Indirect potable use and expansion of the Cotter Reservoir:

Preliminary investigation of environmental issues

Stage 1. Issues Discussion paper

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Prepared by eWater CRC for the ACT Government.

Contents

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Acknowledgement

The authors have referred to, and in places quoted from, a number of reports that have been prepared for ACTEW and/or the ACT Government in the past few years, particularly as part of ACTEW's 2004–05 Future Water Options project. While we have not explicitly cited or listed those reports in this initial discussion paper, we acknowledge their authors' indirect contributions to it.

1 Executive Summary

This Discussion paper is the first of two reports from eWater CRC, assessing and reporting on potential issues that ACTEW's proposed Water2WATER project poses for the environment and ecology of the lower Cotter catchment and the Murrumbidgee River. Human health issues are being dealt with separately by an Expert Health Panel.

Conceptual information about two options for recycling Canberra water has been provided by ACTEW. With both options (A and B), treated wastewater derived from tertiary treatment of sewage will progress from the existing Lower Molonglo Water Quality Control Centre (LMWQCC) to a proposed new on-site facility, for further treatment. The 'advanced' treated water will then be recycled into the lower Cotter catchment where it will enter the Cotter Reservoir, via a constructed wetland and probably a local stream.

Two other outputs of the new plant will be liquid and solid wastes, depending on the treatment option the plant uses. These wastes will either re-enter the LMWQCC with the incoming raw sewage, or, in the case of the reverse osmosis plant wastewater ('brine') from Option A, be piped to evaporation ponds north of Uriarra, for ultimate disposal elsewhere.

ACTEW also proposes also to enlarge the capacity of Cotter Reservoir from 4 GL to 78 GL (GL stands for gigalitre, 1 thousand million litres) to hold the treated water along with other catchment in-flows. Recycling of 25 ML each day is expected initially, rising to 50 ML per day once the new dam wall has been constructed (ML stands for megalitre, 1 million litres).

eWater notes that the technical information so far available on the treatment options is insufficient to carry out a detailed evaluation or proper environmental risk assessment. Therefore, this report makes only preliminary comments on the plant performance and related environmental issues. More detailed analyses will be carried out for our second stage report.

1.1 Environmental issues identified

1.1.1 New treatment plant and water quality

Our preliminary evaluation of the international literature indicates that a well designed and well operating 'Option A' type system (micro/ultrafiltration + reverse osmosis + UV/peroxide oxidation) *has the potential* to remove all viral and bacterial contaminants and organic pollutants, and to reduce salts, nutrients and heavy metals to concentrations similar to, or lower than, that found in natural catchment run-off — this being the appropriate environmental benchmark for our analysis. Notwithstanding, one potential environmental issue noted is the comparatively weaker removal of the nutrient nitrate by reverse osmosis. This could, subject to other environmental factors, increase the risk of algal blooms and uncontrolled aquatic plant growth in Cotter Reservoir.

No treatment system anywhere in the world can be guaranteed to be absolutely failsafe 100% of the time. Consequently, equally important to the treatment system chosen must be the provisions made for detecting failure and ensuring that there is no break-through or leakage of incompletely treated water or wastes. The environmental concerns relating to system failure include:

- infection of fish and other biota by viral and other pathogens — something that could occur during even a single, short failure event;
- accidental land and water contamination because of pipe rupture — especially the treated-water pipe crossing over or under the Murrumbidgee River;
- contamination of local land, streams and groundwaters due to constructed wetland 'overflow' or leakage; and
- shut-down of flow at critical ecological times — especially for wetlands and stream ecosystems that become established under an artificial flow regime.

Advanced water treatment is an energy-intensive process, especially where significant water pumping is required (as here). Preliminary estimates of the power requirements for the new treatment process are about 6000 kW (kilowatts). Assuming operations 24 hours a day, 365 days per year, this translates to an estimated greenhouse gas emission rate of about 57,000 tonnes of carbon dioxide per year from plant operations.

The 'Option B' treatment train (using ozone–biologically activated carbon instead of reverse osmosis) would use a little less energy than Option A. However, there appear to be few other water treatment and environmental advantages of Option B over Option A.

To the extent of any new works required at the LMWQCC site, there are possible impacts on the threatened Pink-tailed Worm Lizard. Infrastructure associated with the proposal must ensure that connectivity is maintained between populations of this species in the immediate vicinity.

1.1.2 Waste management

In any treatment process, one of the biggest environmental risks lies with the handling and disposal of the concentrated waste stream. Issues that need to be further addressed are:

- contamination of birds and animals that will be attracted to the 'brine' ponds,
- groundwater contamination by the wastes,
- brine pond failure and run-off to adjacent streams,
- waste pipe eruption and discharge,
- waste management during prolonged wet periods,
- wind dispersal of dried waste accumulated on site,
- vehicular accident during transport of dried waste.

1.1.3 Water transfers to Cotter catchment

The proposed water-treatment wetlands will need to be sited where the soils, slope and drainage characteristics are capable of dealing with an inflow of 25–50 ML per day. Evaporation and loss through seepage need to be small to maximise the extra water the project aims to make available. The wetlands may be contaminated by pests carried on the wind or by birds, and bird excreta may also reduce water quality.

Water from the wetland is likely to be discharged into a nearby stream before reaching Cotter Reservoir. Subject to further analysis, it is reasonable to expect if water is discharged at rates approaching the proposed 25–50 ML/day that major ecological impacts on local streams will occur. There may be ways to mitigate such impacts to some extent, for example through the use of more than one stream. However, consideration should be given to direct piping and discharge of treated water to the Cotter Reservoir as a less environmentally impacting option.

1.1.4 Enlargement of the Cotter Reservoir

Greatly enlarging the volume of the reservoir may stimulate:

- expansion of populations of alien fish species (Goldfish, trout, Gambusia, Oriental Weatherloach);
- predation on threatened fish species by trout and waterbirds such as cormorants;
- loss of fringing reed-beds which offer cover to Macquarie Perch in the present reservoir and upstream of it, at least until new reed-beds establish in some years time;
- potential loss of spawning habitat for Macquarie Perch upstream of the present reservoir, unless the new water level is kept downstream of natural rock barriers in the river;
- deposition of sediment at the narrow upstream end of the new reservoir, which may block the way for fish to swim out of the reservoir, and possibly smother at least some of the existing habitat on the riverbed for Two-spined Blackfish;
- a larger total habitat for deep-water birds, but temporary loss of habitat for reed-dwelling species such as warblers and grebes until the reeds re-establish; and probable change in amount of shallow-water foraging habitat and adjacent riparian and woodland habitat for other bird species;
- loss of some frog habitat, but for species that are common in this region;
- change in food availability for Platypus;
- low-temperature releases of water through the wall into the river below.

Most, if not all, of these issues are manageable through sound dam planning and design, and through appropriate adaptive management practices for dam operations.

1.1.5 Effects on flows in downstream rivers

A larger Cotter Reservoir will trap much greater volumes of the peak flood flows than the present Cotter dam wall can retain, which could have ecological consequences downstream in the Cotter River. Also, water that is now discharged into the Murrumbidgee River will be diverted to the new treatment plant and then into the Cotter catchment. In summer this may be a good thing, because the existing discharge from the LMWQCC causes the river to be unnaturally high at present. For the rest of the year, the reduced flow may hinder fish travel.

1.1.6 Construction of dam wall, pipelines and plants

Environmental issues that will need to be addressed during the treatment plant, pipeline and dam construction phase include:

- mobilising of sediment into the Cotter River and the Murrumbidgee River, damaging freshwater communities in the area by smothering habitats;
- spills of fuel and other materials that would contaminate land and water;
- drawdown of the Cotter Reservoir, affecting plants and animals in the existing reservoir;
- access through the existing or new dam wall, allowing pest fish to move into the Cotter River from the Murrumbidgee River;
- damage to populations of the Pink-tailed Worm Lizard that may exist near the proposed new treatment plant or pipelines; this species is listed in both Commonwealth and ACT environment protection legislation.

Also, it may take several years to fill the much-enlarged reservoir, causing the flow regime in the Cotter River to be additionally impacted for that time, to the likely detriment of aquatic biota that need seasonally variable flows.

1.1.7 Other issues

There is likely to be a requirement for development referral under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)*. One lizard and two of the fish species present in the Cotter are listed as nationally threatened (Macquarie Perch and Trout Cod), and so the provisions of the EPBC Act are expected to apply.

All the issues listed above, as well as potentially beneficial opportunities presented by the Water2WATER proposal, will be considered in more detail in eWater CRC's stage 2 evaluation.

2 Background

2.1 Preamble

The ACT Government is considering a proposal by ACTEW to augment the ACT's domestic water supply by using advanced treatment of effluent from the Lower Molonglo Water Quality Control Centre (LMWQCC) and returning the water to the domestic system via the Cotter Reservoir and the Mount Stromlo water treatment plant. The proposal would also include enlargement of the Cotter Reservoir from approximately 4 GL to 78 GL. This proposal for Indirect Potable Use is generally known as 'Water2WATER'.

Major elements in the proposal are:

- an advanced treatment facility at the Lower Molonglo plant (LMWQCC),
- piping of treated water to a wetland system to be constructed near to the Cotter Reservoir,
- discharge from the wetland system — via a stream or through sub-surface flow — to the reservoir;
- piping of part of the treatment waste stream to an area near Uriarra village where it would be discharged into evaporation ponds,
- enlargement of the Cotter Reservoir.

Full details of the techniques used, siting and management of facilities will have an influence on potential impacts but are not yet available because the project is still at a conceptual stage.

In late April 2007, eWater CRC was contracted by the ACT Government (Environment & Recreation) to provide a two-stage analysis of environmental risks arising from the proposed Indirect Potable Use (Water2WATER) scheme and associated expansion of the Cotter Reservoir.

This report — an environmental issues Discussion paper — constitutes stage 1 of that analysis.

2.2 Terms of reference

eWater CRC will assess and report on potential environmental impacts of the proposal. Assessment will focus principally on watercourses, groundwater, and aquatic ecosystems, but will also include potential impacts on terrestrial ecosystems. A preliminary listing of potential issues identified by the ACT Government, and a review of these issues and any others identified by the CRC, will comprise the basis for the report. eWater CRC will provide two reports:

1. Discussion paper on issues
2. Technical report on issues and solutions.

Stage 1. Issues Discussion paper

The purpose of the Discussion paper is to identify and provide background to the environmental issues that could arise during the course of this project. This document will provide an overview of issues, be based on existing documents, data or knowledge, and be prepared relatively quickly. Some issues will be difficult to evaluate because we currently have insufficient understanding of the biological processes involved, and/or insufficient details of the proposed activities. For such issues eWater CRC will identify the reasons for the uncertainty surrounding the issue.

The Discussion paper will be used in a public consultation process to alert the community to environmental issues arising from the Water2WATER project.

Stage 2. Technical Report & Risk Assessment

The technical report will build on the Discussion paper through a consideration of potential responses or solutions to environmental issues. Issues to be considered are those included in the Discussion paper, and possibly additional issues identified during the community consultation process. For each issue the report will discuss:

- the likelihood that it will eventuate,
- the environmental consequences if it does eventuate,
- the potential for amelioration through management actions, siting or engineering solutions,
- proposed solutions to it.

As with the Discussion paper, some issues will be difficult to evaluate because we currently have insufficient understanding of the biological processes involved, and/or insufficient details of the proposed activities. For such issues eWater CRC will identify:

- the reasons for the uncertainty surrounding the issue,
- the additional investigations or information required to adequately assess the issue,
- the timing for full understanding of the issue.

The investigation of these issues will, by necessity, be a desk top study. It will be principally aimed at identifying those critical issues that have the potential to result in major environmental damage. These may include those for which the ACT Government has insufficient information to make an assessment, or those for which there are no apparent amelioration measures. The report will articulate the assumptions made in underpinning the assessment of issues.

It is noted that in the process of developing the report there may be a need to seek further information on the proposal or to clarify anticipated management or operational procedures.

The Stage 1 Issues Discussion Paper is to be completed May 21 and the more detailed Stage 2 Technical Report by July.

3 System Definition

This Discussion paper has been prepared on the basis of a series of 'treatment train' options and assumptions — structural and operational — provided to eWater CRC by ACTEW. Any changes to these options and assumptions (as outlined in section 3.1 below) will necessarily affect the issues raised and discussed herein.

3.1 Options for treatment, supply and waste management

3.1.1 New treatment process

(i) At a high level, ACTEW is considering two 'treatment trains' as described below. Both treatment train options commence with tertiary treated sewage from the existing LMWQCC. The additional purification steps will be carried out in a new water purification plant to be built on the site of the existing LMWQCC.

Option A

Microfiltration/Ultrafiltration → Reverse Osmosis → UV/H_2O_2 oxidation → Wetland/Stream → Cotter Reservoir

Option B

+/– Microfiltration/Ultrafiltration → Ozone/BAC → UV/H_2O_2 oxidation → Wetland/Stream → Cotter Reservoir

BAC = Biologically activated carbon
UV/H_2O_2 = Ultraviolet light combined with hydrogen peroxide

The major difference between the two options is the omission of reverse osmosis in Option B, being replaced by ozone–biologically activated carbon treatment. Microfiltration/Ultrafiltration is also a sub-option within Option B. Option A will also include carbon dioxide stripping and pH adjustment before transfer of the treated water to the Cotter system.

(ii) Treated water will be pumped from the new purification plant at LMWQCC to a site approximately 13 km from the plant and through a height differential of approximately +260 m. ACTEW have advised that the treated water pumping regime currently being considered is a constant 25 ML/day for 365 days per year with the option to increase that to 50 ML/day if and when required (e.g. after completion of the Cotter Reservoir enlargement).

(iii) The specific discharge site, either to a new wetland complex or directly to a creek, is yet to be finalised but is taken for the purposes of this paper to be one of the small tributary sub-catchments draining from the north of Cotter Reservoir, between Uriarra Homestead and the tail waters of the existing Cotter Reservoir.

(iv) Water will leave the wetland complex by two possible options under consideration:

(a) percolation through shallow groundwater to the reservoir, and
(b) surface discharge to a nearby tributary stream which then drains to Cotter Reservoir.

(v) From Cotter Reservoir water will be pumped through the existing reticulation system to the Mt Stromlo water treatment plant, diluted as appropriate with water from other reservoir sources, and then treated through the existing drinking-water treatment process.

(vi) Generated from the above treatment process are liquid and solid wastes arising from the Microfiltration/Ultrafiltration (MF/UF), Reverse Osmosis (RO) and Ozone/BAC processes. ACTEW proposes to return solid and liquid wastes from the MF/UF and Ozone/BAC processes (if chosen) to the raw sewage inlet treatment stream at LMWQCC.

However, the proposed RO Plant will generate a separate liquid waste or 'brine' stream — so called because it will contain significant quantities of dissolved salts as well as nutrients, organic compounds and virus particles not removed by ultrafiltration. The waste stream — about 10% of the total volume passing through the plant — will be transported by a separate pipeline to a site located to the north of the Uriarra Homestead and (former) Forestry settlement. There it will be dried through evaporation ponds (or mechanical means if required). The residual waste solids collected by this process will be disposed of by a method yet to be identified by ACTEW, but which may include trucking to land-fill sites outside the ACT.

Another option that may be considered by ACTEW is to return the waste stream to the Murrumbidgee River via the existing LMWQCC outfall.

(vii) Through operation of the existing Cotter–Googong Bulk Transfer scheme, water from Mt Stromlo water treatment plant that is transferred into Googong Reservoir and later to the Molonglo River could contain a component of treated water from Cotter Reservoir.

3.1.2 Enlargement of Cotter Reservoir

An integral part of the project is the enlargement of Cotter Reservoir to allow treated water to be stored and returned as required to the normal potable treatment and supply system. This will be achieved by constructing a larger dam wall immediately downstream from the existing wall. The new wall will increase the maximum storage of Cotter Reservoir from its current volume of about 4 GL to 78 GL. Enlargement of the Cotter Reservoir to 78 GL would increase the total area inundated by about 260 ha.

3.2 Other assumptions made for this study

Based on discussions with ACTEW the following additional assumptions have been made in compiling this Discussion paper.

- After dam wall construction, appropriate environmental flow provisions will be maintained.
- Recreational access to the reservoir and catchment will remain at current restricted levels.
- The proposed treatment process and waste management system (as outlined further in section 4.1) will operate with optimum performance and reliability.
- The catchment of the lower Cotter Reservoir, which was severely damaged by the 2003 bushfires, will be fully rehabilitated in favour of maintaining and enhancing water quality and environmental values. (See ACT Government's 2006 Clean Water, Health Landscapes Draft Strategic Management Plan.)

3.3 Description of receiving waters and lands

The Cotter River catchment is situated in the Brindabella Range, ACT, and occupies an area of about 483 km^2. The river flows in a northerly direction before joining the Murrumbidgee River approximately 72 km downstream at Cotter Reserve. Most of the catchment is managed to protect the quality of the water, and lies within the Namadgi National Park. The Cotter River is an upland boulder, cobble, and gravel-bed river, including bedrock outcrops. It provides habitat for several aquatic species that are listed as threatened with extinction.

The Cotter River catchment provides much of the drinking water supply for the ACT, with three reservoirs (Corin, Bendora and Cotter) providing water storage and regulating flows along the river. Within the upper Cotter sub-catchment, run-off has been of a high quality in the past because of good vegetation cover, soil stability, and limited human activity. However, bushfires in January 2003 burnt through 70% of the land-area within the ACT, including protected National Park areas that also cover the Cotter drinking water catchment. The future response of the Cotter catchment to the bushfires is still uncertain and further research is in progress.

The lower section of the river near Cotter Reservoir previously contained large areas of pine plantations, but most of the burnt pine debris has been cleared, and the residues burned, since the bushfires. The terrain is hilly with some steep slopes. Sandy topsoils overlay thick clay subsoils, and there is some localised soil erosion from debris removal and the extensive system of tracks and firebreaks, and possibly also some sheet erosion.

The lower Cotter catchment currently exhibits run-off having turbidity and bacteriological concentrations high enough to require water treatment before delivery to the water supply distribution system. The lower quality of water in the Cotter Reservoir is because of the more erosion-prone soils of the area, and the greater extent of pre-bushfire activities such as softwood logging and recreational pursuits, and recent debris removal. Until now, Cotter Reservoir has generally only been used for Canberra's water supply in times of high demand, and its sub-catchment has less restricted land-use and public access, compared to the upstream reservoirs.

Land proposed for possible wetland treatment sites was formerly managed as a pine plantation. Under current ACT Government proposals for restoration of this catchment the area is to be planted with native species and allowed to revert to a predominantly native vegetation type dominated by *Eucalyptus mannifera and E. macrorhyncha*, possibly reflecting its original pre-1750 woodland or forest vegetation. In 2007 the former plantation area is regenerating with some native vegetation, some dense pine wildlings and other weeds, particularly along the water-courses.

The fish community of the lower Cotter catchment (between Bendora and Cotter Reservoirs) contains nine species of finfish, plus three crayfish species. A further seven finfish species are known or likely to be present in the Cotter River downstream of Cotter Reservoir. In the Reservoir or river immediately upstream, there are three threatened aquatic species present: Macquarie Perch, Two-spined Blackfish and Murray River Crayfish, as well as five alien finfish species. Brown Trout and Rainbow Trout are distributed throughout the lower Cotter, whilst Eastern Gambusia, Oriental Weatherloach and Goldfish are confined to the Cotter Reservoir and the river immediately upstream.

The population of Macquarie Perch in the reservoir and the river upstream (below Vanity's Crossing) is the sole remaining viable population of this species in the ACT. The previous population in the Murrumbidgee River in the ACT has declined to negligible levels; the population in Lake Burrinjuck is effectively extinct; and the translocated population above Googong Reservoir in the Queanbeyan River is now at non-detectable population size. Hence, sound management of the Cotter reservoir population is critical if the species is to survive in the ACT.

3.4 Flow management in the Cotter River

Flows in the Cotter River have been closely managed under environmental flow guidelines developed as part of the ACT's commitment to COAG (Coalition of Australian Governments) agreements. The flow guidelines have been implemented in an adaptive management framework where sequential decisions are made based on needs and environmental information.

Adaptive management decisions following major events of fire and drought culminated in a much reduced drought-flow regime, commencing in 2003–2004, with minimum flows, variability and flushing flows. The stream ecology has been assessed using aquatic biota, ecological processes, physical features and water quality. It has been demonstrated that this regime has markedly improved and subsequently maintained the ecological condition of the Cotter River, relative to local unregulated streams. This was achieved even with stress from drought and the effects of the January 2003 bushfires.

4 Environmental Issues Identified

4.1 New treatment plant and water quality

An evaluation of potential environmental (and human health) risks must be predicated on the performance of the water treatment process being applied. From a technical perspective* there are a number of major issues requiring close attention and scrutiny with regard to the two treatment trains options:

1. the pathogen and contaminant removal efficiency of the new treatment plant under normal operating conditions;
2. the reliability of the entire process (treatment and waste management) and the provisions for timely detection of and response to system failure; and
3. the level of energy consumption and greenhouse gas emission.

*Note: Potential ecological risks of the treatment system are covered in following sections.

In section 3.1, two treatment train options are summarised. Beneath these summary descriptions lies an enormous amount of treatment infrastructure and process detail that is yet to be finalised by ACTEW. The final built plant could be any one of a multiplicity of possible combinations of specific treatment technologies (type and brand) and operating processes (pressures, flow rates, backwash procedures, etc.).

We have necessarily assumed, within the range of possibilities under Options A and B, that the final treatment system selected by ACTEW will be the <u>very best system available</u>, based on all internationally available treatment & monitoring technologies and operating experiences.

In evaluating these systems, it is also pertinent to note that the feed water to the new treatment plant will have already undergone tertiary treatment at the LMWQCC. Water treated by these means has been discharged under licence to the Murrumbidgee River for many years. A range of contaminants and bacterial pathogens will have been significantly reduced in concentration through this tertiary treatment, before the feed water enters the new Water2WATER treatment system.

In saying this, we do not wish to overstate the potential effectiveness of the treatment system, nor to suggest that the historical discharges from LMWQCC are without environmental impact on the Murrumbidgee River. We simply note that there are existing treatment barriers that are relevant to the full evaluation of the new water recycling system being proposed by ACTEW.

We also note that the technical information so far provided to eWater CRC, or available on the Internet from experiences elsewhere, is insufficient to carry out a proper risk assessment of the performance of either Option A or Option B. By necessity, this will be achieved during the Stage 2 analysis and reporting process.

4.1.1 Treated water quality under normal operations

Option A

Our preliminary scan of the international literature indicates that a well designed and well operating 'Option A' type system (MF/UF+RO+UV/H_2O_2) *has <u>the potential</u>* to remove all viral and bacterial contaminants and organic pollutants, and to reduce salts, nutrients and heavy metals to concentrations similar to, or lower than, that found in natural catchment run-off.

This assumption will be further tested and evaluated through more detailed scientific review during preparation of the Stage 2 Technical Report (refer sec. 2.2). We consider the critical issues of system reliability and monitoring, which impinge on our preliminary assessment, in section 4.1.2 following.

Initial technical evaluations commissioned by ACTEW indicate the following operational performance (treated water quality) for the Option A configuration:

Water Quality Variable	Unit	Feed Water (average)	Treated Water (average)
Total dissolved solids	mg/L	490	<50
pH		7.7	7 – 7.5
Total Nitrogen	mg/L	15	2–3
Total Phosphorus	mg/L	0.2	<0.2
Total Organic Carbon	mg/L	4	<0.25
Viruses and Bacteria	No./100mL	-	Below detection
EDC	ng/L	-	Below detection
NDMA	ng/L		<10

EDC = endocrine-disrupting chemicals; NDMA = n-nitrosodimethylamine

We note with some caution that these figures are initial estimates of a handful of target contaminants provided by engineering consultants to ACTEW. And, the figures are averages — measures of typical performance — rather than the full operational performance range expected from best to worst case. For more detailed assessment of treatment plant performance, such information — and more, including real-world time series data from similar plants operating elsewhere in the world — is required.

One of the potentially important environmental issues noted here, and also in the international literature, is the comparatively poor removal of inorganic nitrogen compounds, especially nitrate and ammonia, by reverse osmosis — typically reported as only 50–90% removal (compared to 95–98%+ for other chemical contaminants).

Total nitrogen levels in the treated water stream are not necessarily higher than may be expected in natural lower Cotter catchment run-off. However, nearly all the 'total nitrogen' in the treated water will be present as dissolved nitrate. This is because the feed water from the LMWQCC will have been passed through the existing 'nitrification' system. Nitrification is a natural process, stimulated in the treatment plant, that converts ammonia and organic nitrogen compounds to nitrate.

Nitrate is a readily available nutrient source for plants and algae. Hence, significant increases in the amount of nitrate entering Cotter Reservoir may increase the risk of algal blooms, as well as the risk of uncontrolled aquatic plant growth. Evaluation of the likelihood and impact of such events is complicated by other environmental factors such as phosphorus concentration, temperature, pH, etc., and is beyond the scope of this initial discussion paper. For now we note the possibility, which will be considered in more detail during the Stage 2 technical study.

It is intended that further 'natural' treatment will occur in the receiving wetlands to be constructed above Cotter Reservoir. While this may be true in principle (including the possibility of some denitrification — conversion of nitrate to nitrogen gas), it is also quite possible that the wetland will actually cause some deterioration in the quality of water entering Cotter Reservoir; for example, due to excreta from the bird and wildlife population that will be attracted to the wetlands.

Because the daily discharge rates proposed (25–50 ML/day) are high compared to natural flow rates in the stream(s) that may receive water from the wetlands, little or no 'in-stream' treatment of the water is likely, unless the design of the wetland system enables it to significantly retard discharge flows (which is unlikely).

Given the above, in on-going planning, consideration also should be given to direct discharge of water to Cotter Reservoir. This would also obviate concerns raised in section 4.4 about the hydrological impacts on Cotter catchment streams that may receive the treated water.

Option B

The main feature of Option B is the replacement of reverse osmosis treatment in Option A with ozone–biologically activated carbon (ozone/BAC) treatment. There are some advantages and several disadvantages of this approach.

In both options, UV/peroxide treatment and safe operation will be critical to ensuring that residual chemical contaminants and pathogens in the treated water are destroyed.

Ozone/BAC will almost certainly use less energy to operate, and will produce less greenhouse gases, given the high energy requirements of reverse osmosis (see sec. 4.1.3). Being a simpler engineering technology it may also be cheaper to build (although as yet we have no figures on this).

Other than this, our preliminary evaluation suggests that there are few environmental advantages of Option B over Option A, especially given that both options include a final advanced oxidation (UV/peroxide) step.

The environmental weaknesses of ozone/BAC compared to reverse osmosis are several, including:

- the lack of salt removal (which is an on-going matter of concern with regard to existing discharges of treated effluent from LMWQCC to the Murrumbidgee);
- generally poorer removal of chemical contaminants and pathogens; and
- the weaker process control because of the need to rely partly on 'natural' microbiological processes to remove contaminants and pathogens.

This is not a general criticism of ozone/BAC which, in less stringent circumstances, is quite reasonably the preferred method of water treatment.

4.1.2 Treatment plant reliability and monitoring

Whatever the final built plant (Option A or B), no treatment system anywhere in the world can be guaranteed to be absolutely failsafe 100% of the time. Consequently, equally important to the treatment system chosen must be the provisions made for detecting failure and ensuring that there is no 'break-through' or leakage of incompletely treated water or wastes. System failure can be minor — performance moving outside approved operating range — or major — a complete failure of the system, with the risk, if not managed, of untreated or partially treated water being transferred into the Cotter catchment or Cotter Reservoir.

The environmental concerns relating to system failure include:

- infection of fish and other biota by viral and other pathogens — something that could occur during even a single, short 'failure event' (see sec. 4.3.2 for more details);
- accidental land and water contamination because of pipe rupture — especially the treated-water pipe crossing over or under the Murrumbidgee River to the Cotter catchment;
- contamination of local land, streams and groundwaters due to wetland 'overflow' or leakage; and
- shut down of flow at critical ecological times — especially for wetlands and stream ecosystems that become established under an artificial flow regime.

It will be imperative to ensure that the treatment system includes 'state of the art' real time monitoring at critical control points throughout the process all the way through to Cotter Reservoir. Linked to this must be the ability to, almost instantaneously, by-pass the treated water back to the normal LMWQCC treatment stream instead of into the Cotter catchment.

At the present time, we consider the issue of system-reliability, monitoring and response one of the biggest unknowns with the proposed Water2WATER treatment system.

4.1.3 Energy consumption and greenhouse gases

Advanced water treatment is an energy intensive process. Internationally, the major energy consuming and, consequently, greenhouse gas-emitting parts of the process tend to be reverse osmosis and pumping.

Estimates of energy consumption for the proposed process are in the order of:

- Dual membrane filtration (MF/UF) 400 kWhr/ML
- UV treatment 200 kWhr/ML
- Reverse Osmosis 800 kWhr/ML
- Pumping to discharge site 3000–5000 kWhr/ML (*estimate only).

A similar plant to that proposed under Option A operating in Singapore uses 700–900 kWhr/ML . The contribution, if any, of pumping to that energy use is at present unknown.

Preliminary estimates by ACTEW's consulting engineers of the power requirements for the new treatment process are about 6000 kW (kilowatts).

Based on an estimated greenhouse gas emission rate of 1.08 kg CO_2/kWhr, and assuming operations 24 hours a day, 365 days per year, this level of energy consumption translates to an estimated greenhouse gas-emission rate of about 57,000 tonnes of carbon dioxide per year from plant operations.

There may be opportunities to use heat generated from the plant itself, and other green energy sources to minimise or offset the net carbon dioxide emissions. New tree plantations may also be a possible source of carbon offsets. About 300,000 trees per year would need to be planted to offset the estimated carbon dioxide production rate.

4.1.4 Site ecology

To the extent of any new works required at the LMWQCC site, there are possible impacts on the Pink-tailed Worm Lizard. This species is listed as threatened under the Commonwealth's *Environment Protection and Biodiversity Conservation ACT 1999*, and has Special Protection Status (SPS) under the ACT's *Nature Conservation Act 1980*. The ACT is the only known stronghold for the species which occupies rocky grassland habitat that is largely confined to rocky river slopes and nearby hills (e.g. Mount Taylor).

Infrastructure associated with the Water2WATER proposal must ensure that connectivity is maintained between populations of this species in the immediate vicinity of the LMWQCC. This general issue has been addressed previously by ACTEW in its development and management of the Control Centre. As part of the detailed planning for the proposal it will be necessary for the local extent of habitat suitable for the species to be assessed, and for disturbance due to on-site works and the pipeline and any associated activities off-site (e.g. vehicle access, spoil dumps, litter etc.) to be avoided in order to minimise loss of habitat for this species.

If above-ground, the pipeline connecting the treatment plant and proposed wetland sites near Uriarra will cross the riparian zones of both the Molonglo River and the Murrumbidgee River. These zones contain relatively intact native vegetation ranging from Tableland Dry Tussock Grassland (native grass species) on the upper slopes, to Tableland Shrubland (*Kunzea ericoides*) mid-slope and Tableland Riparian Woodland (*Casuarina cunninghamiana*) along the river margins.

Between the Murrumbidgee River and the proposed wetlands the pipeline will pass through open rural land where the original woodland vegetation has been severely modified through clearing and introduction of exotic pasture grasses, so risks of environmental impact here are much lower.

Where the route follows roadsides with native vegetation, detailed route planning will be necessary, to avoid loss of or damage to established native vegetation.

4.2 Waste management

In any treatment process, wastewater or otherwise, one of the biggest environmental risks lies with the handling and disposal of the concentrated waste stream. With the proposed Water2WATER treatment process, solid and liquid wastes will be generated at the new LMWQCC site. The liquid waste concentrate from the reverse osmosis (RO) process will be pumped to the Uriarra area for evaporation in purpose-built ponds, and subsequent disposal of solids.

The RO liquid waste ('brine') will contain high concentrations of salts, chemical contaminants and some bacterial and viral pathogens (it is unclear from the information provide to the CRC whether the waste stream will be disinfected prior to pumping).

The volumes of RO liquid 'brine' waste will be quite high — estimated to be about 10–15% of the total volume of water passing through the new plant — about 3–4 ML/day initially and more than double that volume at full capacity.

Environmental issues of concern with regard to Water2WATER plant waste management include:

- contamination of birds and animals that will be attracted to the ‘brine’ ponds,
- groundwater contamination by the wastes,
- brine pond failure and run-off to adjacent streams,
- waste pipe eruption and discharge,
- waste management during prolonged wet periods,
- wind dispersal of dried waste accumulated on sit,
- vehicular accident during transport of dried waste.

There are unlikely to be any significant impacts on native vegetation at the proposed site of the 'brine' ponds because it is largely rural land with scattered trees and exotic pasture grasses. However, this requires further and closer evaluation.

We note that management of concentrated liquid wastes is a well understood and generally well managed process internationally (at least in wealthier countries). Nevertheless, there are many examples of failures around the world that have led to significant and even catastrophic environmental consequences. Consequently, the risks inherent in such waste disposal processes need to be properly evaluated and managed.

4.3 Water transfer to Cotter catchment

The water transfer raises at least three potential risks to the aquatic fauna of the lower Cotter catchment:

- introduction of alien fish species as either eggs, larvae or small juveniles,
- introduction of disease organisms,
- introduction of endocrine disruptors to Cotter Reservoir.

4.3.1 Alien species

A number of fish species (both introduced and native) currently absent in Cotter Reservoir and upstream waters are known to be present in the Molonglo and Murrumbidgee rivers, and hence could possibly be found in sewage water. These are: Carp and Redfin Perch (both introduced species to Australia); and Golden Perch, Murray Cod and Western Carp Gudgeon (native species found elsewhere but not in the Cotter River).

Given that all water proposed to be discharged into the Cotter system will have to have been subject to treatment through the existing LMWQCC and the proposed additional Water2WATER treatment processes, the likelihood of introduction of viable fish material is extremely low (provided there is not catastrophic system failure).

4.3.2 Pathogens

The major concern for the introduction of disease organisms relates to the potential spread of Epizootic Haematopoietic Necrosis Virus (EHNV). This virus, unique to Australia, was first isolated in 1985 on the alien Redfin Perch. It is characterised by sudden high mortalities of fish displaying damage to the renal haematopoietic tissue, liver, spleen and pancreas. The threatened Macquarie Perch found in the Cotter catchment is one of several species known to be extremely susceptible to the disease. EHNV was first recorded from the Canberra region in 1986 when an outbreak occurred in Blowering Reservoir near Tumut. Subsequent outbreaks have occurred in Lake Burrinjuck in late 1990, Lake Burley Griffin in 1991 and 1994, Lake Ginninderra in 1994 and Googong Reservoir, also in 1994.

The EHNV disease has not been recorded from the Cotter system.

It is probably reasonable to assume that the Water2WATER treatment process, if designed and operating effectively to eliminate any potential disease organisms relevant to human health, would also remove EHNV. Consequently, the likelihood of this virus being introduced into the Cotter system through discharge of treated water is considered to be low, assuming the Water2WATER treatment process does not fail (refer to sec. 4.1.2).

Nevertheless, an accidental introduction could lead to severe consequences for Cotter fish populations especially Macquarie Perch, and further investigation of issues surrounding EHNV (including the design of a monitoring system) will be necessary.

4.3.3 Endocrine disruptors

The addition of endocrine-disrupting chemicals to waterways is a threat only recently recognised in Australia. These chemicals either disrupt normal hormone function, or mimic hormones to give an unnatural response. One group of endocrine disruptors is the environmental oestrogens which can mimic the female hormone oestrogen. Major sources of environmental oestrogens are pesticides, detergents and prescription drugs such as antibiotics. In Europe and America there is growing evidence of the changed sex ratios or feminisation of many aquatic species, particularly fish, which have been exposed to environmental oestrogens. This can have severe impacts on the ability of the species to successfully reproduce. Little research has been conducted in Australia on this problem, but it represents a real threat to Australia’s streams, and further investigation is required.

In principle, the reverse osmosis and advanced oxidation treatment that form part of the recycled water infrastructure for Option A should be effective in removing all such organic chemicals. Nevertheless, there are sufficient uncertainties around system design and performance at the current time to warrant more detailed analysis of this issue for the Stage 2 technical report.

4.4 Discharge to wetland and creek system

4.4.1 Wetland site impacts

The location proposed for discharge of the treated water is in an area of moderately steep slope with soils that are prone to erosion. With the information to hand it is not possible to assess how effectively the proposed wetlands will perform in terms of flow, potential for erosion, residence time, and vegetation growth.

Largely because of the previous land-use for this area there will be a need for detailed study of slope, soil and drainage characteristics on which to base the design of a system of wetlands suitable to receive the quantity of treated water (25–50 ML/day) expected for the project. There may be a need to consider alternative locations elsewhere in the lower Cotter catchment for wetland sites more suited to their role, flow requirements and restoration proposals in the catchment. Or indeed, alternative means of waste treatment and disposal.

The wetland site will need to be carefully managed to avoid airborne introduction of pest species by wind and birds.

Evaporative and infiltration losses in wetlands may also be high, which would appear to be counter-productive to the major Water2WATER project objective of maximising water availability in the Cotter Reservoir.

As noted in section 4.1.1, the water-treatment value of the proposed wetlands appears marginal at best, and potentially detrimental. Of course, beyond these water-treatment issues, there are quite possibly incidental ecological benefits that would arise from the new wetlands, and some of these are briefly listed in section 5.2. Whatever the case, the pros and cons of the proposed wetlands should be carefully re-evaluated during on-going analysis and planning.

4.4.2 Stream impacts

Water from the wetland is likely to be discharged into a nearby stream before reaching Cotter Reservoir. Although the CRC has not yet had time to carry out proper hydrological modelling (it will do so during the stage 2 technical study), it is reasonable to expect if water is discharged at rates approaching the proposed 25–50 ML/day that major ecological impacts on local streams will occur.

Scouring, incision and enlargement of the stream channel would be expected, with consequent loss of in-stream, and possibly riparian, plant and animal habitat, as well as major impacts on nutrient processing.

Fish in Cotter Reservoir are likely to perceive a wetland-stream discharge flow of 25–50 ML/day as a signal of the presence of a significant tributary, and attempt to migrate up this ‘tributary’. If such flows were larger than the Cotter inflow during the spawning season of native fish (October–December), fish may attempt to spawn in the wetland discharge, a waste of scarce reproductive effort in threatened native fish.

There may be ways to mitigate such impacts to some extent, for example through the use of more than one stream. However, along with the issues raised in previous sections, this is another reason to carefully consider whether direct discharge of treated water to the Cotter Reservoir may be a better environmental option.

4.5 Enlargement of Cotter Reservoir

A number of recent ecological studies by the University of Canberra and Environment ACT have highlighted the following issues with regard to the proposed enlargement of Cotter Reservoir.

4.5.1 Fish

1. The increase in volume of an expanded Cotter Reservoir is likely to facilitate the expansion of the population of the two trout species (Brown Trout and Rainbow Trout) in the reservoir. An enlarged reservoir will provide both an enlarged area of open water for these species, as well as an enlarged thermal refuge from high seasonal water temperatures. Trout are a known predator of native fish species including the threatened species present in the Cotter Reservoir.

2. Recent research on Macquarie Perch in Cotter Reservoir has indicated that predation by cormorants may be a significant impact on the adult spawning stock. The increase in the abundance of alien fish species (noted below) may attract more cormorants.
3. Macquarie Perch are currently thought to spawn in a short stretch of river immediately upstream of Cotter Reservoir, between the impounded waters and Bracks Hole. The enlarging of Cotter Reservoir will inundate such spawning habitats, rendering them unsuitable for Macquarie Perch. This is not considered a major issue as long as the enlarged reservoir does not impound waters up to the base of an impenetrable barrier to fish movement (i.e. there is new spawning habitat available and accessible) (see next issue). The situation that occurred as a result of constructing Googong Reservoir must be avoided. In this situation the impounded waters extended to the base of a natural barrier (Curleys Falls) that prevented Macquarie Perch accessing spawning habitats. The population of Macquarie Perch ceased to recruit, and faced certain extinction if remedial actions (a controlled translocation beyond the barrier) had not been undertaken.
4. The upstream limit of the full storage level of the enlarged reservoir appears to be in an area that contains a number of barriers to Macquarie Perch movement. This is a concern as it may severely curtail the breeding opportunities for this species, depending on how much spawning habitat is available between the reservoir and these barriers. Detailed mapping is required to accurately locate the extent of the impounded waters and the location of the barriers.
5. Cotter Reservoir has extensive fringing emergent macrophyte beds (primarily *Phragmites australis*) which have been shown to provide important daytime resting habitat for adult Macquarie Perch. These reedbeds may also provide cover and/or feeding habitat for smaller life stages of Macquarie Perch. Filling of the reservoir will result in the loss of these macrophyte beds, as they are inundated. As there are few significant sources of *Phragmites* upstream, it will take perhaps some years before reedbeds re-establish around the new reservoir-edge.
6. The alien fish species Goldfish, Eastern Gambusia and Oriental Weatherloach generally prefer slow-flowing or still water habitats. The expansion of the capacity of Cotter Reservoir from 4 GL to approximately 78 GL will significantly increase the available habitat for these alien species. The impacts of increased population sizes of two of these species on existing aquatic communities are not likely to be severe, as they are not generally aggressive or predatory species, and few detrimental impacts have been attributed to them in Australia.
7. Enlargement of the reservoir has the potential to destroy currently suitable habitat for the threatened Two-spined Blackfish above the reservoir. Enlargement of the reservoir will relocate upstream the initial sediment deposition zone, resulting in the existing suitable habitat being smothered. The rapidity with which this occurs will be dependent on the sediment supply to the reservoir. In the low sediment-supply Bendora Reservoir, blackfish are still abundant, although their numbers appear to have declined since the 2003 bushfires (none are present in Cotter Reservoir).
8. Prolonged and variable drawdown of the reservoir during normal operations may result in the loss of the important *Phragmites* macrophyte beds, as occurred in the late 1990s during maintenance on Cotter Reservoir when water levels were reduced by approximately 4 to 5 metres for about six months. The *Phragmites* beds recovered after this drying, but took some years to reach their previous extent, and the proposed unconstrained drawdown of the enlarged Cotter Reservoir would militate against such recovery.
9. Similarly, recent research has indicated that the boulder and cobble habitat at the downstream end of the reservoir provides preferred habitat for young-of-year Macquarie Perch. Drawdown of the expanded reservoir will likely expose a significant quantity of this rocky habitat, making it unavailable to small Macquarie Perch.
10. Stream-borne sediment is usually deposited at the upstream margin of an impoundment, where flowing water encounters the still waters of the impoundment and sediment settles out. Providing that such sediment beds are covered by a sufficient depth of water during the late spring–early summer breeding season of Macquarie Perch, fish can swim above the accumulated sediment to leave the impoundment and access flowing waters. Should the impoundment water levels be drawn down at this time, there may be only a thin channel of

shallow water covering such sediment beds, preventing fish leaving the impoundment or exposing them to increased predation from cormorants.

Management of the above threatened-fish issues could place some constraints on reservoir operation (timing and rate of change of water levels) unless acceptable mitigation measures are employed. Many, if not most, of these potential impacts are manageable through sound planning, ecological risk mitigation provisions included in the reservoir build stage, and good adaptive management practices.

There has been a dam in the Cotter for decades; therefore, provision of fish passage or obstruction thereof is not considered a major issue. In fact, Cotter dam serves as an important barrier keeping the alien species Redfin Perch and Carp out of the Cotter River upstream of the reservoir.

Consequently, fish passage upstream must not be provided in the proposed new dam. This issue has previously been highlighted in *Action Plan 29 Ribbons of Life: ACT Aquatic Species and Riparian Zone Conservation Strategy*.

4.5.2 Birds and animals

Previous studies have concluded that an enlarged Cotter Reservoir will increase total habitat for water birds, particularly those that favour deeper water, such as Blue-billed Duck, Musk Duck and grebes. The establishment of dense reed banks along the flooded margins would provide some habitat opportunities for reed-dwelling waterbirds such as bitterns, rails and crakes (but they will need shallow areas to forage) and warblers.

Constraints identified for an enlarged Cotter Reservoir include impact on good quality habitats on eastern banks and upper reaches of the Cotter River, minor loss of habitat for rare and threatened woodland birds, minor loss of habitat for threatened lizard (although based on known distribution, impacts are unlikely) and loss of riparian habitats along upper Cotter River.

Enlarging the storage capacity will flood considerable areas of existing amphibian habitat in the Cotter River, both in the bed of the river, and in adjacent riparian areas. Populations of riverine frogs are likely to be removed from this stretch of the river. The main species affected will be the Rocky Stream Frog, the Eastern Banjo Frog and the Common Eastern Froglet. These are common species in the ACT region.

An enlarged Cotter storage may affect Platypus populations through changes to benthic (bottom) food availability and increased water depth. Increased water depth may change suitability of habitat because Platypuses are apparently unable to forage successfully for small food items at depths greater than about 5–10 metres. Cold-water releases from the Reservoir should be avoided because this may impose additional stress on animals inhabiting waters downstream (see sec. 4.6 for more discussion).

4.5.3 Terrestrial ecosystems

An assessment of flora and fauna at all potential Future Water Option sites, including the enlarged Cotter Reservoir, has been conducted recently by Biosis Research. Most of the areas under native forest within the Cotter catchment are relatively undisturbed, apart from the obvious bushfire damage in 2003. These areas are mainly in the upper catchment, in Namadgi National Park. Slopes near the Cotter Reservoir were planted with exotic conifers in the 1920s and there has been infestation of blackberries and other weeds in these areas. Downstream of Cotter Reservoir, areas have been cleared for recreation purposes, although native Casuarina trees are still the main riparian species. Surveys following the 2003 bushfires have found that many riparian species are demonstrating signs of recovery and re-growth, although there is a loss of shrub species and groundcover that trap sediments and stabilise steep banks.

Enlargement of the Cotter Reservoir to 78 GL would increase the total area inundated by about 260 ha. In addition, another approximately 120 ha of buffer zone would be created, assuming a buffer 50 m wide from the water edge, or 230 ha if the buffer was 100 lineal metres wide. As to plant species affected by Cotter Reservoir enlargement, the Biosis report concluded: “no threatened species have been previously recorded...and none were recorded during this assessment.” It noted that there is ‘potential habitat’ for two threatened species listed under the

Environment Protection and Biodiversity Conservation Act: *Pomaderris pallida* and *Thesium australe*.

4.6 Cotter and Murrumbidgee rivers downstream

4.6.1 Flow regime and other physical effects

Previous studies by the University of Canberra suggest that an enlarged Cotter Reservoir will not dramatically worsen the current flow regime downstream of Cotter Reservoir — which is already significantly modified from natural conditions. It should be noted that these modelled analyses in 2005–06 were conducted based on rainfall predictions and proposed operating conditions that may have been subsequently revised by ACTEW. This will be checked during the stage 2 technical reporting period.

Notwithstanding, there will be some hydrological disturbances, most notably on the trapping of high flows. This is because a large Cotter dam will capture significant volumes of peak flood flows that the current dam is too small to retain. Such changes could have ecological consequences downstream. There will also be changes to flow variability and seasonality but, unlike high flows, these flow characteristics are already affected by the existing dam.

The current Cotter dam traps all coarse sediment; therefore, any changes to sediment transport caused by the enlarged Cotter dam will probably have little or no impact on sand transport or deposition.

The effects downstream of the Cotter confluence in the Murrumbidgee River will largely be related to the decreased discharges from the LMWQCC (equivalent to the amount of water transferred to the Cotter catchment). The current discharge of treated water significantly increases the flows in the Murrumbidgee River in the summer months, relative to natural conditions. Consequently, the Water2WATER process may mitigate the harm from return flows during summer.

At other times of the year, lessening of flow may exacerbate the fragmenting effect of natural low flow barriers to fish movement such as small chutes, waterfalls or riffles.

Unless carefully managed, ecologically damaging cold water releases are much more likely from a deeper Cotter Reservoir. This is best prevented through artificial mixing, a multi-level off-take or other suitable engineering processes that can be included in the dam design.

4.6.2 Biota

A small population of Macquarie Perch still exists in the Cotter River below Cotter Reservoir, and in the lower Paddys River. A reduction in flows from Cotter Reservoir will have further impact on fish communities in the final 2 km of the Cotter, and place further stress on this small, isolated remnant of Macquarie Perch by further restricting movement between the Cotter, Paddys and Murrumbidgee rivers. Active rehabilitation measures in the lower Paddys River may be required to mitigate the loss of habitat in the lower Cotter River.

The vulnerable Murray River Crayfish still occurs in the section of the Cotter River below Cotter Reservoir. Species in this reach of the Cotter River may be affected by reduced flows caused by an enlarged dam or during construction of the dam (due to sedimentation).

Previous studies have shown that macroinvertebrate communities are impaired downstream of all three existing dams on the Cotter River. As already noted, increasing storage capacity in the lower Cotter River will reduce high flow events, and it is possible that macroinvertebrates will show some further impairment.

For the Murrumbidgee River downstream of the LMWQCC plant, there may be a small ecological benefit in reducing discharges. Discharged treated effluent is suspected of forming a ‘barrier’ to fish migration from the Murrumbidgee River, possibly as a result of an aversion response by fish to some constituent of the discharge. Fish sampling in 1994, 1996, 1997 and 2003 demonstrated the absence of Golden Perch and Murray River Crayfish from a site immediately below the discharge point, but that they were present 5 km downstream in the Murrumbidgee River.

4.7 Construction phase

There will be a need for high quality construction and restoration standards where the pipeline passes through native vegetation, especially when crossing the riparian zones of the Molonglo and Murrumbidgee rivers, or following roadsides with native vegetation.

Dam construction has been shown to cause significant impacts on aquatic communities, mainly through the large amounts of sediment that are deposited in streams as a result of construction activity. Increased delivery and accumulation of sediments in the stream will adversely affect spawning, feeding and rearing habitats of Two-spined Blackfish and Macquarie Perch. Of particular concern are the Macquarie Perch spawning habitats immediately upstream of Cotter Reservoir, which are critical for the maintenance of the population in the reservoir. Reduced flows will also accentuate fish passage problems in this reach, as natural barriers become more problematic in the absence of high flows.

Another issue surrounding the reservoir enlargement is the potential effect on the aquatic ecosystems during the filling phase of the reservoir. There will be a trade-off between the time taken to fill the reservoir and the impact on the aquatic ecosystem. The reservoir will be filled most quickly if only the minimum environmental flow requirement is released from the dam, and the rest of the inflows captured. Even under this scenario, for average inflows it will take approximately 12 months to fill the 78 GL reservoir — much longer if drought or below average conditions continue. However, this pattern of constant low flow release is likely to have detrimental effects on the aquatic biota that rely heavily on the seasonality of the flows.

A spill control plan will need to be implemented to control any accidental discharge of construction-related fuels, lubricants, and other materials.

It is also unclear at the present time to what extent the existing Cotter Reservoir will need to be drawn down for operational or safety issues during construction of the new, larger dam wall downstream. There are potentially serious ecological consequences if such draw-down is not carefully managed.

As referred to earlier, the construction of the new dam wall must be carried out while maintaining an intact barrier to invasion by Carp and Redfin Perch from below Cotter Reservoir.

In summary, unless managed very carefully, dam wall construction could cause significant damage to downstream habitats, impacting on fish and other aquatic species such as Platypus.

5 Additional Comments

5.1 EPBC ACT

There is likely to be a requirement for development referral under the provisions of the Commonwealth Environment Protection and Biodiversity Conservation Act (1999). Under the environmental assessment provisions of the EPBC Act, actions that are likely to have a significant impact on a matter of national environmental significance are subject to a rigorous assessment and approval process. An action includes a project, development, undertaking, activity, or series of activities.

The Act identifies seven matters of national environmental significance, one of which is nationally listed threatened species and ecological communities. One lizard and two of the fish species present in the Cotter are listed as nationally threatened (Macquarie Perch and Trout Cod), and so the provisions of the EPBC Act are expected to apply.

5.2 Environmental opportunities

This paper has highlighted many potential environmental risks of the Water2WATER project that must be further evaluated and carefully considered.

However, we also note that the new recycling project also offers some opportunities to improve the environmental condition in the lower Cotter catchment — a catchment that has from an ecological perspective been severely modified by historic land-use and, recently, bushfires.

These opportunities include:

- Pipeline from LMWQCC to Uriarra — potential for new plantings to link with existing and proposed restoration and community plantings in the area.
- Proposed new wetland — could be integrated with ACT Government's planning and management of the lower Cotter area in terms of their restoration projects and fire fuel management. The wetland could be part of the proposed fire management plan for native restoration, chain of ponds, multiple discharge points.
- Proposed new wetland — could become a focus for off-reservoir nature-based recreational opportunities and eco-tourism.
- Enlarged Cotter Reservoir — could include creative conservation of habitat for threatened fish and other aquatic biota by designing edge contours and macrophyte vegetation, and installation of fish habitat structures.
- Rehabilitation of the catchment area surrounding the lower Cotter Reservoir is important to maintain water quality, and will serve to enhance environmental values and provide an exemplar of the benefits and the methods used to achieve them.

These opportunities will be considered in more detail during stage 2 of eWater CRC's evaluation.