



Department of Water  
Government of Western Australia

# Interim Position Statement: Constructed Lakes



Department of Water

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**Subject of cover photograph**

Examples of Constructed Lakes.(Drainage and Waterways Branch, Department of Water, 2007)

# Interim Position on Constructed Lakes

The *Interim Drainage and Water Management Position Statement: Constructed Lakes* is designed to guide developers, landowners, local government and State Government agencies on the Department of Water's (DoW) position on constructed lakes. Constructed lakes are defined as constructed, permanently inundated basins of open water, formed by simple dam walls or by excavation below ground level.

Constructed lakes differ from constructed wetlands, which are vegetated detention areas that are either permanent or ephemeral and are designed and built specifically to remove pollutants from drainage runoff, or for their ecological functions. Advice about constructed wetlands is available in Chapter 9 of the *Stormwater Management Manual for Western Australia* (DoW & SRT, in publication).

The Position Statement is intended to provide guidance on issues that should be considered when constructed lakes are created in urban (i.e. residential, commercial and industrial) areas for drainage, irrigation storage, recreation or aesthetic purposes; and in rural areas if they are created solely or partly for recreation or aesthetic purposes, e.g. adjacent to wineries, restaurants, accommodation and tourism facilities. The checklist in Table 1 provides guidance that DoW officers will use during the assessment of proposals for constructed lakes. DoW officers will utilise the information in the checklist as a basis for requesting additional information or to set conditions for the design and management of the constructed lake.

The Position Statement does not apply to the management of constructed lakes in rural areas that are created for the purpose of drainage, mining voids, irrigation storage or stock watering, as other conditions may apply.

DoW recognises that well-designed and maintained constructed lakes can have community benefits that are similar to those gained from natural wetlands, such as aesthetic and recreational values and health benefits associated with passive recreation. However, it is necessary to manage the issues associated with constructed lakes.

If a constructed lake is proposed, the proponent should demonstrate, through the design of the lake and planning for ongoing management, that the following issues will be addressed:

- strategic planning and general requirements
- water use efficiency
- protection of natural wetlands, waterways and other water dependent ecosystems
- algal and aquatic weed blooms
- acid sulfate soils and iron monosulfides
- on-going maintenance and life-cycle costs
- mosquitoes and midges
- flood risk and drainage management
- integration with other passive recreation and public open space

Guidance on these issues is provided in Table 1, below.

DoW is the lead agency for management and protection of waterways, total water cycle management, water use efficiency and environmental water provisions for water dependent ecosystems.

The Department of Environment and Conservation (DEC) is the lead agency for the management and protection of wetlands and for the investigation and management of acid sulfate soils and iron monosulfides, which may cause water contamination if poorly managed. The DoW also considers management and protection of natural wetlands and management of acid sulfate soils as part of its responsibility for total water cycle management.

Ongoing maintenance, life-cycle costs and health and nuisance issues, such as mosquitoes and midges, are considered but are not specifically addressed by the DoW. These issues are managed by the relevant Local Government Authority. Issues relating to the health risks from mosquitoes are also managed by the Department of Health.

DoW will undertake a qualitative literature review and interview project to evaluate the performance of constructed lakes in the south west of the State. This project will be conducted in 2007 and will guide a future field assessment of constructed lakes. The results of these projects will contribute to the final Position Statement. This interim position statement will be reviewed within 12 months.

**Table 1: Checklist and advice on the requirements for constructed lakes**

Checklist of requirements (✓ or ✗)	Additional advice
<b>Land use planning for drainage and water management</b>	
<input type="checkbox"/> Has the constructed lake been approved in regional or district planning? <input type="checkbox"/> Is the constructed lake clearly indicated on the local structure plan, subdivision application and subdivision plan?	Where a constructed lake is proposed, it should be clearly indicated on any local structure plan and subdivision plan to ensure the lake is considered at both levels of planning. If a lake is not indicated on either a local structure plan or a subdivision plan, it cannot be considered by the relevant authorities. Subdivision or development approval will be required for the lake from the relevant decision maker. If a constructed lake is proposed, the proponent should liaise with the relevant local government to determine whether a separate development approval is required.
<b>General requirements</b>	
<input type="checkbox"/> If the constructed lake is proposed solely for irrigation storage, has the developer or landowner demonstrated why alternatives, such as groundwater bores or tanks, are not viable options?	Alternative water supply and storage methods (such as groundwater bores) are a more efficient use of water and will have less management issues if irrigation is the sole purpose of the constructed lake.

**Table 1 cont.**

<b>Checklist of requirements (✓ or ✘)</b>	<b>Additional advice</b>
<input type="checkbox"/> If the constructed lake is proposed as a component of the stormwater management system, is it consistent with the <i>Decision Process for Stormwater Management in WA</i> (DoE & SRT, 2005a).  <input type="checkbox"/> If the constructed lake is proposed as a component of the stormwater management system, does the design demonstrate how the constructed lake will provide stormwater management benefits?	<p>The Decision Process provides a decision framework for the planning and design of stormwater management systems and guidance on maintaining natural drainage processes (i.e. the pre-development hydrology) within land developments in urban and peri-urban areas. It does not apply to rural areas. Use of the Decision Process will result in minimising potential changes in the volume of surface water flows and peak flows due to urban development. If not managed, these could lead to adverse impacts on water regime, water quality, habitat diversity and biodiversity in receiving water bodies (i.e. waterways, wetlands, coastal marine areas and groundwater) and public health and amenity. Priorities may include managing the magnitude of peak flows and the volume and seasonality of catchment run-off.</p>
<input type="checkbox"/> Has the developer or landowner demonstrated consideration of the local conditions when deciding whether the lake will be lined or unlined?	<p>The local conditions (e.g. hydraulic conductivity of the soil, soil nutrients and groundwater level and quality) should be considered when deciding whether the constructed lake should be lined or unlined. For example, constructed lakes should not be connected to groundwater that has existing or potential for high nutrient levels, however an unlined lake may offer benefits in terms of natural buffering of the water storage.</p> <p>Lining may produce both positive and negative effects. Potential positive benefits include preventing contamination of groundwater (e.g. due to accidental spills, illegal waste disposal, formation of iron monosulfides and inappropriate use of fertilisers and pesticides) and improving the water use efficiency of constructed lakes where the water level is artificially maintained, by preventing or minimising seepage losses. However, lining could increase the risk of eutrophication by increasing water temperatures, restricting emergent vegetation and eliminating groundwater inflows, which may significantly reduce summer turnover in the lake.</p>

Table 1 cont.

Checklist of requirements (✓ or ✘)	Additional advice
<b>Water use efficiency</b>	
<input type="checkbox"/> Does the design minimise surface area and use other design methods to reduce water loss through evaporation?  <input type="checkbox"/> Has a water balance calculation been provided, which demonstrates that the net loss of water will be acceptable?	<p>Perth's evaporation rate is generally higher than it's rainfall and a significant proportion of the water in a constructed lake can be lost through evaporation. The evaporation losses are dependent on the local climatic conditions, depth of the lake and its surface area. Constructed lake design can significantly decrease evaporation by reducing the surface area.</p> <p>The Department does not support supplementing constructed lakes with scheme water for any reason.</p>
<input type="checkbox"/> If the constructed lake is proposed for the purpose of irrigation storage, has the developer or landowner demonstrated that landscaping has been designed to minimise the amount of water required for irrigation.  <input type="checkbox"/> If the constructed lake is proposed for the purpose of irrigation storage, has the developer or landowner demonstrated that the volume of water in the constructed lake is consistent with the irrigation requirements?	<p>The volume of the constructed lake should meet irrigation requirements. It should be consistent with the proposed area of land to be irrigated and the projected water demand of the land use or crop type.</p> <p>If landscaped parks and gardens are to be irrigated, they should be designed in such a way as to reduce the amount of water required for irrigation. For example, water-wise plant species should be selected for landscaped areas to reduce the irrigation requirement. Refer to Section 2.2.7 Maintenance of Gardens and Reserves of Chapter 7: Non Structural Controls (DoE &amp; SRT, 2005b) in the Stormwater Management Manual for WA for additional advice.</p>
<input type="checkbox"/> If required, has the developer or landowner applied for a <i>Rights in Water and Irrigation (RIWI) Act 1914</i> licence?	<p>A RIWI Act licence is required to take water in proclaimed groundwater or surface water areas. If granted, licences may contain conditions on the sustainable use of water. Schedule 7(2) of the RIWI Act ensures licences are in the public interest, ecologically sustainable and environmentally acceptable.</p> <p>Further advice is available from the relevant regional office of the Department.</p>

Table 1 cont.

Checklist of requirements (✓ or ✘)	Additional advice
<b>Protection of natural wetlands, waterways and other water dependent ecosystems</b>	
<input type="checkbox"/> Will the proposal impact on natural wetlands, waterways and other water dependent ecosystems located near to, or downstream of, the constructed lake? <input type="checkbox"/> Have adequate wetland buffer areas and waterway foreshore areas been designated to protect any wetlands and waterways located adjacent to, or downstream of, the constructed lake? <input type="checkbox"/> Has maintenance of the hydrologic regimes of nearby and downstream wetlands, waterways and other water dependent ecosystems been adequately considered?	<p>For further information on wetland protection and management, refer to the DEC internet page: <a href="http://wetlands.environment.wa.gov.au">http://wetlands.environment.wa.gov.au</a>.</p> <p>For further information on waterway protection and management and maintaining environmental water provisions for water dependent ecosystems, refer to the following DoW internet pages: <a href="http://waterways.water.wa.gov.au">http://waterways.water.wa.gov.au</a> <a href="http://policies.water.wa.gov.au">http://policies.water.wa.gov.au</a></p>
<input type="checkbox"/> Does the proposal avoid modifications to Conservation and Resource Enhancement management category wetlands? <input type="checkbox"/> If it is proposed to modify a Multiple Use management category wetland, has the Department of Environment and Conservation granted approval (i.e. based on the merits of the proposal)?	<p>Constructed lakes should not be created by modifying wetlands of conservation significance, such as Conservation or Resource Enhancement management category wetlands. Proposals to modify Multiple Use management category wetlands to create constructed lakes will be considered by the Department of Environment and Conservation on their individual merits.</p>
<input type="checkbox"/> If required, has the developer or landowner applied for a RIWI Act permit? <input type="checkbox"/> If required, has a RIWI Act licence been granted, or is it likely to be granted?	<p>A RIWI Act permit is required to modify the bed and banks of a watercourse (i.e. waterway) in proclaimed surface water areas and in some limited circumstances in unproclaimed areas (e.g. when the water access point is on Crown land and accessible by a public road or reserve).</p> <p>Further advice is available from the relevant regional office of the Department.</p>

**Table 1 cont.**

<b>Checklist of requirements (✓ or ✗)</b>	<b>Additional advice</b>
<input type="checkbox"/> Does the proposal avoid directly connecting the constructed lake to natural wetlands and waterways (e.g. via pipes, constructed channels or drains)?	<p>Constructed lakes should not be directly connected to natural wetlands and waterways (e.g. via pipes, constructed channels or drains) due to the risk of causing adverse impacts on hydrology (i.e. increasing the magnitude of peak flows and the volume of catchment runoff and altering the seasonality of catchment runoff), causing adverse impacts on water quality, altering the geomorphology, causing loss of habitat; and introducing weeds and pests (e.g. mosquitofish (<i>Gambusia holbrooki</i>)).</p> <p>The Department of Water prefers that lakes are not constructed on natural waterways. However, if a lake is approved to be constructed on a waterway, the developer or landowner will be expected to demonstrate that the natural hydrologic regime of the downstream ecosystem will be maintained, using a method endorsed by the Department of Water.</p>
<p><b>Algal and aquatic weed blooms</b></p>	
<input type="checkbox"/> Has the developer or landowner demonstrated (e.g. by modelling) that the turnover (i.e. rate of water exchange) and circulation of the constructed lake will be adequate to significantly minimise the risk of algal and aquatic weed blooms?	<p>A combination of water quality inputs to the lake, organic load and water circulation influence the water quality in a lake. Algal growth can occur rapidly under favourable conditions. Demonstration of adequate turnover time and circulation is required to reduce this risk.</p> <p>The turnover time should consider inflow, seasonality and losses due to evaporation, leakage to groundwater (for unlined lakes) and irrigation requirements, if the lake will be used for irrigation storage.</p> <p>Constructed lakes should not be allowed to discharge directly to natural waterways and wetlands (i.e. by pipes and constructed channels).</p>
<input type="checkbox"/> Has the developer or landowner demonstrated that the water quality will not contribute to algal and aquatic weed blooms?	<p>Algal and aquatic weed bloom formation in constructed freshwater lakes is primarily driven by phosphorus availability (loading) and flushing.</p>

Table 1 cont.

Checklist of requirements (✓ or ✖)	Additional advice
<input type="checkbox"/> Has the developer or landowner used appropriate non-structural and structural methods to maintain or treat water quality?	<p>To maintain or treat water quality, non-structural and structural methods should be used in particular combinations to suit the local conditions. This is known as a 'treatment train approach'.</p> <p>Further advice is available in the <i>Stormwater Management Manual for WA</i> (DoW , 2004 -). Refer to Chapter 7 for non-structural methods to prevent pollution of stormwater, including community engagement and behaviour change programs and best practice maintenance of the stormwater network, parks and reserves. Chapter 9: Structural Controls is currently being completed, however preliminary advice is available on the Department's internet page: <a href="http://stormwater.water.wa.gov.au">http://stormwater.water.wa.gov.au</a> .</p>
<b>Acid sulfate soils and iron monosulfides</b>	
<input type="checkbox"/> Has the developer or landowner identified whether there is a risk of acid sulfate soils (ASS) being present?  <input type="checkbox"/> If ASS have been identified, are the proposed management practices consistent with relevant guidelines in the DEC's ASS Guidelines Series?	<p>ASS should not be drained, excavated or exposed by lowering the watertable, as this may cause acidification of water and may contaminate surface and groundwater with arsenic, aluminium and heavy metals (if these are present in the soils) and cause damage to aquatic and riparian ecosystems.</p> <p>For land where there is a significant risk of drainage or excavations disturbing shallow (&lt;3m below ground level) ASS (e.g. land identified as high risk under <i>Planning Bulletin 64: Acid Sulfate Soils</i> (WAPC, 2003)), a desktop risk assessment is required, which may be a precursor to on-site field investigations. In areas of the State for which ASS risk maps have not yet been produced, Planning Bulletin 64 requires existing Environmental Geology maps (published by the Department of Industry and Resources) to be consulted to identify whether ASS may be present.</p> <p>ASS risk areas for the Perth Metropolitan Area can be viewed in the <i>Perth Groundwater Atlas</i> (DoE, 2005), which is available on the DoW's website. Digital copies can be obtained from the DoW.</p> <p>DEC has prepared the ASS Guidelines Series to assist agencies, developers and individuals to manage development in areas where ASS may or will be impacted upon. Copies of documents in the Acid Sulfate Soils Guidelines Series and further technical advice and information can be obtained from the DEC's website.</p>

**Table 1 cont.**

<b>Checklist of requirements (✓ or ✘)</b>	<b>Additional advice</b>
<input type="checkbox"/> Is appropriate management proposed to minimise the risk of iron monosulfides forming in the sediments of drainage systems?  <input type="checkbox"/> Has the developer or landowner demonstrated that inflow water quality (i.e. sulfate and ferrous iron) will not contribute to the formation of iron monosulfides?	<p>Iron monosulfides are an important component in the cycling of iron and sulfur in ASS environments (Smith, 2004). Sediments in open drains and basins in these types of environments may contain a black, organic rich ooze known as MBOs (monosulfidic black oozes) (DoE &amp; SRT, 2005b). These sediments may require special removal techniques to prevent oxygenation which can trigger acid release and de-oxygenation of the water body (DoE &amp; SRT, 2005b). Some sediments can accumulate iron monosulfide minerals between cleaning events, which may cause a net release of acid upon the sediments drying (DoE &amp; SRT, 2005b).</p> <p>Management to minimise the risk of iron monosulfide formation involves avoiding formation of anoxic sediments and loading of iron and sulfate to drainage systems. This may include maintaining high sediment dissolved oxygen levels and minimising organic load and primary production in the constructed lakes and drains (Bush et al, 2004). Developers or landowners should also demonstrate that inflow water quality will not lead to the formation of iron monosulfides through increased sulfate and iron transport in drainage systems (DEC, 2004), particularly where subsoil drains are used to control maximum groundwater levels.</p> <p>The Land and Water Quality Branch of the DEC can provide additional advice and support.</p>
<p><b>Other issues considered, but not the specific responsibility of the Department (e.g. on-going maintenance, life-cycle costs, mosquitoes and midges)</b></p>	
<input type="checkbox"/> Has the developer or landowner adequately considered the requirements for on-going maintenance?  <input type="checkbox"/> Has the developer or landowner adequately considered the life-cycle cost of maintenance and retrofitting or replacement, including all associated infrastructure?	<p>Developers or landowners should engage in consultation with the relevant local government authority regarding ongoing maintenance of a constructed lake and associated infrastructure.</p>

**Table 1 cont.**

<b>Checklist of requirements (✓ or ✗)</b>	<b>Additional advice</b>
<input type="checkbox"/> Has the developer or landowner proposed to avoid using algicides and algistats or using them only where appropriate, for the management of algal and aquatic weed blooms?	<p>Algicides should not be used to control algal blooms especially if constructed lake is connected to the natural system. Algicides are toxic to aquatic flora and fauna.</p> <p>Algistats may alter the chemical composition or physical properties of a water body, which may adversely impact on aquatic flora and fauna. Algistats should only be used where they will not adversely impact on downstream aquatic ecosystems.</p>
<input type="checkbox"/> Has the local government provided support for the proposal?	<p>As the local government will, in most cases, ultimately be responsible for management and maintenance of the constructed lake, their agreement is considered necessary. It is recommended that negotiations with local government be carried out an early stage so as to confirm support for the constructed lake, including its ongoing management and maintenance requirements especially with reference to lakes constructed for aesthetic purposes.</p>
<input type="checkbox"/> Has the developer or landowner demonstrated that the design and management of the proposed constructed lake will minimise the risk of mosquitoes and midges?	<p>Refer to the Chironomid Midge and Mosquito Risk Assessment Guide for Constructed Water Bodies (Midge Research Group of WA, 2007) and Guidance Statement No. 40: Management of Mosquitoes by Land Developers (EPA, 2000) for design and management advice to minimise the health and nuisance issues from mosquitoes and midges. Contact the Department of Health, Midge Research Group or the relevant local government authority for further advice.</p>

# Abbreviations

<b>ASS</b>	Acid Sulfate Soils
<b>DEC</b>	Department of Environment and Conservation
<b>DoE</b>	The former Department of Environment
<b>DoW</b>	Department of Water
<b>DWMP</b>	Drainage and Water Management Plan
<b>EPA</b>	Environmental Protection Authority
<b>SPP</b>	Statement of Planning Policy
<b>SRT</b>	Swan River Trust
<b>WA</b>	Western Australia
<b>WAPC</b>	Western Australian Planning Commission
<b>WRC</b>	The former Water and Rivers Commission

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## Contributors

This report was prepared by the Drainage and Waterways Branch from the Water Resource Management Division of the Department of Water.

Advice and contributions were provided by the Kimberley, Mid-West Gascoyne, Kwinana Peel, Swan and South-West Regions; Aquatic Science, Water Allocation and Water Licensing Branches of the Department of Water; Wetlands Program and Land and Water Quality Branch of the Department of Environment and Conservation; Swan River Trust; Essential Environmental Services; City of Armadale and the Department for Planning and Infrastructure's Water Team.