Association: Concord, Sydney, 30 November 2000