futurewateroptions

FOR THE ACT REGION IN THE 21ST CENTURY

ACTEW CORPORATION

FUTURE WATER OPTIONS FOR THE ACT REGION - IMPLEMENTATION PLAN

A recommended strategy
to increase
the ACT's water supply

April 2005

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Executive Summary

In April 2004, the ACT Government released "Think water, act water – a strategy for sustainable water resources management". The strategy defined actions to achieve sustainability objectives for water use in the ACT to 2050, including to:

- *increase the efficiency of water usage; and*
- *provide a long term reliable source of water for the ACT and region.*

As part of the development of this strategy, ACTEW produced an evaluation report in April 2004 'Options for the next ACT water source', which identified nearly 30 possible options for a long-term reliable water source for the ACT. It concluded that three options were suitable for more detailed assessment:

1. *building a new dam on the Gudgenby River near Mount Tennent, south of Tharwa;*
2. *enlarging the existing Cotter Dam; and*
3. *transferring water from Tantangara Dam in New South Wales into the ACT.*

For each option, alternatives have been assessed to determine the optimum proposal. The alternatives have involved different sizes of storages, and different ways of treating and transferring water. They included the Angle Crossing option (formerly known as the Virtual Tennent Option), where Gudgenby River water is pumped from the Murrumbidgee River to the existing Googong Reservoir instead of building a new storage, and allowing Tantangara water to flow into the ACT along the Murrumbidgee River.

The ACT Government asked ACTEW to produce a final report on the preferred approach for additional supply, if it were required. This is that report, now presented for consideration by the ACT Government.

The report summarises the social, environmental and economical implications of the various options, restates the need for additional supply and describes the preferred path to achieve it. Companion reports are available on a range of technical studies that served as inputs to the analysis, as well as stand-alone reports on each of the three broad options, including a number of alternatives within each option.

Key Planning Variables

New scientific information on climate variations and climate change, the implications of natural disaster events such as the bushfires of January 2003, the effects of the current prolonged drought and the review of environmental flows have all necessitated ACTEW's previous predictions be reviewed. The six key planning variables that underlie predictions for future water demand are:

- *Natural Environmental Risk Factors*
    1. *climate variability and climate change,*
    2. *bushfires reducing inflows to existing ACT reservoirs due to regrowth,*
- *Government Planning Parameters*
    3. *population growth to 500,000 in 2032 (as identified in the ACT Government's Spatial Plan) and servicing growth in the surrounding region,*

4. *the water use efficiency targets (reductions in water consumption of 12 per cent per capita by 2013 and 25 per cent by 2023) in "Think water, act water".*

- *Factors set by Government*

5. *environmental flows requirements from the reservoirs at Googong, Corin, Bendora and Cotter to maintain the health of river ecosystems. This report is initially based on the 1999 Environmental Flow Guidelines. These guidelines are under review by Environment ACT with the analysis soon to be completed and finalised in August 2005. In early March, Environment ACT provided to ACTEW an indication of the 'proposed new environmental flows' and these proposed changes have also been modelled separately, to estimate the impacts on future water supply for the ACT; and*

6. *Acceptable levels for the duration, frequency and severity of water restrictions during times of drought.*

Predictions of future conditions based on these six key planning variables show that reservoir storage levels would become low to very low in periods of drought. As concluded in ACTEW's December 2004 report to the ACT Government, "An Assessment of the Need to Increase the ACT's Water Storage", there is a need to continue to plan for additional water supply in the ACT, unless the community is prepared to accept periods of significant water restrictions on a scale unprecedented elsewhere in Australia.

What is a Reliable Water Supply?

A long-term reliable water source for the ACT means having sufficient supply to account for climate variability and climate change, the bushfire impacts on runoff from catchments, projected population growth for the ACT and surrounding region, while meeting the Government's water efficiency targets and flows to protect the environment of the regulated river systems. A reliable water supply also means providing customers with a guarantee that their reasonable water demands will be met, subject to appropriate water restrictions being imposed during prolonged droughts.

Based on other Australian water utilities, there is currently a consensus that duration of restrictions should occur no more than five per cent of the time. There is also a perception that the ACT community wishes to avoid prolonged imposition of Stage 3 or higher. Based on these factors and for the purpose of this report, "a reliable water supply" means that water restrictions would apply for no more than five per cent of the time. This implies restrictions of some sort (stage 1 or stage 2) would be imposed for about one summer every five years, or perhaps one full year each twenty years. Stage 3 restrictions, where sprinklers are not permitted, could occur about one summer every 25 years. Ideally, stage 4 or stage 5 restrictions would not be required, but of course they may be needed in an absolutely catastrophic drought.

Water restrictions inconvenience and cost the community. An economic study has been carried out on the existing water supply system to quantify these costs in the ACT to households, businesses, the tourism industry, Canberra's parks and public places, ACTEW and the ACT Government itself. The study found that stage 1 restrictions cost $3.5 million per year, stage 2 cost $16 million per year and stage 3 cost $60 million per year. To provide a perspective on the cost of restrictions, it is estimated that the current drought has so far cost the ACT economy approximately $71 million.

The quantity of water supplied to the ACT and Queanbeyan in recent years has averaged 65 GL per year; although water consummation can be over 70 GL in a hot year. Around 70 to 73 GL per year will be required by 2023 and 77 to 88 GL in 2053, depending on the rate of population growth and success with water efficiency measures among other factors.

Diversity of Community Views

Over the duration of the Future water options project, many opportunities have been provided for the community to express values and views on the future water options. The process has been extensively promoted on the internet, television, radio and print media, the website has been consistently updated and substantial opportunities for briefings have been provided. As a result of this, approximately 1500 to 2000 people have had direct contact with the project. Whilst this is a pleasing result, it must be viewed in the context that the outcomes from the project will affect nearly 350,000 people. Therefore, despite the best efforts of the process, the views expressed in this report can only be considered to represent a small percentage of the wider community.

As part of a community consultation program, four community meetings were held in November 2004 to help identify priorities in terms of future water options. In all four meetings, the most important issues perceived by those participating were:

- *protection of public health;*
- *reliable future water supply; and*
- *effect of new storages on aquatic ecosystems.*

The community consultation process was an attempt to gather as much community opinion and feedback as possible. The results have been constructive and helpful with a number of Canberrans and interested NSW residents engaging in debate about the best way to provide a reliable water supply for the ACT and region. Views were, as expected, diverse, but the process has enabled ACTEW to test many of the ideas being considered. Community consultation has not provided a uniform view, nor was this the expectation, and further debate on the preferred option can be anticipated. It has however, ensured a transparent process informed by community views.

Improving the Efficiency of Existing Infrastructure

Even if work was to commence immediately, a new dam could not be built and filled, even in a period of no drought, before about 2011. Therefore as part of the overall analysis, initiatives to supplement the ACT's water supply in the interim have been assessed.

Since the project commenced, the use of the Cotter Reservoir has been initiated, following completion of the new Mt Stromlo water treatment plant (WTP), which has enabled the treatment of the lesser quality water from the Cotter Reservoir. The use of the Cotter Reservoir has increased the amount of water available by up to 50 ML/day.

A second initiative to increase yield using the existing infrastructure is to divert water from the Cotter catchment to Googong Reservoir – referred to as the Stromlo to Googong Reticulation Transfer. The transfer of water from the Cotter catchment to Googong Reservoir is now possible because of the ability to treat water at much higher flows than was previously possible. The capacity of the Mt Stromlo water treatment plant has been increased to upto 300 ML/day and has been operational for some time and its performance proven. Also, as a component of the Googong water treatment plant upgrade, pumps within the reticulation system enable higher pumping rates which means that more water can now be pumped around the reticulation

system. On average, some 29 GL of water spills from the Bendora and Cotter Reservoirs each year. The Stromlo to Googong Reticulation Transfer involves capturing a proportion of these spills, transferring via Canberra's existing water mains, bypassing Googong WTP, and storing in Googong Reservoir. Environmental flows, under the existing guidelines, will be maintained under this scheme.

The hydrology modelling suggests that, on average, about 12 GL of water could be obtained each year from the Stromlo to Googong Reticulation Transfer at a capital cost of $20 million. Crucially, it can be implemented within about 12 months. While it involves a higher operational cost, it would enable a quick and relatively cheap boost to Canberra's water supply. ACTEW has already commenced work to implement this scheme.

Evaluation of the Options

Enlarging the Cotter Dam to 78 GL (at a cost of about $120 million) has few environmental and social issues. The main disadvantages are sediment discharge in the lower Cotter catchment where the damage wrought by the January 2003 bushfires has accentuated an existing erosion problem and associated impacts on water quality. With appropriate catchment remediation, which will be required regardless of whether the enlarged dam is built, and with treatment of Cotter water at the new Mt Stromlo WTP, it is expected that this situation will be manageable.

The Angle Crossing Option (previously referred to as the Virtual Tennent Option) involves the transfer of water from the Murrumbidgee River, near Angle Crossing, but notionally emanating from the Gudgenby River, to the Googong Reservoir via a new weir, pump and pipeline. At a pumping rate of 60 ML per day, an additional 8 GL per year (on average) of water will be transferred to Googong Reservoir at a capital cost of about $35 to $40 million. It is expected to take two to three years to have Angle Crossing operational. The Angle Crossing Option also provides more diversity into the water supply system by drawing water from a third catchment.

The best of the Tennent Dam alternatives is to build a 43 GL dam and then enlarge it to 159 GL if additional supply is required. The key disadvantages are the damming of an unregulated river, with some damage to the catchment's yellow box woodland and associated fauna (such as bird corridor connectivity). There are social issues resulting from the need to resume all 14 rural lessees and relocate the families involved, although the possibility of a Tennent Dam has been known for many years and is reflected in lease conditions. Catchment remediation will be required to protect water quality. The 43 GL Tennent Dam is some $65 million more expensive then the enlarged Cotter option (due mainly to the need for road relocation and a new water treatment plant). The main advantage of a large Tennent Dam is that it would meet the long term future water needs of the ACT and region.

The best Tantangara option – releasing up to 20 GL down the Murrumbidgee River each year for transfer to Googong Reservoir – has few environmental costs and some environmental benefits. From a social perspective there may be some negative effects, as essentially the upper Murrumbidgee will become part of the Canberra region's drinking water supply catchment and this may impact on the activities of local landholders. While there is currently no water trading scheme in place in the Murray-Darling Basin to allow the transfer of a NSW water right to the ACT, this is likely to occur in the foreseeable future under the National Water Initiative. In addition, the ACT will need to negotiate a "water Cap" under the auspices of the Murray-Darling Basin Initiative. These complexities mean the Tantangara option currently provides a lower level of security (some "sovereign risk") relative to using only the ACT's controlled water, a concern that was consistently raised during community consultations. Having Angle Crossing Option

implemented, however, would facilitate its later adoption, as the major infrastructure would be in place.

Recommendations

Because of the availability of the Stromlo to Googong reticulation transfer, it is now possible to initiate a strategy for water supply for the ACT and region that was not previously available. That strategy is a phased one, which would:

(a) require the immediate building of the infrastructure necessary to provide a reliable water supply for a substantial period ahead; and

(b) allow sufficient time to deliver any of the bigger infrastructure options, if necessary, in the light of more definite information.

Consistent with this strategy, ACTEW recommends the following.

1. ***It is recommended that** implementation of the option to pump water from the Murrumbidgee River near Angle Crossing to Googong Reservoir (formerly known as the Virtual Tennent Option) commence immediately.*

2. ***It is recommended that***
   i. *the remaining options of an enlarged Cotter Dam to 78 GL, a small (43 GL) or a large (159 GL) Tennent Dam and transferring water from Tantangara Dam down the Murrumbidgee River into the ACT be retained as future viable options; and*
   ii. *ACTEW be ready to implement one of these options without delay, if required, through the development of a work program, implementation of formal processes for regularly reviewing the six assumptions, and completing analysis, design and other relevant technical studies for an approval process.*

3. ***It is recommended that** additional technical analysis be undertaken for the each of the dam options, including refining the dam design, further detailed examination of pipeline routes and additional examination of the benefits of building a new water treatment plant near the Tennent Dam versus transferring water from the Tennent Dam into the Mt Stromlo water treatment plant.*

Immediate Action

Based upon the six key variable assumptions, the Angle Crossing Option, together with the soon to be implemented Stromlo to Googong Reticulation Transfer, it is expected that the ACT would have a reliable water supply until about 2023 without the need for prolonged restrictions. It is anticipated that water pumped near Angle Crossing would be allocated from the Gudgenby catchment.

This project will need to be completed in close co-operation with NSW agencies and the Greater Queanbeyan Council. It is estimated this will cost in the vicinity of $35 to $40 million and be completed within two to three years.

Future Actions

The Angle Crossing Option allows a much better decision to implement, if needed, one or more of the larger infrastructure options later because better experience and knowledge will be available about whether the six key variable assumptions are actually working out in practice.

It should be recalled that the Future Water Options project commenced with three options, but this was further expanded to some 26 alternatives once a variety of ways of delivering each of the options was developed. In addition, many other suggestions were brought to the attention of the project team and considered. This process also encouraged people to look at the way the current water supply system is operated and to examine more efficient ways of delivering water. The development of the reticulation transfer option was a result of this process and provides a relatively cheap way to increase the amount of water available to Canberra and the region.

There are many different scenarios that could eventuate over the next 15 years. For example:

a) if high population growth together with climate change and significant bushfires impacts were to occur, the next preferred option would likely be to build the large Tennent Dam. If a lower population growth were to occur, or if climate change and the bushfire impacts are not as severe as is currently thought an enlarged Cotter Dam would most likely be preferred. The ACT's population growth over the past year was about 0.2 per cent and if this were to continue there may not be a need for additional water at all. One of the virtues of making the next decision in some 15 years is that this will bring the Tantangara Option into play. When a robust water trading scheme is established in the Murray-Darling Basin transferring water from Tantangara to Googong Reservoir becomes more viable due to its low cost and the environmental benefits that would be gained in the Murrumbidgee River;

b) considering the water efficiency program, if larger savings are obtained more quickly, again there may not be a need for additional water supply. On the other hand, if the efficiency targets are not met and population growth occurs more quickly than per capita water reduction, there would be a need for a large Tennent Dam;

c) between now and 2023, it is likely that three more reviews of the environmental flow guidelines will occur. As a better understanding of river ecology is obtained through the monitoring and management of environmental flows, the volume and type of flows are also likely to change;

d) it is likely that permanent water conservation measures will be introduced into the ACT. This will require that the ACT's water restriction scheme be reviewed.

The analysis undertaken for this project has provided the tools and knowledge so that a decision on the next supply option, if needed, can now be made more quickly.

Future Analysis

Additional technical analysis should be undertaken for the each of the dam options, including refining the dam design, further detailed examination of pipeline routes and additional examination of the benefits of building a new water treatment plant near the Tennent Dam versus transferring transfer water from the Tennent Dam into the Mt Stromlo water treatment plant.

The Cotter catchment has been significantly impacted by the bushfires. Careful management and appropriate monitoring is required to ensure that the catchment is able to supply high quality water for use in the ACT and region.

The Naas and Gudgenby Rivers provide the next best water supply catchments for the ACT based on the analysis presented in this report and previously in ACTEW's report of the larger list of options. The site needs to be preserved as a future water source. There are some environmental values that could be protected and enhanced. There are significant Yellow Box grassy woodlands that could be improved and better wildlife corridors can be provided over the next several years to provide a better catchment from an environmental perspective, as well as positioning the catchment as a future water supply. This approach is consistent with the National Capital Plan. In undertaking this rehabilitation, however, the future inundation areas need to be identified to ensure they are protected. Better wildlife corridors, and improvements to the Yellow Box woodland should occur above the proposed high water mark of the large Tennent reservoir.

There are 14 rural lessees in the catchment of the proposed Tennent Dam. There are some inconsistencies in the conditions and terms of the leases. It is recommended that the existing leases are reviewed and a more common approach taken.

There are also residual cultural heritage uncertainties. A detailed analysis of the Naas Valley and areas affected by the Tantangara option would contribute to filling gaps in current knowledge. Further consultation with Aboriginal groups should be done as part of this exercise.

The Tantangara Option should be kept under review, as water policy initiatives mature. Having the Angle Crossing weir and associated pumps and pipeline in place would facilitate its later adoption, as the major infrastructure would be in place. ACTEW will continue to participate and support actions under the National Water Initiative including the development of a robust water trading scheme. In addition, ACTEW will continue to contribute to the development of an ACT water Cap.

1 Introduction

In April 2004, the ACT Government released *Think water, act water - a strategy for sustainable water resources management*[1]*.* This strategy defined actions to achieve sustainability objectives for water use in the ACT to 2050*.* Also, in April 2004, ACTEW produced *Options for the next ACT water source,* which identified nearly 30 possible options for boosting Canberra's water supply[2] and concluded that three options were suitable for more detailed assessment. These options are to enlarge Cotter Dam, build a new dam near Mt Tennent or transfer water from Tantangara Dam in NSW to the ACT. A dedicated project, *Future Water Options,* was initiated to determine, based on these three options, the preferred approach to securing the future water supply needs and to deliver on the objective in *Think water, act water* "*to provide a long-term reliable source of water for the ACT region".*

The ACT Government asked ACTEW to produce a final report on the preferred approach for additional water supply, if it were required. This is that report which is presented for consideration by the ACT Government.

This report summarises the social, environmental and economic implications of the various options and describes an implementation strategy to provide a reliable water supply for the ACT and region. Companion reports are available that assess the individual options in detail [3,4,5].

The ACT has been foremost among the Australian States and Territories in allocating water to environmental flows. More than half the total water resources of the ACT are allocated to environmental flow. In an average year, 272 GL is allocated to the environment from the total available water of 494 GL (55 per cent of the total volume of water available) with 222 GL available for human use[6].

At present, ACTEW extracts approximately one third of the water available for human use (65 GL per year) to supply water to about 370,000 people in the ACT and Queanbeyan. In addition, the ACT returns about half of this water via the Lower Molonglo Water Quality Control Centre to the Molonglo River, which then flows on to the Murrumbidgee River. This water is reused downstream and provides a valuable resource to the environment and water users in NSW within the Murray-Darling Basin.[7]

From the perspective of downstream users, the flow from the ACT includes all the Murrumbidgee River inflows into the ACT plus 94 per cent of the water resources controlled by the ACT. The ACT is a substantial net exporter of water.

From the perspective of people living in the ACT region, the ACT has enough water available to supply more than a million people. Currently this many people cannot be supplied with water due to a lack of storage. The original decision for the location of the ACT was, in part, based on the ready availability of substantial water resources of high quality.

[1] ACT Government (2004), *Think water, act water,* Vol 1 "Strategy for sustainable water resource management in the ACT;" Vol 2 "Explanatory document;" Vol 3 "State of the ACT's water resources and catchments," April 2004.
[2] ACTEW (2004), *Options for the Next ACT Water Source*, April 2004.
[3] ACTEW (2005), *Tantangara Option Report*, April 2005.
[4] ACTEW (2005), *Cotter Option Report*, April 2005.
[5] ACTEW (2005), *Tennent Option Report*, April 2005.
[6] ACT Government (2004), *Think water, act water,* Vol 3 "State of the ACT's water resources and catchments," April 2004.
[7] Consulting Environmental Engineers (2005), *Value of Effluent Discharged from LMWQCC to Murrumbidgee River*, April 2005.

2 Need for Additional Water Supply in the ACT

The need for additional water supply in the ACT depends on six key variables.

Natural Environmental Risk Factors

New scientific information has been obtained on the impacts of climate variability, climate change and the recent bushfires on the amount of water that is likely to runoff into the Googong and the Cotter reservoirs:

1. climate variability and climate change,
2. the impact of bushfires on storage inflows in the ACT.

Government Planning Parameters

The ACT Government has outlined population projections in the *Spatial Plan*[8] and water efficiency targets in *Think water, act water*. These projections are adopted in this report:

3. population growth to 500,000 in 2032 and servicing growth in the surrounding region,
4. meeting the water use efficiency targets (reduction in water consumption of 12 per cent per capita by 2013 and 25 per cent by 2023) set out in *Think water, act water*.

Factors within Government/Community Control

The ACT Government and the community could agree to alter the existing Environmental Flow Guidelines. They could also agree to accept a modified form of water restrictions:

5. environmental flows of water between and from the reservoirs at Googong, Corin, Bendora and Cotter are required to maintain the health of the river ecosystems. This report is initially based on the 1999 Environmental Flow Guidelines[9]. These guidelines are under review by Environment ACT with the analysis soon to be completed and finalised in August 2005. In early March, Environment ACT provided to ACTEW an indication of the 'proposed new environmental flows'[10] and these proposed changes have also been modelled separately,[11,12] to estimate the impacts on future water supply for the ACT.
6. the duration, frequency and severity of water restrictions[13].

Before discussing these variables, it is necessary to address the question: *what is meant by a 'reliable water supply'?*

2.1 Water Resources Modelling

2.1.1 Reliable Water Supply

Determining what will be regarded as a 'reliable water supply' is a first step. The provision of unlimited water supplies for the ACT and region is technically possible but would come at great

[8] ACT Panning and Land Authority (2004), *The Canberra Spatial Plan*, March 2004.
[9] ACT Government (1999), *Environmental Flow Guidelines*, May 1999.
[10] Environment ACT (2005), *Correspondence to ACTEW on revised environmental flows*, January and February 2005.
[11] ActewAGL (2005), *ACT Future Water Options Water Resources Modelling report – Volume 1*, April 2005.
[12] Centre for International Economics (2005), *Economic benefit-cost analysis of new water supply options*, April 2005.
[13] ACTEW (2004), *An Assessment of the Need to Increase the ACT's Water Storage,* December 2004.

expense. The objective must be to achieve levels of water availability within realistic financial, environmental and social cost parameters, with the proviso that at least reasonable levels of water availability must be guaranteed at all times.

During extended periods when rainfall and runoff are low, restrictions will be imposed to reduce water consumption and ensure that supplies do not run out. Assessments have been made based on comments by people in the ACT and Queanbeyan [14,15], the costs of restrictions[16], and comparison with practice elsewhere[17], to determine a definition of a 'reliable supply' that has been adopted as the basis for water supply planning for Canberra.

The adopted approach equates a reliable water supply to restrictions being imposed for five per cent of the time. This means that, on average, water restrictions of some sort (stage 1 or stage 2) will be imposed about one summer in every five years, or perhaps one full year of restrictions may be required in 20 years. Stage 3 restrictions, where sprinklers are not permitted, would occur about one summer in 25 years. It is expected that stage 5 restrictions would not be required.

A corollary of this definition is that the water supply system would be said to be "failing" if restrictions need to be imposed more frequently.

Thus, the adequacy of water supply during times of drought should be based on the measures shown in Table 2.1 below.

Table 2.1: Measuring a long-term reliable water supply system

Measure	Indicator
Reliability of supply	Minimum amount of total storage at the end of the most severe drought event (more severe than any event the ACT has experienced to date).
Time in restrictions	Duration of time spent in all stages of water restrictions
	Frequency of water restrictions
	Severity: expressed as the time in stage 3 restrictions or greater

2.1.2 Six Key Planning Variables

Having defined 'reliable water supply', the need for additional water supply depends on the six variables identified earlier. These variables have been incorporated into a computer hydrology model of Canberra's water supply.

New scientific information has been obtained on the impact of climate variability, climate change and the recent bushfires on the amount of water that is likely to flow into the Googong and Cotter catchment reservoirs. Due to the inevitable uncertainties associated with this predictive information, a conservative approach has been taken.

[14] ACTEW (2005), *Consultation Report, A report on the consultation process undertaken as part of the Future Water Options Project*, April 2005.
[15] ACTEW (2005), *Stage 1 Social Impact Appraisal, An overview of the social impact of the Future Water Options Project*, April 2005.
[16] Centre for International Economics (2005), *Economic benefit-cost analysis of new water supply options*, April 2005.
[17] WSAA / SKM (in prep), *Framework for Urban Water Resource Planning*.

The model relies on rainfall and stream flow records for the various catchments, data for which is available for about 90 years. This data may not, however, be representative of future climatic conditions. Even without accounting for climate change, the ACT is almost certain to experience droughts worse than those experienced during the past century. This is illustrated by the current drought that is now the "worst on record" and based on existing data would have been difficult to predict even a few years ago.

To overcome this limitation the standard hydrological approach to understand how the water supply system might behave in even more extreme droughts[18] is to extrapolate from the existing historic climate record. While such extreme events may occur in the future, albeit only rarely, they can be provided for in the planning process in a way not possible using historic data alone.

Taking into account the risk of climate change there is the possibility that future climate will depart from past trends because of global warming. Advice on the likely impact of the greenhouse effect on local rainfall, temperature and evaporation rates has been sought from CSIRO. The following summarises CSIRO's thinking on key topics:

- mean annual temperatures could increase by up to 1.5ºC by 2030 and 5ºC by 2070, leading to more extreme temperatures in the ACT region;
- by 2030, average winter and spring rainfall could reduce by up to 9 per cent (the distribution of summer and autumn rainfall changes are not as clear), with an increase in the frequency and intensity of rainfall;
- evaporation could increase by up to 10 per cent by 2030; and
- in the 1970s, a sudden shift in climate saw runoff from water supply catchments in the southwest of Western Australia reduce significantly; it is possible that the ACT region's climate could also shift over a short period, reducing runoff from ACT catchments.

The impacts of these elements of climate changes are interconnected. Increases in temperatures are likely to result in increased evaporation, meaning more water use. Even in wet years, rainfall effectiveness would be reduced by higher evaporation. Under these circumstances, a 10 per cent reduction in rainfall and changing rainfall patterns could result in a reduced runoff into the ACT's reservoirs by up to 20 per cent by 2030[19].

One consequence of the 2003 bushfires is a reduction in the inflows into the reservoirs on the Cotter River. This is because more water is taken up by vegetation regrowth following bushfire, leaving less runoff into streams and reservoirs. To determine the magnitude of this effect, ACTEW has commissioned a study of the likely reduction in inflows due to the 2003 bushfires[20]. The reduction in inflows into Corin reservoir are expected to gradually decrease by approximately 15 per cent in about 17 years after the bushfires, with reduced flows expected to continue to occur for more than 50 years. Similar reductions are likely for Bendora reservoir.

The ACT Government has outlined population projections in the *Spatial Plan*[21] and water efficiency targets in *Think water, act water*. These projections, which are adopted in this report, include:

[18] SKM (2004); *Update of Water Resources Strategy for Canberra and Queanbeyan - Stochastic Generation of Climate Data, Report* - 65 pages (ACTEW Corp. Doc. No. 3959).
[19] CSIRO (2003); *Climate Change Projections and the Effects on Water Yield and Water Demand for the Australian Capital Territory – Executive Summary, Report* – 6 pages (ACTEW Corp. Doc. No. 3948).
[20] DHI/Ecowise Environmental (2005)*; Predicted Impact of Bushfire on Corin Dam Catchment Yield*, April 2005.
[21] ACT Panning and Land Authority (2004), *The Canberra Spatial Plan*, March 2004.

- Canberra's population growth to 500,000 by 2032 and the need for ACTEW to service growth in the surrounding region as well; and
- reduction in per capita mains water consumption of 12 per cent by 2013 and 25 per cent by 2023. These measures include an investment by the ACT Government and community of some $323 million to achieve the 25 per cent reduction[22]. The range of measures to be implemented to meet these targets include education and awareness programs, increased water pricing, rebates for more water efficient toilets and showerheads, rain water tanks etc, indoor and outdoor water "tune ups", audits and retrofits for the commercial and government sectors, increased recycling and use of grey water. It also assumes that new suburbs will be much more water efficient than existing Canberra suburbs.

Total water demand will increase as the population grows. The increase will be moderated by the achievement of the water efficiency targets discussed above. The point at which the existing water supply system, or the future system, will prove inadequate (relative to the reliability definition) is therefore dependent on the rate at which the population grows.

For water supply planning purposes in Canberra, it is obviously prudent to plan so that sufficient water will be available to service the needs of the ACT Government's official population projections.

Finally, future water supply requirements will depend on the balance between water required for environmental flows and that available for human consumption.

Canberra's water supply is sourced from local rivers and streams. These waterways are a vital part of the natural environment and need to function as elements in natural ecological systems. Environmental flows are provided to ensure a minimum flow is maintained in rivers and streams so that they remain healthy. The ACT's environmental flow regime was introduced in 1999 and generally requires that low flows in rivers are protected. This means that certain volumes of water must always be released from all dams. The provision of water for environmental flows means there is less water remaining in the dams for human use.

Environment ACT is currently reviewing the existing environmental flow regime in consultation with relevant groups, including ACTEW. In the report submitted to the ACT Government In December 2004, ACTEW examined a 'modified environmental flow' based upon data supplied by Environment ACT. Since that time, Environment ACT are further developing new environmental flow guidelines. In March 2005, the "proposed new guidelines" were provided to ACTEW so that an assessment of these new flows could be carried out as a part of this project. This report makes an assessment of the impact of the proposed new environmental flows being developed by Environment ACT to examine any potential impacts on the timing for a new supply for the ACT.

2.1.3 Analysis of the Options

As noted in Chapter 1, ACTEW's 2004 water options study identified three options for more detailed analysis. These were to:

- build an enlarged dam at Cotter, replacing the existing Cotter Dam;
- build a new dam on the Gudgenby River (the Tennent Dam); and
- purchase water from Tantangara Dam in NSW and transfer it to the ACT.

[22] Institute For Sustainable Futures (2003), Demand Management Recommendations.

Closer examination of these options revealed many alternatives, for example, the possibility of a 'Virtual Tennent Option' – now referred to as the Angle Crossing Option (in which water that would have been captured in Tennent Dam is pumped from a weir on the Murrumbidgee River to Googong Reservoir). In all, some 26 alternatives and option combinations were identified and analysed as part of this project.

2.2 When is additional supply required?

As ACTEW stated in its report to the ACT Government in December 2004, unless the residents of the ACT are willing to accept the regular occurrence of water restrictions of a severity and frequency unprecedented in planning elsewhere in Australia, then additional water supply is now needed for the ACT.[23]

2.3 How much water do we need?

A variety of factors affect the demand that a city places upon the available water resources including:

- population growth;
- the amount of water consumed (generally expressed as per capita consumption);
- the frequency, duration and severity of restrictions; and
- the effects of climate change, climate variability and bushfires.

In this report the performance of the existing water supply system has been modelled assuming restrictions would be applied as stated in the Water Restrictions Scheme[24] for the existing water supply system. The modelling that has been carried out for the new options has optimised the restriction scheme to account for the new infrastructure and to ensure the water supply does not run empty. For the purposes of comparison with these optimised schemes, an optimised scheme has also been developed for the existing system.

The future demand placed on the water resources by the consumers in the ACT region has been estimated and is presented below in figure 2-1. Three scenarios are depicted:

- high population growth as outlined in the ACT Government's Spatial Plan coinciding with no reduction in water demand;
- high population growth with a 25% reduction in demand for water through meeting the water efficiency targets of *Think water, act water; and*
- moderate population growth and a 12 per cent reduction in water demand.

The combination of the higher forecast population growth curve, and meeting the 25 per cent water efficiency target, results in relatively flat total water demand until 2023 (this is the yellow curve in the figure below), because the increased demand for water induced by population growth is offset by enhanced water efficiency targets of a 12 per cent reduction in per capita consumption by 2013 and a 25 per cent reduction by 2023. Similarly, if population growth

[23] ACTEW (2004), *An Assessment of the Need to Increase the ACT's Water Storage,* December 2004.
[24] http://www.actew.com.au/restrictions/.

followed the Australian Bureau of Statistics medium projection and only a 12 per cent reduction in per capita demand was achieved by 2023, a similar total demand would be placed on the water supply (shown by the green curve in the graph below).

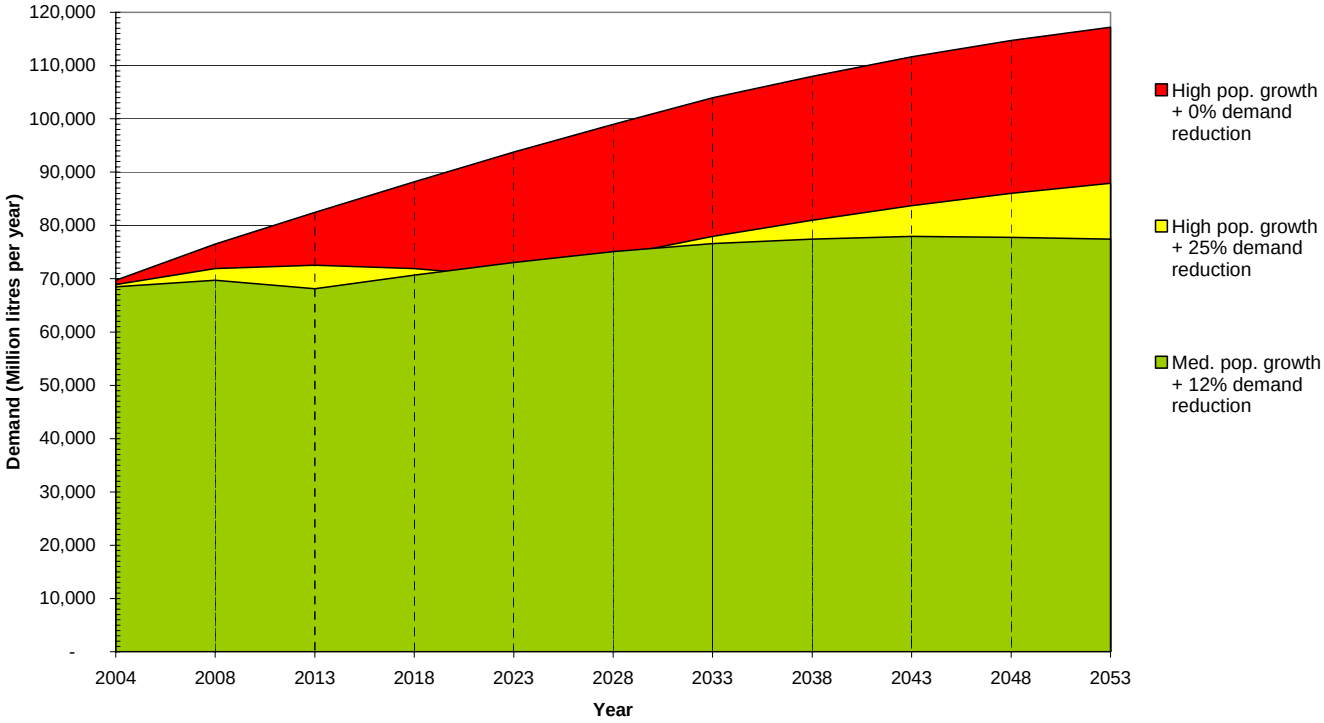


Figure 2.1: ACT and region future water demand

In the five years 1999 to 2003, the quantity of water supplied to the ACT and Queanbeyan has ranged from 60 to 66 GL per year and as high as 73 GL within the last decade. To provide "a reliable water supply" in the future it is estimated that 70 to 73 GL per year will be required by 2023 and 77 to 88 GL per year in 2053, depending on the rate of population growth, success with water conservation measures among other factors. This is equivalent to an increase in water demand of about 23 per cent over the next 30 years and by up to 40 per cent over the next 50 years. However, if no improvements were made in water efficiency, more than 110 GL would be required to supply the high population growth identified in the ACT Government's Spatial Plan.

2.4 Time in Restrictions

Figure 2.2 shows the cumulative time in restrictions of the existing water supply system based upon the six key variables. In particular:

- by 2043, restrictions would be in place 100 per cent of the time, initially with around a third of these being at stage 3 or above, but by 2055 with half of these at stage 3 and above;
- the time at stage 5 grows rapidly, initially at 1 per cent of the time, but increasing to 14 per cent by 2055.

- the time at stage 3 and above increases 3-fold over the period (from 17 to 48 per cent).

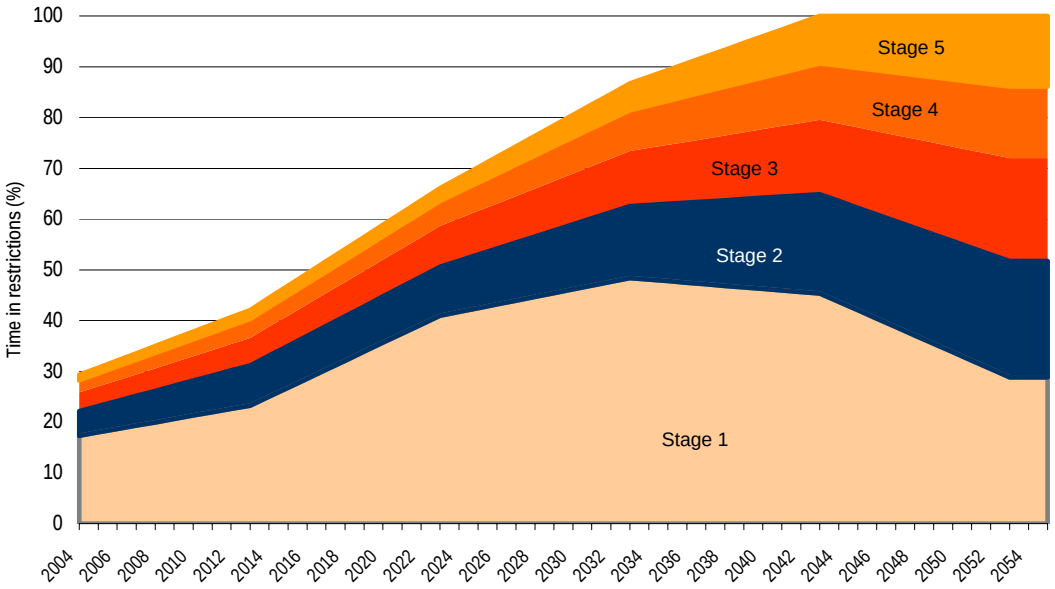


Figure 2.2: Time spent in restrictions.

2.5 Cost of Restrictions

Studies carried out by the Centre for International Economics[25] and NERA/ACNielson[26] have assessed the costs of restrictions, based on the existing system to the ACT and Queanbeyan community.

Table 2.2 summarises the total cost of water restrictions, including household, commercial, recreational, tourism, transaction (ie. the cost to implement restrictions), ACT Government and ACTEW costs, both currently and in 2055 (expressed in real terms). These costs should be interpreted as the cost of spending one year at the specified level of restrictions.

As an illustration, it is possible to apply these costs to the water restrictions that the ACT has experienced during the recent drought. Since December 2002, the ACT has been in stage 1 restrictions for 5 months, stage 2 restrictions for 11 months and stage 3 restrictions for 11 months. Using the current cost column from Table 2.2, the cost of these restrictions comes to $71 million.

Table 2.2: Total cost of spending one year in restrictions, by level

Level of restrictions	***Current cost***	***Projected cost in 2055***
	$ million	$ million
stage 1	3.5	9.4
stage 2	16.1	41.5
stage 3	60.1	157.6
stage 4	81.0	215.1
stage 5	162.8	428.9

Source: CIE estimates.

[25] NERA and ACNielson Research (2003), *Willingness to Pay Research Study,* a report for ACTEW Corporation and ActewAGL, September 2003.
[26] *ibid.*

Figure 2.3 shows the largest costs by type, are household costs that increase from $4 million (57 percent of total costs) to $81 million (47 per cent of total costs) by 2055. Recreational costs increase from $1 million to $35 million (20 per cent of total costs) by 2055. Commercial costs increase from $1 million to $28 million (16 per cent of total costs) by 2020. Tourism and civic environment costs increase to $18 million (10 per cent) by 2055. Increases in transaction, ACTEW and ACT government costs remain relatively small, but still reach $10 million by 2055.

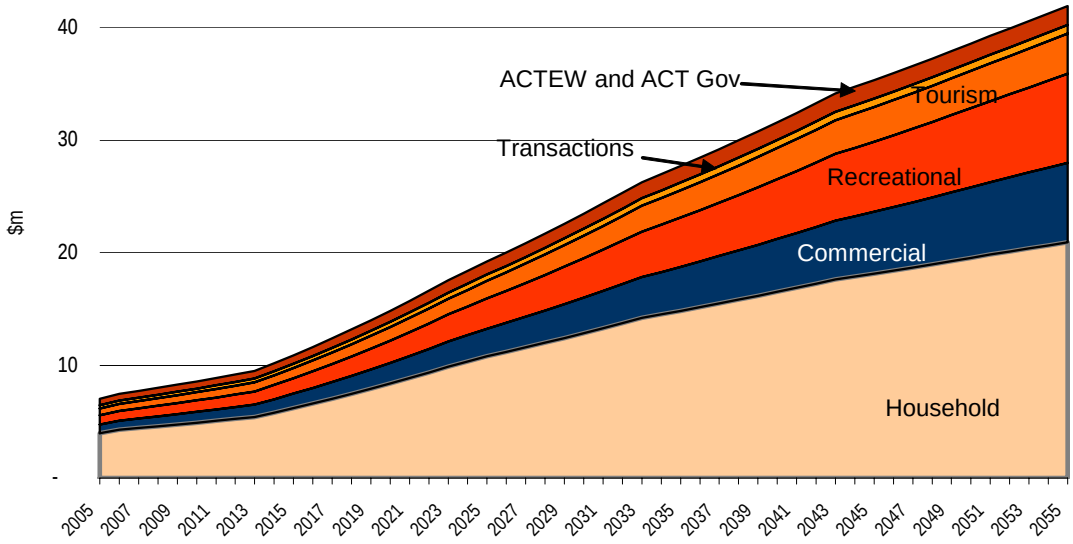


Figure 2.3: Costs incurred by each sector due to restrictions.

In comparison, if only moderate population growth occurred and there was a 12 per cent reduction in water demand, then the following costs are predicted.

The total expected cost of restrictions increases from $7 million in 2005 to $42 million by 2055. Most of the costs arise because of restrictions at stage 3 or above. In 2025, the cost of stage 3 and above comes to around 80 per cent of total costs, with the costs of stages 3, 4 and 5 being roughly equal. These relative proportions remain the same out to 2055, although the relative cost of stage 3 increases slightly.

The total cost of stages 3 and above increases from $6 million to $35 million over the period shown on the chart. The costs of stages 1 and 2 are relatively small, increasing from $1 million to $7 million by 2055. (Figure 2.4)

Figure 2.5 shows the expected cost of restrictions by type of cost. The largest costs are the household costs, which initially account for over half of total costs to just under half by 2055 (going from $4 million to $21 million). Recreational and commercial costs are a similar magnitude, and by 2055 account for around a third of total costs (increasing from $1 million each to around $7 million each). The tourism and civic environment costs account for around 10 per cent of costs by 2055 (increasing from $1 million to $4 million). ACTEW and ACT government costs together reach around $3 million by 2055.

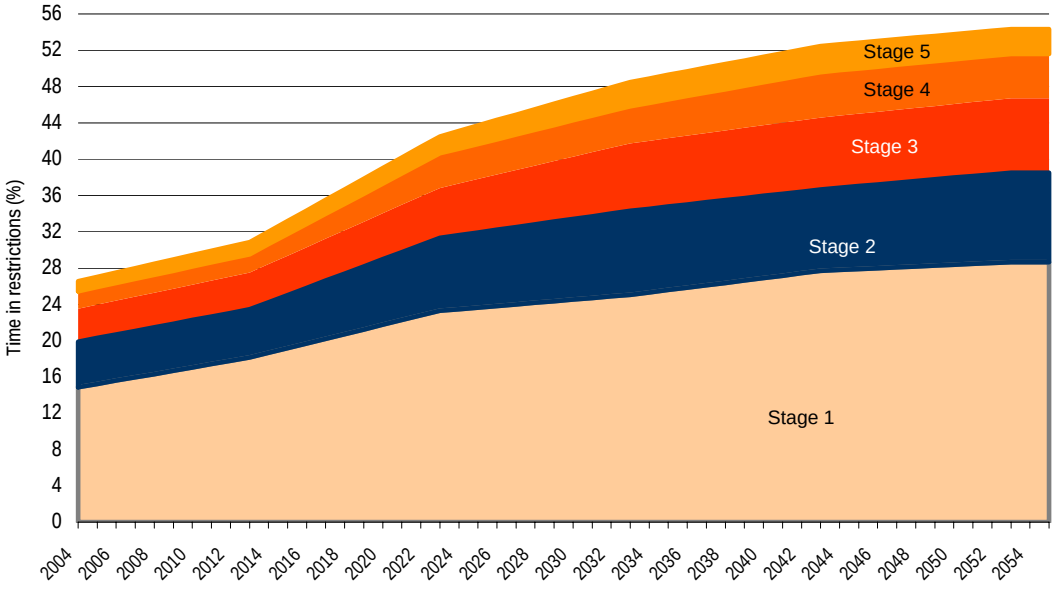


Figure 2.4: Cost of restrictions by type of costs – moderate population growth and a 12% reduction in water demand.

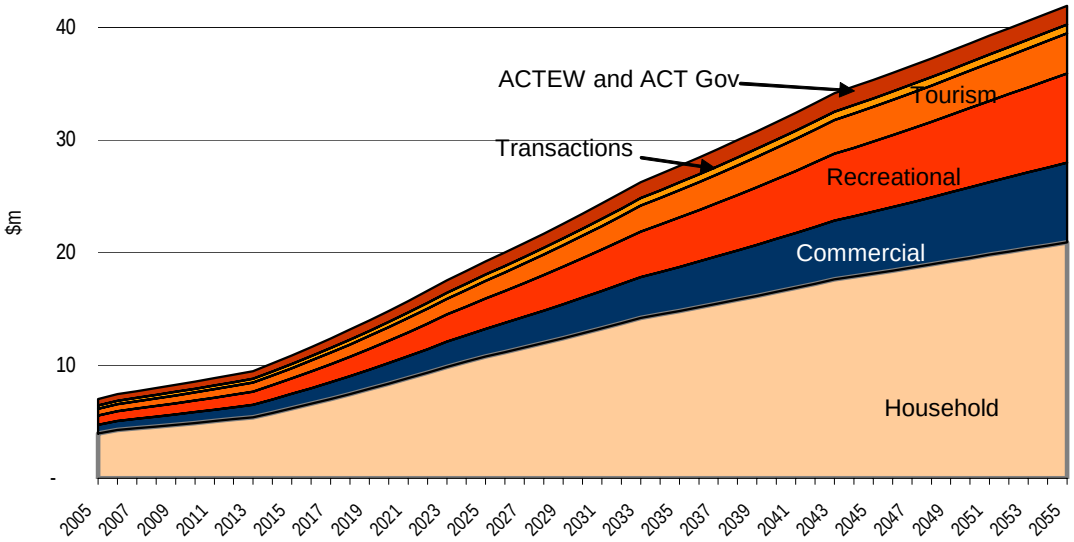


Figure 2.5: Costs incurred by each affected sector due to restrictions – moderate population growth and a 12% reduction in water demand.

3 Potential Water Sources

ACTEW's April 2004 options report identified new water supply options and contingency planning for a continuing drought.[27] It re-assessed previously proposed schemes and developed new options in a three-staged approach depicted in Figure 3.1. The locations of the three options are shown in Figure 3.2. The final three options to be examined in further detail have a range of alternatives that are considered and discussed in relevant chapters later in this report.

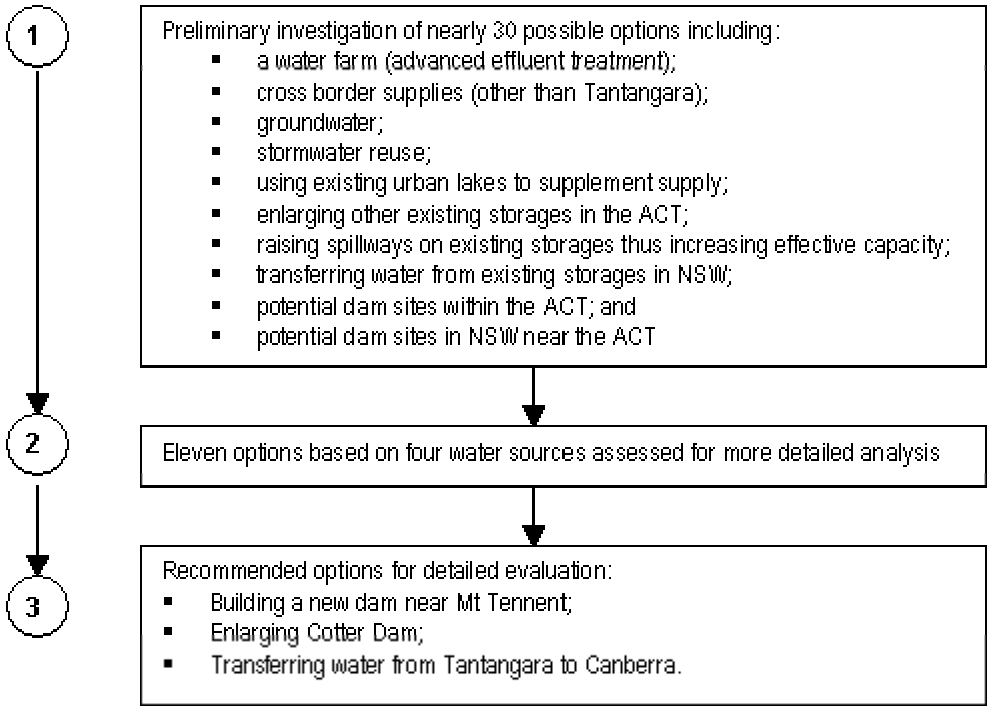


Figure 3.1: Assessing Options For The Next ACT Water Source

[27] ACTEW (2004), *Options for the Next ACT Water Source*, April 2004.

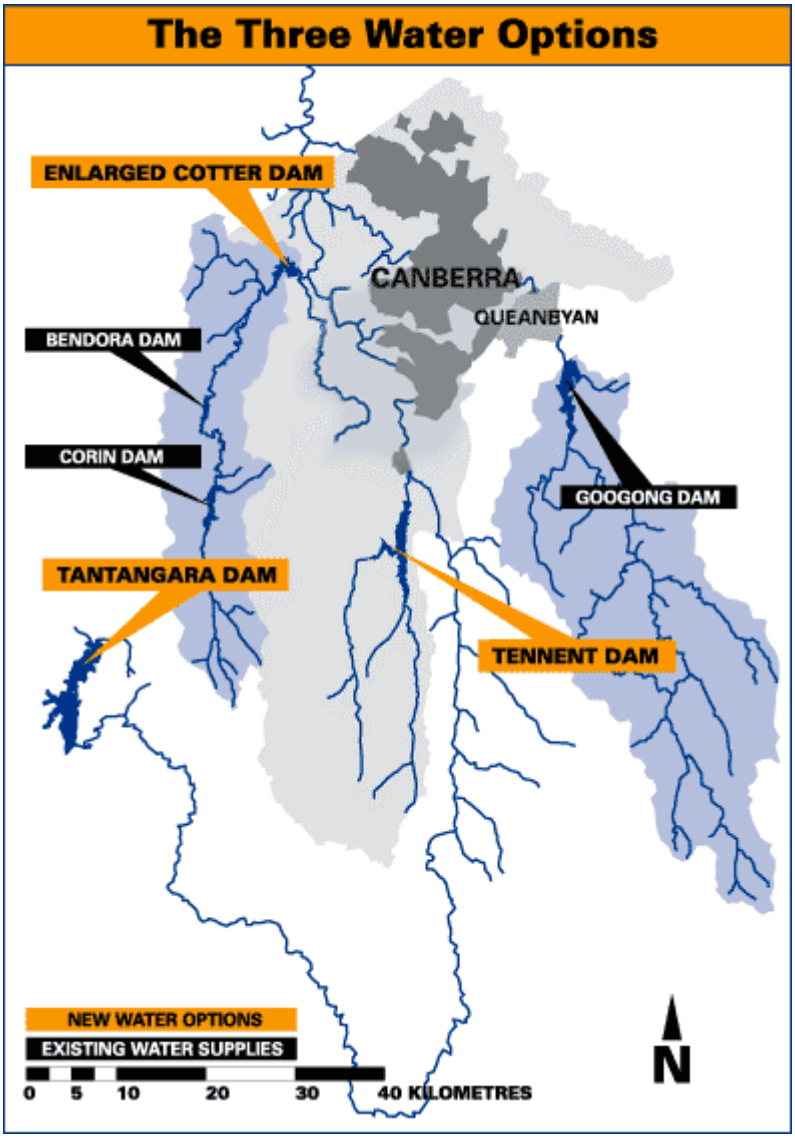


Figure 3.2: Short-listed options for further evaluation.

3.1 Sustainability Framework

The concept of sustainability:

- recognises that effective environmental solutions must achieve a balance with economic and social issues;
- reflects ecologically sustainable development as defined in the *1992 National Strategy for Ecologically Sustainable Development: "ecologically sustainable development is development which aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations";* and
- means maintaining or enhancing total resources without reducing any one type of natural, human, social, physical or financial capital to the point of irreversibility.

ACTEW's objectives generally include ecologically sustainable development principles:

- the precautionary principle, whereby a lack of scientific certainty should not be used to postpone taking action to prevent environmental degradation;
- the inter-generational equity principle, whereby the present generation should ensure health diversity and productivity of the environment for the benefit of future generations;
- conservation of biological diversity and ecological integrity; and
- improved valuation and pricing of environmental resources.

3.1.1 Environmental, Social and Economic Parameters

Analyses conducted for the *Future Water Options* project used "triple bottom line" or TBL (environmental, social and economic) assessment, similar to those used by other water agencies in Australia and overseas.

The assessment criteria were developed from the eleven core sustainability dimensions set out by the ACT Office of Sustainability in the document: *People, Place, Prosperity.* From these dimensions, twelve sustainability criteria were developed with expert input, and in consultation with interested members of the community, for the evaluation of the future water options.

The 12 assessment criteria set out in Table 3.1 include the environmental, social and economic factors. They are designed so that:

- there is equal consideration of economic, environmental and social factors;
- they represent the key issues involved in the comparison of the options as identified in public and agency consultation, can be measured for the different options, and cover the sustainability areas to ensure proper account is being taken of all factors to achieve objectives;
- they are able to show a difference for the various options;
- they do not overlap, in order to avoid the problems of double counting;
- they reflect local, regional, basin-wide, national and worldwide concerns and interests; and
- they provide a direct measure of inter-generational equity.

Table 3.1: Sustainability Criteria for Evaluation of Future Water Options

Criteria	Sector
Effect on aquatic ecology	Environment
Effect on terrestrial ecology	Environment
Greenhouse gas emissions	Environment
Intrinsic value	Environment
Risk to public health	Social
Heritage and cultural values	Social
Landscape and amenity values	Social
Recreational opportunities	Social
Cost and affordability	Economic
Reliability	Economic
Employment creation	Economic
Distribution of costs and benefits	Economic

An initial set of environmental, social and economic criteria for the sustainability assessment was developed in scoping workshops involving project team members, specialist consultants and representatives of government agencies. The draft criteria were refined after discussions with the ACT Office of Sustainability and the Sustainability Expert Reference Group. To add rigour, the refined list was evaluated by interested members of the community and community groups in four workshops held in November 2004. The Institute for Sustainable Futures then reviewed these criteria to include best practice examples from sources such as CSIRO and the Institute's own experience.

To ensure alignment with Government sustainability goals the project team refined the list to ensure it incorporated the criteria the community had ranked as most important and that they corresponded to policy documents such as '*People, Place, Prosperity*' and the ACT Water Strategy *'Think water, act water'.*

3.1.2 Assessment Procedure

The procedure adopted to assess the various options was as follows:

1. A summary of the key environmental, social and economic issues relating to the construction and operation of each of the options being assessed was prepared by the environment manager, planning manager and an independent third party, summarising the findings of the specialist consultants.

2. A sheet was then prepared, summarising the key issues for each of the options, and with a column for scoring the option in the sustainability assessment workshops. The effects, levels or attributes of the options, with respect to each criterion, were described quantitatively.

3. At the workshops, the criteria were discussed sequentially, with the key information being read first, then questions from the participants of the appropriate specialist manager and then discussion in the workshop;

4. Workshop participants then scored each option for each criterion in turn, using an eleven point scale: - 5 (worst) to 0 (no change) to + 5 (best).

5. After each of the three groups (environmental, social or economic) of four criteria had been scored, participants weighted the criteria (so that the sum of the weights for each group of criteria added to 30). The weighting was a judgment of 'how important each criteria was relative to the others'.

6. The average score and the average weighting for each criterion were then calculated.

7. The average scores were multiplied by the average weightings to derive the normalised average score for each group of criteria and the ranking of the options calculated for each group of criteria established the option with the highest normalised average score was ranked first, and so on; and

8. Calculating the normalised average score for all 12 criteria derived the overall rank of the options.

3.1.3 Results

The preferences and rankings developed in the sustainability workshops reflect the views of a small number of participants of generally informed people. The community has not been surveyed as a whole for the TBL assessment and it would, of course, be impossible to obtain a single answer that represents the views of "the community".

Nonetheless, the results of the sustainability assessment at the three workshops showed that there is a range of views as to the best option. No single option was favoured in all workshops although, overall, there was a slight preference for the Cotter option. The Tennent options ranked highly in one workshop and poorly in another. Similarly, the Tantangara options ranked highly in one workshop and poorly in others. This result reinforced the lack of any alternative being far superior to any other.

3.2 Risk Assessment

A qualitative risk assessment of the future water options has been conducted in accordance with the Australian/New Zealand Standard for Risk Management[28]. The risk assessment identifies risk sources associated with the implementation of the option alternatives, assesses the level of risk involved and establishes control measures to reduce the level of risk. This approach is similar to that used by ACTEW more generally in its business activities.

The methodology for risk assessment involves two stages. The first is to determine the 'inherent risk', or the risk that exists before control measures are applied. The second stage is to determine the 'residual risk', or that level of risk that still remains after control measures have been implemented. In both stages the level of risk has been calculated as the *likelihood* (in a numeric scale) of an event occurring multiplied by its *consequence* (also scaled numerically) to reach levels of extreme, very high, high, moderate or low risk.

It is very important to understand that the fact that something is described as being of 'extreme inherent risk' does not mean that the likelihood of it actually occurring is 'extremely high'. In fact the likelihood of it happening may be very low. This is particularly the case when examining risks associated with water supply management; it is often found that the consequences of an action (or in fact, inaction) can be severe or even catastrophic. For example, if an action was to

[28] Australian/New Zealand Standard 4360: 2004 (Risk Management).

build a dam, there is a risk that the dam could fail and the city be left without a water supply. The consequences of this action are catastrophic. In a risk management sense, this consequence is multiplied (numerically) with the likelihood. For this particular example, the likelihood of failure would be rare. The inherent risk, however, is high. Therefore, care needs to be taken when using risk terminology associated with the risk management of water supplies – and a thorough understanding is needed of the application of control measures and mitigation strategies to fully comprehend the notion of risk.

Each of the option alternatives has first been assessed assuming that the option is to be implemented on its own. All of the option alternatives were found to have very high or extreme risks when approached this way (mostly due to the significant consequences of the risk rather than the likelihood of occurrence). When some of the option alternatives were combined and assessed together a number of these very high and extreme risks were significantly reduced. For example, the Angle Crossing Option has a very high inherent risk that the reliability of supply expected, if this option were implemented on its own, would lead to an occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions. When combined and assessed with the Stromlo to Googong Reticulation Transfer Option this risk is reduced to a moderate level.

Based on the inherent risk level, the acceptability and required action for each risk source has been determined.

The following risk reduction methods (based upon the A/NZ Standard) have been applied for all risks.

- avoid the risk;
- reduce the likelihood of occurrence / probability.
- reduce the consequences;
- transfer to another party, normally better equipped to manage the risk; and
- retain and manage the risk.

4 Community Consultation

Over the duration of the *Future water options* project, many opportunities have been provided for the community to express values and views on the three options. The process has been extensively advertised in the electronic and print media, the website has been consistently updated and substantial opportunities for briefings have been provided. As a result of this, approximately 1500 to 2000 people have had direct contact with the project. Whilst this is a pleasing result, it must be viewed in the context that the outcomes from the project will affect nearly 350,000 people. Therefore, despite the best efforts of the process, the views expressed in this report can only be considered to represent a small percentage of the wider community.

The community consultation program included:

- 18 briefings of community and business groups;
- 15 ACT Government, Commonwealth agencies and advisory bodies were briefed, some on several occasions during the project;
- project website developed which was available from August 2004. The amount of website activity is summarised in Table 4.1;
- information sent to 450 community groups in September 2004; and advertisements in relevant media;
- sustainability workshops held in January and February 2005 with over 30 participants from community, Government and professionals;
- In November 2004, 66 people attended four Community Values Meetings held at the Olim's Hotel, Ainslie. The meetings were designed to explore stakeholder's interests and values within the context of the triple bottom line approach that had been developed to assess the options; and
- "Palette of Possibilities" Exhibition held over 4 days in Canberra and one day in both Queanbeyan and Cooma. Over 800 people attended the exhibition.

Table 4.1: Future Water Options website visits and views

Month	Visits	Views
August	205	1,281
September	436	2,447
October	354	2,234
November	385	2,559
December	334	2,828
January	409	3,496
February	852	7,134
March (up to 11/3/05)	225	1,751
TOTAL (project to date)	**3,200**	**23,720**

Visits = Number of visits to the Future Water Options web site home page
Views = number of pages viewed by all visitors

Table 4.2: "Palette of Possibilities" Exhibition Attendances

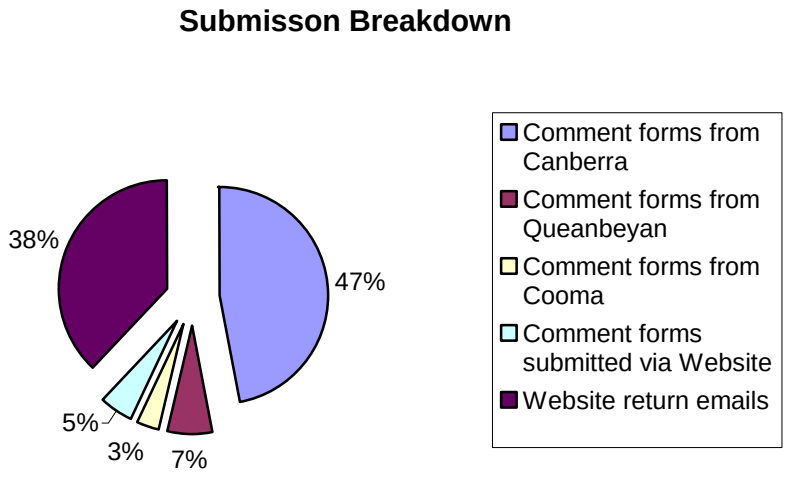
Location	Date	Visits
Canberra	Friday 18 Feb	140
Canberra	Saturday 19 Feb	160
Canberra	Sunday 20 Feb	182
Canberra	Monday 21 Feb	103
Canberra	Monday 21 Feb – technical session	60
Queanbeyan	Wednesday 23 Feb	123
Cooma	Friday 25 Feb	57
	Total	**825**

4.1 Outcomes from Consultation

Throughout the consultation program, ACTEW has found the community to be extremely well informed on issues associated with the need for a new water source, or eager to gain more information. An interesting trend at the Exhibition, for example, was the amount of time people would spend viewing the information or discussing issues with staff. Visits of up to 45 minutes were commonplace, with some people staying for well over an hour.

ACTEW received 255 written responses during the life of the project. The majority were received at the Exhibition, but nearly 100 written contacts were also made through the project website.

The following is a summary of issues that have arisen during the consultation process on various aspects of the project:



4.1.1 Tantangara Transfer

Comments on the Tantangara option from both ACT and NSW residents focussed on the reliance on NSW water, with ACT residents believing the ACT should be self-sufficient and NSW residents concerned that the ACT was taking "their water".

4.1.2 Tennent Dam

People who preferred the Tennent option saw value in introducing a new catchment to spread the risk to the ACT's water supply. There was also a view that these options have the most benefits economically, environmentally and in terms of recreation.

There was strong support for the large Tennent Option from those people wanting a large water source as soon as possible, with the capital cost irrelevant in the context of ample water. Some people saw benefit in a cautious or staged approach and therefore saw the small Tennent Option as providing the flexibility to expand to the large Tennent Option when and if required.

4.1.3 Virtual Tennent Dam

People were generally less informed about this option, therefore more time was spent explaining the concept and clarifying issues. Many people believed that the virtual Tennent option provided a good short-term supply option. There was concern, however, that it may delay the future dam and should be an interim step only. Concern was also expressed at the possible effect on the river, in particular to those downstream of the weir.

4.1.4 Enlarged Cotter Dam

The overwhelming response from those in favour of the Cotter Option was that it is an existing water catchment area, and an existing dam being expanded. There was a perception that this would mean an easier planning process leading to timely implementation.

4.1.5 Other Comments

As part of a community consultation program, four community meetings were held in November 2004 to help identify priorities in terms of future water options. In all four meetings, the most important issues perceived by those participating were:

- protection of public health;
- reliable future water supply; and
- effect of new storages on aquatic ecosystems.

The responses confirm that some Canberra residents place a high priority on a reliable water supply with a relatively low incidence of restrictions. However, the comments at the meetings indicated that some other residents are prepared to accept water restrictions during prolonged droughts. Both types of comments have been received from other feedback venues, including a public presentation in February 2005 and comments made directly to ACTEW's website and in the media.

Several suggestions were made that Canberra's population should be capped and/or increasing urban density as a way of conserving water. There were also varying attitudes regarding restrictions and general conservation measures. Some people are tired of restrictions; others suggested that water conservation measures such as grey-water recycling, rain tanks and creating water conserving gardens needed to be increased. Some argued for permanent restrictions.

A general trend throughout all the consultations was concern about the effect of water restrictions on the public domain. The diminution of Canberra as the "garden city", the effect on parks, street trees and the sports grounds, were all raised as major concerns.

4.2 Conclusions

The community consultation process was an attempt to gather as much community opinion and feedback as possible. The results have been constructive and helpful with a number of Canberrans and interested NSW residents engaging in debate about the best way to provide a reliable water supply for the ACT and region.

Views were, as expected, diverse, but the process has enabled ACTEW to test many of the ideas being considered. Community consultation has not provided a uniform view, nor was this the expectation, and further debate on the preferred option can be anticipated. It has however, ensured a transparent process informed by community views.

A full report entitled "Report on the Consultation Process Undertaken as part of the Future Water Options Project"[29] has been produced detailing the community consultation process.

[29] ACTEW (2005), *Consultation Report, A report on the consultation process undertaken as part of the Future Water Options Project*, April 2005.

5 Cotter River Options

5.1 Description of the Issues

The Cotter River catchment is approximately 48,200 hectares (or 482 km^2)[30]. It is bounded by the Tidbinbilla range in the east, the Brindabella range in the west, and enjoys a reliable rainfall due to this topography.[31] The upper Cotter catchment (above Corin Dam) is rugged and virtually unmodified by human activity. There is some localised soil erosion along tracks and firebreaks. Native fauna is abundant and recreation is limited by the need to protect water quality. The lower sections of the catchment, near Cotter Dam, previously contained large areas of pine forest; the remnants of this forest have been cleared since the bushfires of January 2003, and replanting to pines is planned for most of the area. The terrain is hilly with some steep slopes and these slopes will be planted with native vegetation. Sandy topsoils overlay thick clay subsoils, and there is some localised soil erosion from logged areas, tracks and firebreaks.

The three reservoirs on the Cotter River form part of the ACT's water supply. Corin is the uppermost reservoir with a capacity of 75 GL; downstream is Bendora, which has a capacity of 11 GL. Water flows by gravity from Bendora to the Stromlo water treatment plant. Further downstream is the Cotter reservoir, the smallest reservoir on the Cotter River with a capacity of 4.7 GL.

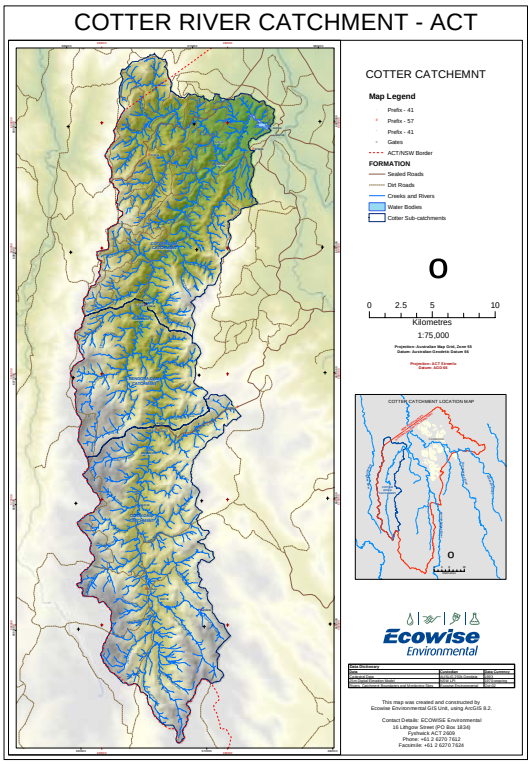


Figure 5.1: Cotter River Catchment

[30] All but 10 km^2 is within the ACT; the balance is in NSW.
[31] EJ Best (1969), *"Geological report on site investigation and construction of Corin Dam,"* Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, report 1969/111, p 2.

5.2 The Cotter Alternatives

The Cotter Option involves four alternatives:

- retain the existing Cotter Dam and construct a new Coree dam 7 km upstream of the Cotter Dam – storage volume 68 GL;
- use of existing Cotter Dam – storage volume 4.7 GL;
- construct a new Cotter dam – storage volume 45 GL;
- construct a new Cotter Dam – storage volume 78 GL.

A comprehensive assessment of the issues for the Cotter Option can be found in the Cotter Option Report[32]. The major issues are summarised below.

5.3 Environmental and Social Issues

Soils in the lower Cotter catchment, especially those that prior to the bushfires in January 2003 contained pine plantations, the Pierces Creek landscape in particular, are highly prone to erosion. The soil type is intrinsically fragile, and this has been exacerbated by disturbance in the catchment due to management activities, lack of post-bushfire recovery of vegetation and the impact of internal forest management roads. It is likely to take between five and ten years before the erosion risk of the pine forest land will be substantially reduced[33]. If the Cotter Dam enlargement option proceeds, priority would need to be given to reservoir and immediate catchment studies. An analysis of land management methods applied to pine plantations and the broader catchment, with particular reference to urban water supply catchment values would be required.

In terms of the aquatic environment, four species (three fish and one crayfish) have been declared as threatened and are potentially affected by Cotter Dam enlargement. Macquarie Perch and Trout Cod are listed as endangered at both ACT and national levels, whereas Two-spined Blackfish and Murray River Crayfish are listed as vulnerable in the ACT.

Enlargement of the Cotter Dam to 78 GL capacity, however, has been rated by Environment ACT as having a low impact on fish because it provides opportunities for active enhancement of threatened fish habitats and populations in the lower Cotter catchment. For example, a larger dam would inundate areas that are currently potential barriers to fish movement. An agreed suite of protocols would be needed to minimise potential impacts on threatened fish if an enlarged Cotter Dam were constructed.

The key water quality characteristics relative to drinking water are turbidity, colour, iron, manganese, pH or acidity, algae, chlorophyll-a, and coliforms. As water temperatures increase in the Cotter reservoir each spring and summer, the reservoir becomes stratified with colder (and denser) water at the bottom, and warmer (and less dense) water at the top. Sediment microorganisms decrease dissolved oxygen concentrations and release dissolved nutrients (such as nitrogen and phosphorus) and metals (such as iron and manganese) into the water column. Around April–May, surface waters cool down quickly and the reservoir experiences an

[32] ACTEW (2005), *Cotter Option Report*, April 2005.
[33] ACT Government (2003), *Shaping our Territory. Final Report: Opportunities for Non-Urban ACT,* November 2003.

overturn, with the now cooler, heavier surface water sinking to the bottom. This distributes the previously released material throughout the reservoir.

The new Stromlo water treatment plant will be able to handle projected levels of nutrients and metals in the reservoir water assuming good catchment management practices are applied and that reservoir destratification is used during the warmer months. Nevertheless, the more that catchment management practices prevent sediment being discharged into the reservoir, the less treatment will be required.

The release of iron and manganese during summer stratification, and the mixing of these metals throughout the reservoir during the autumn turnover, is a normal water reservoir phenomenon, although it may be more pronounced in the Cotter due to sediment discharge and turbidity. Total iron and manganese releases by sediments in an enlarged Cotter Dam may make it cost effective to de-stratify the reservoir by mechanical means. This would reduce iron and manganese levels, and may be less costly than additional treatment at the Stromlo facility. Additional assessment of destratification is warranted.

The Cotter precinct is a well-established recreation area in the ACT, especially for families. A range of enhancements has been proposed in the *Shaping Our Territory*[34] report and several follow up studies[35]. The concern is that recreational uses within the catchment itself may conflict with the primary function of the catchment, which is the provision of safe, high quality drinking water. According to the chief executive of the CRC for Water Treatment and Quality, *it is more important to maximise the reduction in public health risk than to approve recreational access, even if such access results in treated water that can meet existing drinking water guidelines.*[36]

Accordingly, before the construction of a new Cotter Dam proceeds, these issues and potential conflicts will need to be resolved and an agreed position established. The opportunity to incorporate some recreation design features into a new dam should be considered within the context of providing high quality drinking water.

There does not appear to be any major Aboriginal cultural heritage constraints to Cotter Dam enlargement, with only a low to medium probability of containing additional culturally significant Aboriginal sites within areas affected by dam construction and inundation of the reservoir.

In terms of non-Aboriginal heritage, the existing Cotter Dam appears on the Register of the National Estate and a further five sites (a disused mine site, the Cotter Pumping Station, the upper Cotter catchment, the Murrumbidgee corridor and the Murrumbidgee River itself) would be indirectly affected by Cotter Dam enlargement.

5.4 Costs of the Option and Alternatives

Cost estimates for the enlarged Cotter reservoir to 45 GL would be $98 million for the dam, $3.5 million for land clearing/site preparation, $1.5 million for pipelines and $14.9 million for the pump station and $0.8 million for other infrastructure.

Cost estimates for the enlarged Cotter reservoir to 78 GL are $120 million. Catchment remediation will be in addition to these costs.

[34] *ibid*.
[35] ACT Government (2004), *Shaping Our Territory. Revitalising the Cotter: Action to date and future opportunities*, September 2004.
[36] Don Bursill (2005), Peer Review of "Technical Advice on ACT Reservoir Recreational Water Use Options, January 2005.

5.5 Cotter alternatives that are not preferred for future supply

5.5.1 Coree Dam

The Coree Dam alternative was included in the event that engineering and geological studies detected a fatal flaw, preventing enlargement of the Cotter Dam. Analysis concluded "*the assessment did not identify any fatal flaws associated with the (Cotter) site* [37]". Accordingly, the Coree Dam option has not been considered further.

5.5.2 Cotter Dam 4.7 GL

At the time of initiating these studies the Cotter Reservoir was not a part of the ACT's water supply system. It has now been brought back into service as the upgrading of Stromlo water treatment plant enables treatment of the poorer quality water from the Cotter Reservoir. This adds up to an additional 50 ML/day to the water supply system. Cotter is now a permanent component of the ACT's water supply system and ways of using this supply more effectively have now been examined. In particular, Cotter now forms a part of the Stromlo To Googong Reticulation Transfer Option.

5.5.3 Cotter Dam 45 GL

The 45 GL dam rated poorly on a cost per amount of water stored basis, and from a native fish perspective when compared to the larger option.

The Cotter alternative remaining for consideration is to enlarge the dam to a capacity of 78 GL.

5.6 Preferred Cotter Alternative

5.6.1 Cotter Dam 78GL

The proposed Cotter Dam enlargement will provide a storage volume of 78 GL (). The dam will have a crest level approximately 50 m higher than the existing dam and 76 m above the riverbed level. The dam will be of roller compacted concrete construction and located within the gorge about 125 m downstream of the existing dam. A multi-level intake tower with separate inlets for water supply and environmental releases will be located on the upstream face of the dam. Associated works include: foundation treatment, spillway and energy dissipater, diversion works for the river during construction, and outlet works (for water supply, environmental flow releases and to enable the reservoir to be emptied for safety or inspection reasons).

Two saddle dams would also be required to hold back water in lower saddles of the reservoir catchment. These will be approximately 16 m and 11 m high and constructed of zoned earth and rockfill, or zoned earthfill embankments.

[37] GHD (2005), *Cotter, Tennent and Coree Options (Engineering) Report*, April 2005.

Figure 5.2: Proposed Cotter Dam

The existing 750 mm and 600 mm diameter water mains from the Cotter Dam to the Cotter Pump Station will be utilised. These have adequate hydraulic capacity to carry the maximum supply of 180 ML/day except at very low reservoir storage levels. A new 750 mm diameter pipeline crossing of the Murrumbidgee River will be required to replace the existing twin 450 mm diameter mains located in a tunnel under the Murrumbidgee River. A new pump station will be sited adjacent to, and south of, the existing pump station. Architectural treatment to the façade of the pump station will be required to match the existing heritage listed building. The pump station will have a capacity of 180 ML/day and will connect to the existing 600 mm and 900 mm diameter pipelines that run from the existing Cotter Pump Station to the Stromlo water treatment plant.

The new dam would enable hydropower generation, with up to 1950 kW being generated, or 17 million kWh per year, assuming a daily environmental water release of 300 ML. The cost would be about $1.2 million, plus $0.2 million for transmission and sub-station costs.[38] The benefits are the generation of $1.4 million of electricity each year assuming an average rate of 8 cents per kWh.

5.7 Issues to be addressed if Cotter option favoured

The following issues need to be addressed more fully if the Cotter Option is adopted.

1. Catchment Management
2. Fish Management Plan
3. Water Quality Issues
4. Destratification of the Reservoir
5. Recreation Uses
6. Existing Cotter Dam Heritage Plan

[38] *ibid*.

5.8 Risk Assessment

A qualitative risk assessment of the preferred Cotter alternative identified potential risk sources should that alternative be implemented on its own. Section 3.2 of this report outlined the risk level categories used in the assessment and the actions that would be required to control the risk situation. Those risk sources that pose the greatest level of risk for the Cotter Option are listed below and outlined in the risk assessment report[39].

The major inherent risk sources, should the Cotter Option be implemented on its own, are:

- very high inherent risk that the reliability of supply expected, if this option were implemented on its own, would lead to an occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions;
- very high inherent risk that the condition of the catchment after the January 2003 bushfires will contribute to high turbidity and poor water quality;
- very high inherent risk of poor ongoing catchment management practices impacting on water quality; and
- very high inherent risk associated with management of the recreational use of the Cotter catchment.
- very high inherent risk that delays during the approval process could lead to several more years with occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions.

5.8.1 Control Measures

The inherent risk that the reliability of supply provided by the Cotter Option would lead to an unacceptable amount of time in stage 3 restrictions or worse, can only be mitigated by implementing the Cotter Option combined with other intermediate supply options. When the Cotter Option was combined and assessed with the Stromlo to Googong Reticulation Transfer Option and the Virtual Tennent Option this risk is reduced to a moderate level.

Reducing the other major inherent risks will require control measures that include, planning and implementation of improved catchment management practices and the development of a recreation management plan.

[39] URS (2005), *Future Water Options Risk Assessment*, April 2005.

6 Tennent Options

6.1 Description of the Issues

The Tennent Dam catchment comprises a total area of approximately 70,647ha (706 km^2), the bulk of which is used for national park conservation related purposes. Just over one quarter of the area is devoted to agriculture and a small area is devoted to forestry (this is subject to review as the Ingledene Forest was destroyed in the January 2003 bushfires). Another area of former pine plantations, Boboyan, has been converted back to native vegetation and national park uses.

The Tennent catchment extends from just south of Tharwa and forms the ACT's southern boundary with New South Wales. It is completely contained within the ACT(See Figure 6.1).

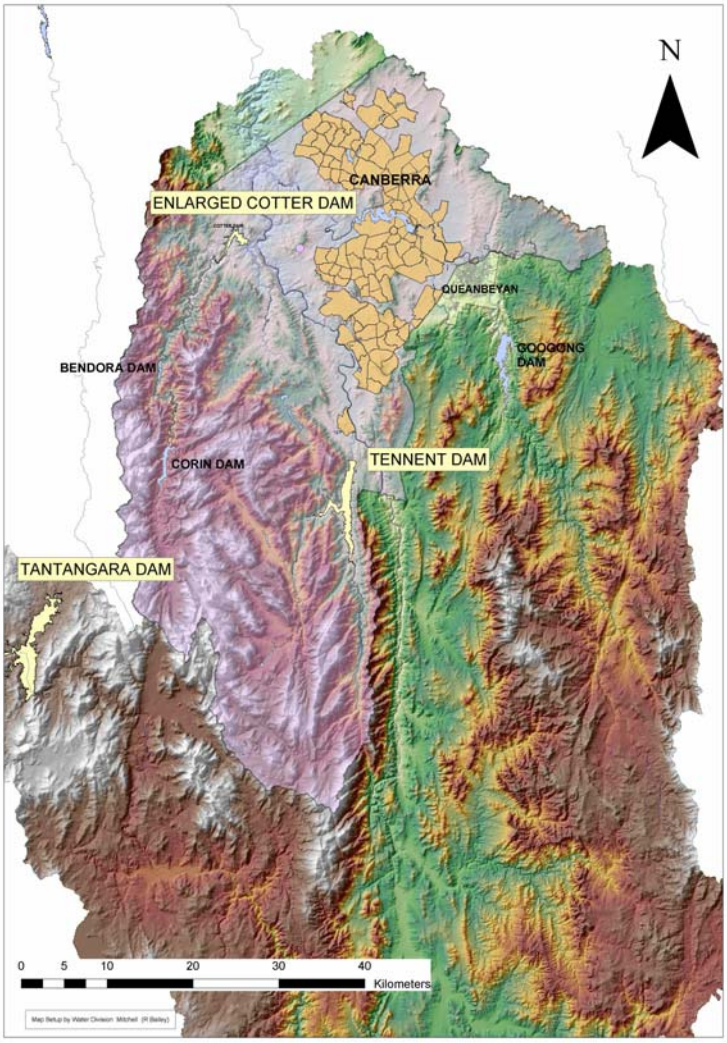


Figure 6.1: Tennent Dam Site and Gudgenby River Catchment

The Naas and Gudgenby rivers flow predominantly through the forests of the Namadgi National Park. The catchment is mountainous and the water quality is high. River flats and swamps occur along the major streams. Diverse aquatic communities and natural riverbank vegetation mean that the rivers in Namadgi are of high ecological value. Soils on the steeper slopes in Namadgi tend to be shallow and stony. Sandy topsoil and clay subsoil is typical on the lower slopes while deep alluvium is found on the flats.

The rural part of the catchment is undulating to hilly with a mixture of improved and native pasture and scattered trees. Topsoils are sandy and subsoils are thick clay. Land management practices have resulted in some erosion.

Climate and terrain are significantly different in the Naas-Gudgenby catchment to that in the Cotter. Elevation ranges from 600 to 1,780m. Undulating terrain and gently sloping valleys occur in the lower parts of the catchment. Rainfall ranges from 550 to 960 millimetres (mm) with higher elevations having higher rainfall.

Historically, this area has been utilised for grazing with most intense grazing activity in the lower reaches of the catchment, the Orroral valley, Gudgenby station, and along Naas Creek. The more rugged terrain has been used for light grazing on an intermittent basis until the dedication of the park. It has been progressively withdrawn since then, with the last stock exiting in 1989. No mining activity has been documented within the catchment.

Satellite tracking stations at Honeysuckle Creek and Orroral Valley have been closed and their infrastructure mostly removed. Their functions have been consolidated with the Tidbinbilla Tracking Station within the Cotter Catchment.

6.2 Description of the Alternatives

The Gudgenby-Naas catchment has long been identified as a potential future water supply for Canberra[40]. Four alternatives (dams storage capacities of 43, 76 and 159 GL and a virtual dam) have been considered, three involve the construction of a dam on the Gudgenby River (Figure 6.2) and the virtual dam involves construction of a weir on the Murrumbidgee River.

[40] National Capital Authority (2002), *Consolidated National Capital Plan*, February 2002.

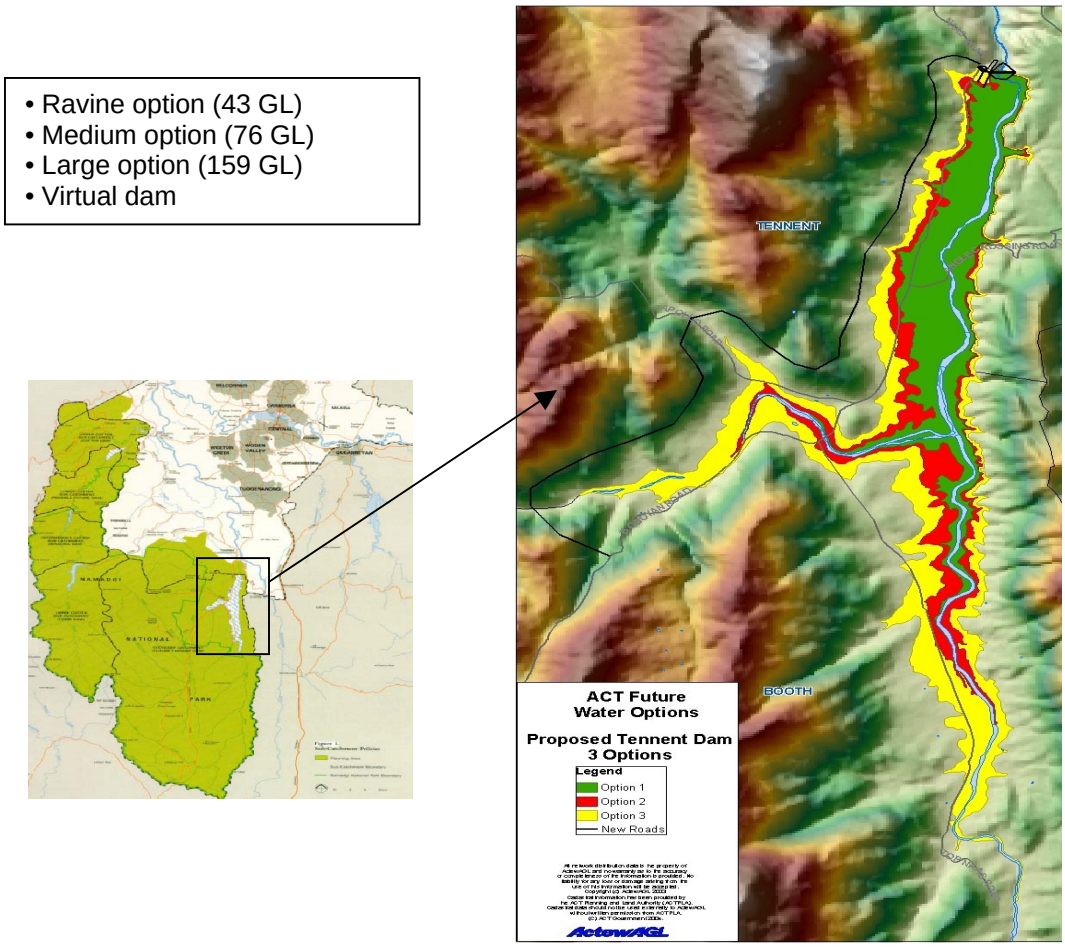


Figure 6.2: Alternatives for the Tennent Dam

Water from a new Tennent Dam would require treatment prior to delivery to Canberra households. This could be either via the Stromlo water treatment plant or a new plant that would be constructed near the dam site. The first option would involve construction of a pipeline from Tennent to the Stromlo water treatment plant, the second would require a pipeline to a location in Tuggeranong where it would be connected into the existing water supply system. The pipeline locations are shown on Figure 6.3.

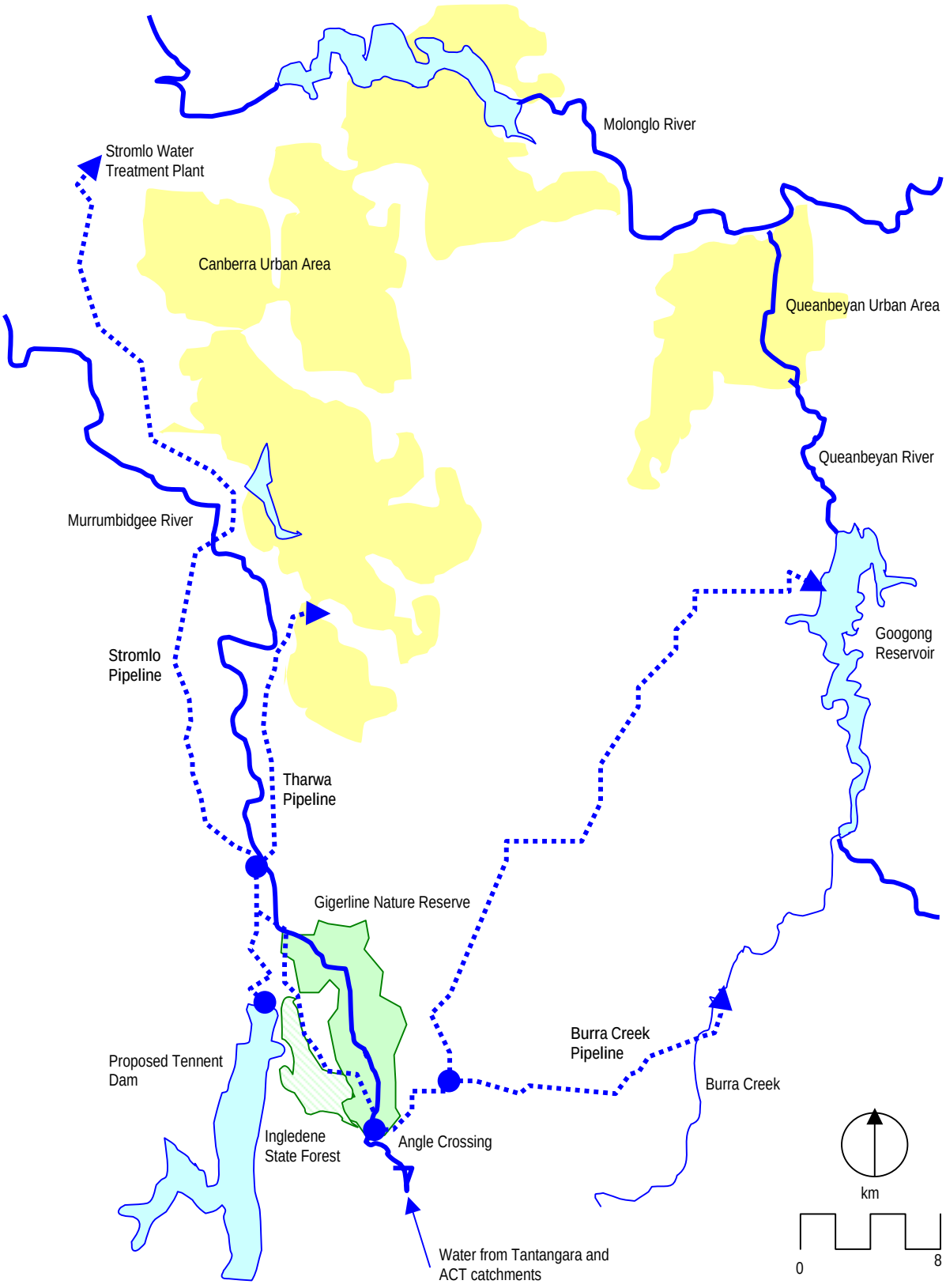


Figure 6.3: Pipeline routes

6.3 Environmental and Social Issues

6.3.1 Environmental

Implementation of any of the alternatives would require a detailed assessment of the environmental impacts of the proposal; this would be completed following the selection of a preferred option and the development of firm design concept plans. Work completed to date has been aimed at determining whether or not the natural environment issues associated with any of the options were of such significance that the option should be discarded without further investigation[41]. The conclusion has been that there are no insurmountable issues related to the natural environment for any of the alternatives. Key findings related specifically to the dam alternatives are as follows:

- sedimentation and scour patterns in the river will inevitably change; the degree of change and the resultant impact can be successfully managed;
- requirement for provision of fish passage is considered unlikely;
- construction impact on downstream environments will require careful management;
- damming of an unregulated river;
- dams should include measures to mitigate the downstream effects on the aquatic biota, such as installing a multi-level off-take to prevent cold water pollution;
- all three dam alternatives will result in the inundation of a large area of Yellow Box Red Gum Grassy Woodland that is an endangered ecological community; some areas of woodland not inundated will be fragmented. The affected areas include 235 ha of partially modified Box/Gum Grassy Woodland and 199 ha of moderately modified Woodland;
- between 2.07 and 2.85 ha of roadside vegetation (Naas and Angle Crossing Roads) comprising mostly secondary grassland will also be removed; and
- a number of non-endangered vegetation types will also be removed, including about 4.29 ha of Callitris woodland along steep valley walls at the proposed dam wall construction site.

The point has been made that the Tennent Dam would be the first dam on a currently unregulated river system. The value of such a system is perceived to be significant by some. The environmental investigations discussed in this report have shown that the impact on the river system is in fact minimal. It is noted that the dam location is near the lower end of the Naas Gudgenby catchment and that the length of river to be inundated has already been substantially impacted by agriculture.

The loss of woodland is the most significant of the above impacts and the only one that, if not resolved, may compromise a decision to proceed with a dam. Substantial tracts of land in the Naas and Gudgenby valleys above the inundation area that are classified as Yellow Box Red Gum Grassy Woodland under Action Plan 27 are currently within rural leases. These would be returned to public ownership and it is most likely that the Namadgi National Park boundaries would be extended to encompass this land. Advice from Environment ACT has indicated that

[41] Biosis Research (2005), *Terrestrial Flora and Fauna and Vegetation Study*, April 2005.
Navin Officer Heritage Consultants (2005), *Cultural Heritage Assessment*, January 2005.
Water Research Centre, University of Canberra (2004), *Aquatic Ecology Study*, December 2004.
Environment ACT (2005), *Fish Impact Study*, April 2005.

this would be consistent with the ACT Lowland Woodland Conservation Strategy[42] adopted by the ACT Government in April 2004. This would allow the woodland to recover to a more natural state and may be considered to outweigh the impact of inundating the areas of woodland in the lower catchment.

The impacts of the various Murrumbidgee River weir options are as follows:

- potential transfer of alien fish species (Oriental Weatherloach and Carp) from Murrumbidgee River to Googong Reservoir (Moderate impact; and
- there will be a requirement for provision of fish passage (Minor impact).

Detailed assessments of flora and fauna issues associated with potential weir sites and pipeline alignments have not been conducted at this stage. Whilst the possibility does exist, it is nevertheless considered to be unlikely, that such work when undertaken will preclude the Virtual Tennent option.

6.3.2 Social

Archaeological consultants who have prepared a report on the heritage aspects of the future water options have examined the area that would be inundated by the proposed Tennent Dam[43]. They have found that the inundation area and construction site will not directly impact recorded Aboriginal sites for the Tennent Dam. Sixteen recorded sites may be impacted in the vicinity of the inundation and construction site areas due to the creation of roads and ancillary works.

It will be necessary to conduct a more comprehensive survey of the entire affected area prior to a decision to proceed with a dam. The consultants predict that *"the most likely site types to be found in the Tennent study area are small, low density artefact scatters, isolated finds, stone arrangements and possibly art sites…… it is considered a medium to high probability that these types of sites will be located in the area".*

Some of the pipeline alternatives for both the dam (to Stromlo and to Tuggeranong) and the virtual dam alternatives (Tharwa to Googong Reservoir) were also examined and in each case a number of sites were identified. Again, it is considered that none would be of sufficient significance to preclude any of the proposed pipelines. The consultants did not examine the Angle Crossing to Burra Creek alignment but again, whilst a detailed survey would be required it is unlikely that any sites would be discovered that would preclude construction of this alternative.

Aboriginal groups that were consulted noted that the Tennent Dam Option is likely to have a high impact on Aboriginal archaeological sites and their cultural values, and is therefore not a preferred option. ACT Aboriginal groups noted that consultation with them must be an integral component of all further stages of assessment of the options.

Block 92 Tennent is a former Travelling Stock Reserve and has been included in a Native Title Claim.[44] ACT Government policy would probably require that the claimants be consulted and advised if the Tennent Option was to proceed.

There are 34 recorded non-Aboriginal sites, generally of minor significance, that will be directly impacted by a Tennent Dam. It is also possible that a further 66 recorded sites in the vicinity

[42] Environment ACT (2004), *Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy*, March 2004.
[43] Navin Officer Heritage Consultants (2004), *Cultural Heritage Assessment*, January 2005.
[44] KMR Consulting (2004), *Land Ownership Study*, December 2004.

may be impacted during construction. None of the recorded sites are listed on the ACT Heritage Register and their presence would not preclude the construction of a dam.

Any recreation in the vicinity of a new dam would need to be consistent with the protection of water quality and quantity.

Following the January 2003 bushfires a Recreation Strategy[45] for the Natural Areas of the ACT has been prepared and released by the Act Government as an Interim document.

The interim strategy highlights places that relate to the Tennent option and are important for recreation. These include:

- the Orroral Valley, a significant access point for day and overnight visitors to Namadgi;
- the Boboyan (and Naas/Gudgenby) Valley and the Boboyan Road, the main thoroughfare through the park;
- upper Naas - Mount Clear – with a particular focus on horse riding and the proposed redevelopment/relocation of the bicentennial national trail;
- Tharwa and the Tharwa precinct is an important location for tourists and the local community offering art, craft and café opportunities; and
- Angle Crossing recreation area.

The proximity of Tennent Dam to Namadgi National Park is likely to enhance the attractiveness of both. In 2001/02 Namadgi accommodated a total of 154,452 visitors[46], with the added attraction of a major water feature in the vicinity this number would be expected to increase. A reservoir would have a dramatic effect on the appearance of the landscape. The current view from the Naas/Boboyan road over cleared farmland would be replaced by a view over a body of water. The 'framing' of the water body by the high ridgelines on either side would enhance the aesthetic appeal.

The Tennent supply would provide Canberra with a third major water source and would add to the security of the water supply. The water quality outcomes likely to be achieved at all of the Tennent alternatives have been found[47] to be well within the range that is able to be utilised for human consumption, with appropriate treatment.

The residents of the Naas and Gudgenby valleys would be seriously affected if a decision were made to proceed with a Tennent dam. If a dam proceeds, then residential and agricultural activity would be precluded from the catchment. Consultation with the existing rural lessees as the planning and analysis process proceeds would need to be given a high priority to ensure that they are fully informed as work progresses.

A key issue for the Tennent Dam proposal is the impact of the ongoing uncertainty and, if it is built, the dam itself, on the valley residents. Financial impacts would be avoided by the compensation mechanisms that are built into the lease arrangements for the rural properties, and the Lands Acquisition Act 1994. Some psychological impacts would be unavoidable. The

[45] Janet Mackay, Planning for People (2004), *Interim Recreation Strategy for the Natural Areas of the ACT*, Prepared for Environment ACT, April 2004.
[46] *ibid*.
[47] ActewAGL (2005), *Tennent Option Water Quality Report*, April 2005.

proposal affects 14 rural holdings[48] and would require the relocation of 11 families that in some cases occupy two or three households.

Of the total 8347ha of land currently occupied under long or short term lease or agistment arrangements about 1400ha is located on the valley floors and is reasonably level and cleared; this would be regarded as viable and in parts good quality agricultural land. Some of the leases that would be subject to acquisition are either short term or include clauses ("land withdrawal clauses") providing for the withdrawal of the lease, in the event the land be required by the Government (e.g. for a dam). Some of the leases are for longer terms (25 years), do not have withdrawal clauses and have renewal rights under section 171(A) of the Land Act.

In the event that a decision is made to continue to reserve the site for a dam but to not proceed with construction in the short term then a scenario whereby the current short-term leases are re-issued for as long a term as possible, say 30 or 50 years, but without automatic renewal rights, could be considered. This system provides for sufficient security of tenure for the lessees to commit financial and other resources to sound land management and agricultural practices, maximizing the potential of the land, whilst at the same time reserving the land for a future dam when and if the need eventuates.

6.4 Cost of the Option and Alternatives

Costs for the three alternative Tennent Dam sizes vary with the size of the dam and are dependent on whether the water is piped to the Stromlo water treatment plant or treated at Tennent and piped to the mains supply system in Tuggeranong. Assuming that treatment is at Tennent costs for the three dam sizes are estimated to be as follows, exclusive of operating costs:

- small 43 GL $185 million
- medium 76 GL $204 million
- large 159 GL $250 million

A decision to pipe the water to Stromlo water treatment plant would result in a saving of $12 million for each of the above alternatives.

The preferred Virtual Dam alternative involving a weir near Angle Crossing with water being pumped to Burra Creek and thence to Googong Dam has been costed at $35 to $40 million, exclusive of operating costs.

6.5 Tennent alternatives considered

Two possible weir sites, other than at or near Angle Crossing, have been assessed:

- a pump station and weir at the Cotter; and
- a weir and pump station at Tharwa, 400m upstream from the Tharwa Bridge.

A weir site approximately 150 metres upstream from the main Cotter pump station has been identified and assessed as being suitable. Gudgenby – Naas water could be collected here for supply to consumers directly via the Stromlo water treatment plant. It is considered preferable that water for human use is, ideally, subject to a period (at least several days) of "detention time" in a reservoir to allow pathogens to die off before treatment. Consequently direct pumping

[48] KMR Consulting (2004), *Land Ownership Study*, December 2004.

from the river to the treatment plant is not a preferred option for long term supply. The Stromlo to Googong Reticulation Transfer option picks up some of the advantages of this alternative.

The Tharwa weir site is likely to have sediment problems. There could also be an issue with the Tharwa Bridge as the weir may stop sediments from reaching the bridge that needs a sediment supply to maintain the integrity of its footings [49]. In addition there would also be a cost penalty with the Tharwa alternative[50] due to increased pipeline length and pumping costs. The Tharwa site has therefore not been considered further.

Intermediate sizes of Tennent Dam could be contemplated. The hydrological modelling has been undertaken on a 76 GL dam but it could be expected that the performance of this dam would be somewhere in between the small and large size dams. The environmental and social impacts are similar, and similarly the cost would be about midway between the small and large dams. A more detailed sizing and costing evaluation would be undertaken as part of the detailed design phase if a dam option were to proceed.

6.6 Preferred Tennent Alternatives

Costs for the reservoir (including catchment clearing, road relocation and other such costs) range from $185 million to $250 million depending on dam size, water treatment plant location and pipeline choices. The larger dam is more economical on a cost for water gained. The social and environmental impact of the three options would not differ significantly. Agricultural activity and permanent human habitation of the valleys would not be permitted under any option due to water quality impacts. The most substantial environmental impact will be due to the inundation of areas of yellow box red gum grassy woodland and the damming of a currently unregulated river. The degree of inundation and or fragmentation of these communities will be high under all options. Existing infrastructure including roads and powerlines in the Naas and Gudgenby valleys will require relocation if a reservoir is constructed. Costs for relocation of this infrastructure range from $25 million to $35 million depending on the reservoir size.

Selection of a preferred Tennent Dam option would depend on how the new dam would integrate with supplies from other water sources. In the event that a decision was taken to construct a new Tennent Dam with no other supplements to the water supply system then the largest dam would be needed for a reliable supply[51]. While this is a costly option, a combination of water supply alternatives would deliver an adequate supply at less cost[52]. The hydrology analysis has indicated that, in combination with other new infrastructure such as a virtual dam, the small Tennent dam performs adequately.

6.7 Risk Assessment

A qualitative risk assessment of the preferred Tennent alternatives identified potential inherent risk sources should those alternatives be implemented on their own. Section 3.2 of this report outlined the risk level categories used in the assessment. Those risk sources that pose the

[49] Future Water Options Project, Review of Constraints - Aquatic Ecology and Fish Issues, Minutes of Meeting on, 1 December 2004.
[50] GHD (2005), *Cotter, Tennent and Coree Options (Engineering) Report*, April 2005.
[51] ActewAGL (2005), ACT Future Water Options Water Resources Modelling report – Volume 1, April 2005.
[52] Centre for International Economics (2005), Economic benefit-cost analysis of new water supply options, April 2005.

greatest level of inherent risk for the Tennent options are listed below and outlined in the risk assessment report[53].

The major inherent risk sources, should the Tennent alternatives be implemented on their own, are:

Small Tennent Option:

- very high inherent risk that the reliability of supply expected, if this option were implemented on its own, would lead to an occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions;
- very high inherent risk that a road through the catchment may impact water quality;
- very high inherent risk that recreational use of the reservoir foreshore could impact water quality; and
- very high inherent risk that delays during the approval process could lead to several more years with occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions.

Large Tennent Option:

- extreme inherent risk of over capitalisation and subsequent redundancy;
- very high inherent risk that a road through the catchment may impact water quality;
- very high inherent risk that recreational use of the reservoir foreshore could impact water quality; and
- very high inherent that delays during the approval process could lead to several more years with occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions.

Virtual Tennent Option (Angle Crossing Option):

- very high inherent risk that the reliability of supply expected, if this option were implemented on its own, would lead to an occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions. Of course, it needs to be understood that this option would only be implemented in conjunction with the Stromlo to Googong Reticulation Transfer option.

6.7.1 Control Measures

The inherent risk that the reliability of supply provided by the Small Tennent and Angle Crossing Options would lead to an unacceptable amount of time in stage 3 restrictions or worse, can only be mitigated by implementing these options when combined with other supply options. When the Angle Crossing Option (formally known as the Virtual Tennent Option) is combined and assessed with the Stromlo to Googong Reticulation Transfer Option this inherent risk is reduced to a moderate level.

[53] URS (2005), *Future Water Options Risk Assessment*, April 2005.

Reducing the other major inherent risks will require control measures that include, planning and implementation of improved catchment management practices and the development of a recreation management plan.

7 Tantangara Transfer Options

7.1 Description of the Issues

Tantangara Dam lies on the Murrumbidgee River about 6 km downstream of the Gurrangorambla Creek confluence in Kosciuszko National Park. Part of the Snowy Mountain Scheme, Tantangara Dam impounds Murrumbidgee headwaters for diversion to Eucumbene Dam. Tantangara operates as an annual storage - the reservoir fills and empties in a one-year cycle. This maximises the volume of water diverted to Eucumbene but leaves the reservoir only filled to around 30 per cent of its potential volume.

NSW and Australian Government agreements will mandate Tantangara Dam environmental flows to improve river health by June 2005. Current outlet upgrades to meet the new flow requirements will also allow water extraction from the surface and other water levels to reduce downstream impacts.

The Tantangara transfer option involves the purchase and transfer of water from NSW via Tantangara Dam into the ACT. The Tantangara water transfer option involves five main actions (Figure 7.1).

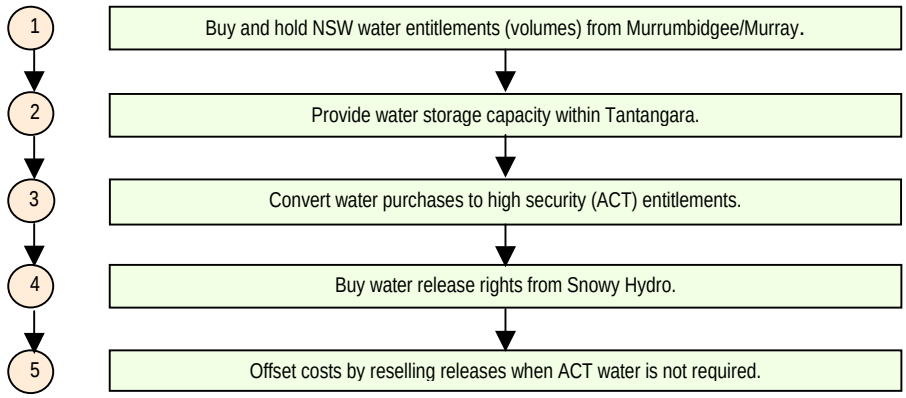


Figure 7.1: Tantangara Water Transfer Arrangements.

7.2 Description of the Alternatives

Initially, four Tantangara transfer options (Figure 7.2) at flow capacities of 60 ML/d, 180 ML/d and 360ML/d were considered. The most likely flow capacity of 180ML/d was applied to the following alternatives plus a proposed Murrumbidgee pumping transfer to Googong Dam:

- *Alternative A* - water pumped from directly below Tantangara through two pumping stations and 30km of pipeline across the Bimberi Range at Murrays Gap to discharge into the Cotter River upstream of Corin Reservoir.
- *Alternative B* - water flows from a reconstructed Tantangara Dam outlet 10 km down the Murrumbidgee to a diversion weir with a tunnelled discharge into Porcupine Creek that in turn flows into the Upper Cotter River.
- *Alternative C* - water flows 17kms down the Murrumbidgee to a diversion weir at the Yaouk Valley for pumping up the valley to a tunnel and then into Porcupine Creek.

- *Alternative D* – water flows through a 17km pipeline along the Murrumbidgee River corridor to allow gravity flow from Tantangara to Porcupine Creek (within the same Yaouk Valley pipeline route as alternative C).

- *Alternative E* – transfer along Murrumbidgee River then via a small weir, pump and pipeline to transfer water for storage in Googong Dam.

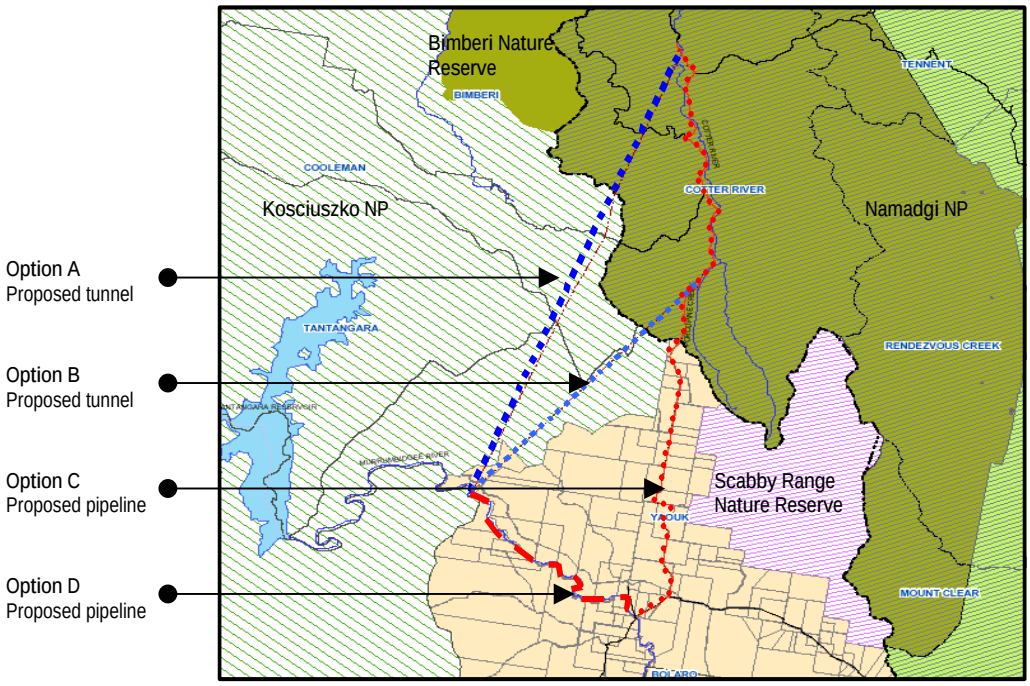


Figure 7.2: Preliminary Short-Listed Tantangara Transfer Options

The Tantangara Option has some distinct advantages and disadvantages compared to the Cotter and Tennant Dam options. Advantages include:

- comparative water supply reliability through seasonal snowmelt;
- diversified water source risks by sourcing outside existing ACT catchments;
- high water quality through snowmelt and national park catchments;
- low costs in that a new dam is not required;
- low environmental costs (compared with dam construction);
- potential shift of Murray-Darling Basin water from low value to high value use;
- opportunity to cooperate with NSW in regional water supply; and
- potential environmental flow benefits.

Disadvantages include:

- the need to purchase NSW water rights as opposed to harvesting ACT water;
- participation in complex and immature water market;

- complex negotiations with NSW and Snowy Hydro;
- reliance on NSW in the absence of an ACT Murray Darling Basin water Cap;
- complex approvals process across multiple jurisdictions;
- environmental concerns related to development and operations; and
- vulnerability to terrorist or other catastrophic disruption.

7.3 Environmental and Social Issues

A comprehensive assessment of the issues can be found in the Tantangara Option report[54]. The major issues are summarised below.

The release of water from Tantangara Dam down the Murrumbidgee River (both for the ACT's water consumption and enhanced environmental flows) could significantly improve the river's health. Enhanced water quality and ecological diversity is likely to have important benefits well downstream of the ACT. All of the Tantangara pipeline, tunnel and river flow alternatives would produce benefits proportional to their respective flow lengths, environmental characteristics and duration. The Murrumbidgee River flow alternative with its 100km downstream flow mimicking natural events would have benefits beyond the shorter pipeline and tunnel variations.

Transferring this water into Googong reservoir could also result in more frequent spilling from the reservoir and provide additional environmental flows benefiting Queanbeyan, Lake Burley Griffin and the Molonglo River health, amenity, and recreation opportunities.

These advantages are counterbalanced by environmental risks associated with:

- site works and pipeline construction; and
- transferring water, species and other materials between catchments.

Epizootic Haematopoietic Necrosis Virus (EHNV) is fish virus that has never been recorded in the Cotter catchment but outbreaks have occurred in Googong and Canberra's lakes resulting in significant fish kills. Although not detected in the Upper Murrumbidgee and Tantangara, there is a possibility that the virus is within or will be transferred to these waters via recreational fishing. Under these circumstances the risks to native fish populations in the Cotter far outweigh the risks in Googong.

Tantangara alternatives discharging water via Porcupine Creek and the Upper Cotter River would significantly alter stream geomorphology, sediment movement, water quality, hydrological disturbance, and habitat condition. Pipelines traversing national park and freehold areas would have a significant impact on:

- threatened species;
- sensitive habitats including grasslands, alpine bogs and wetlands;
- heritage values; and
- conservation values that extend through wilderness areas.

Consequently, all the pipeline alternatives and the tunnel flowing into the Cotter catchment headwaters are highly constrained. The long tunnel, discharging three km upstream of Corin

[54] ACTEW (2005), *Tantangara Option Report*, April 2005.

Dam, is the most benign alternative because it has the least impact on existing stream flows, habitat, heritage and conservation values.

The long tunnel option also has potential benefits for Murrumbidgee River health but only for the 16km reach between the dam and proposed tunnel. Conversely, the tunnel has comparatively greater environmental risks including high conservation values in the Upper Cotter, high quality receiving waters in Corin Dam and potential site impacts related to tunnel, associated facilities, and access construction. Most of these impacts could be managed with mitigation measures but the comparative risks once again favoured the Murrumbidgee river flow alternative.

The Tantangara Option alternatives are compromised by their current inability to source ACT-controlled water. Ultimately, the ACT cannot secure a future water supply through Tantangara unless it participates in the Murray Darling Basin Cap. There is also a possibility that competing high security users may have to ration water in extreme drought conditions. For these reasons the option should be considered less desirable than its Cotter and Tennant Dam counterparts in the short to medium term. Comparative risks favour the Murrumbidgee river flow option largely because of its lower cost and water source flexibility (both ACT and NSW).

All the Tantangara alternatives are relatively inexpensive and non-intrusive because of their significant and flexible use of existing infrastructure. A resolution of the “Cap” coupled with additional security provided through ACT water sources in the Murrumbidgee River flow (or Tennant “Virtual Dam”) alternative could render it as one of the more sustainable and cost effective options in the future.

The Tantangara Option has potential impacts on heritage values. Investigations have yet to identify any significant constraints related to site activities but Indigenous groups have indicated that the Upper Cotter and Murrumbidgee Valley have high cultural significance. The Cotter pipeline and short tunnel alternatives would have the largest impact while the long tunnel and Murrumbidgee river flow alternatives have a lower impact largely due to their restricted development footprint. Both the long tunnel and Murrumbidgee river flow options would be subject to full heritage assessments but the latter’s pipeline route to Googong Reservoir within a road reserve and outside a national park implies a lower cultural impact.

Works, flow changes, and transport activities could affect the environment, community values and residential amenity along the Murrumbidgee. Specifically, the construction effects would include:

- transport and road safety conflicts associated with materials and plant movements;
- noise and dust near access roads and site areas;
- visual impacts associated with pipeline, weir and tunnel portals;
- spoil, waste and wastewater discharges; and
- river flow changes associated with weir commissioning.

Some of these effects could be beneficial in the medium to long term (eg improved access roads, recreation opportunities at the weir) while others could require mitigation, especially over the short term. The Cotter pipeline alternatives would have largest negative impact especially those with routes via Yaouk Valley.

Activities and operations within Namadgi National Park associated with the pipeline and tunnel alternatives could potentially effect public recreation, heritage, and landscape values characterising these wild areas. Mitigation measures over the short, medium and long term

would be required to ameliorate these potential impacts. Cotter pipeline and short tunnel alternatives with significant works in Namadgi would have the greatest impact on park values. The long tunnel would include some development within the park but mitigation measures including spoil and wastewater discharge outside Namadgi would limit impacts. There is no impact on Namadgi National Park associated with the Murrumbidgee river flow alternative.

The Tantangara Option has sustainability advantages due to its flexibility and relatively low capital works requirements. Cotter pipeline and tunnel alternatives have comparatively higher energy, works and social impacts. The long tunnel with its potential hydropower capacity and Murrumbidgee River flow alternative with its environmental and cost benefits feature superior sustainability characteristics.

7.4 Cost of the Alternatives

Water rights purchase, storage fees, and hydro generation opportunity costs apply to the Tantangara Option. These costs include the following:

- Water purchase – a one-off capital cost of approximately $20M-30 million for 20GL (high security entitlements) that pays for the “right” to use this water. This entitlement could be purchased from downstream users including irrigators.
- Hydro electricity compensation paid to Snowy Hydro[55] – an annual operating cost between $4.6 million and $5.9 million comprising:
    - Annual Option Fees (Payable on 30 January Each Year) $786,000;
    - Option A Exercise Fees (payable only if option called) executed by 30 April each year - $3,840,000; or
    - Option B Exercise Fees (payable only if option called) executed by 31 October each year - $5,120,000.

Judicious trading may offset some annual operating costs but in a year where the full 20GL was required ACTEW could expect to pay between $4.6 million and $5.9 million for water excluding the capital and operating costs of the transfer system infrastructure.

Transfer system capital costs[56] for the main alternatives include:

- *Alternative A* - $76 million;
- *Alternative B* - $89 million;
- *Alternative C* - $120 million[57];
- *Alternative D* - $98 million;
- *Alternative E* - $35 million[58]; and
- In addition, the cost to purchase a 20 GL high security water right from an interstate irrigator would be in the vicinity of - $30 million.

[55] Snowy Hydro Corporation (2004), Pers. Comms. Roger Whitby, February 2004.
[56] SMEC (2005), *Water Supply Infrastructure, Tantangara Option*, February 2005.
[57] Revised figures from internal ACTEW calculations including environmental and compliance costs.
[58] GHD (2005), *Cotter, Tennent and Coree Options (Engineering) Report*, April 2005.

High security entitlements could be temporarily traded at any point in the future so there is some likelihood that this "capital" may increase in value. Under these circumstances, all the Tantangara alternatives represent comparatively good value for money although pipeline alternatives with pumping have relatively high operating costs. The Murrumbidgee River flow alternative is the least expensive although its operating costs (due to pumping) are comparatively higher than the long tunnel alternative (due to gravity flow and hydropower opportunities).

7.5 Alternatives that are not preferred

The Tantangara Option includes significant components and activities within or adjacent to national parks. Tantangara Dam, its catchment and about 17km of the proposed Murrumbidgee discharge reach lie completely within Kosciuszko National Park. Works associated with the pipeline and tunnel alternatives would occur inside Namadgi National Park and proposed tunnel routes lie beneath Bimberi Wilderness.

Environmental, heritage and social risks associated with the pipeline and tunnel alternatives plus their location within Namadgi and Kosciuszko National Parks precluded further consideration. Of these alternatives, only the long tunnel has a lower risk profile and while these risks could be managed with mitigation measures, there remain limitations imposed by supply security and cost issues.

The following refined alternatives (removing Kosciuszko National Park works) were also excluded.

7.5.1 Pumping Main Alternative

This alternative includes a weir 25 km downstream of Tantangara linking into Cribbs Creek via 26 km of buried pipeline traversing Yaouk Valley and Namadgi National Park. Construction interactions with these areas would have considerable impacts on amenity, recreation values, landscape values, threatened species, and heritage values.

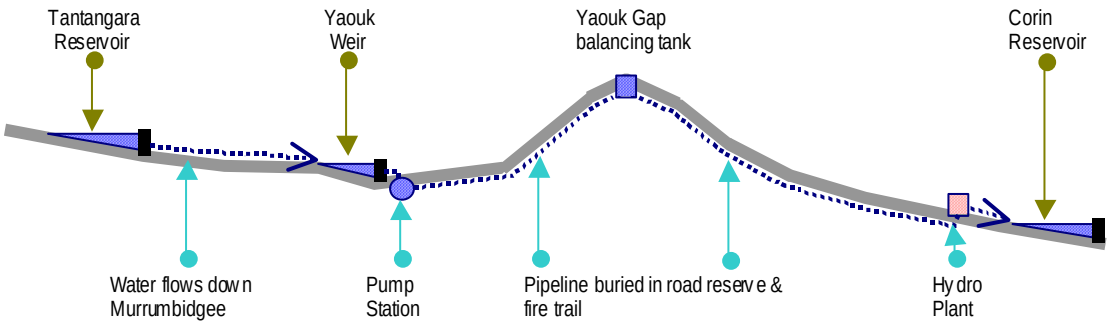


Figure 7.3: Pumping Main Alternative (pipeline via Yaouk Valley and Namadgi NP)

7.5.2 Pumping Main with Tunnel Alternative

This alternative includes a weir 25 km downstream of Tantangara linking into Cribbs Creek via 24 km of buried pipeline traversing Yaouk Valley and Namadgi NP with a 2 km short tunnel

beneath Yaouk Gap to reduce pumping costs. Despite the tunnel inclusion, construction interactions with these areas would have considerable impacts on amenity, recreation values, landscape values, threatened species, and heritage values similar to the option described above.

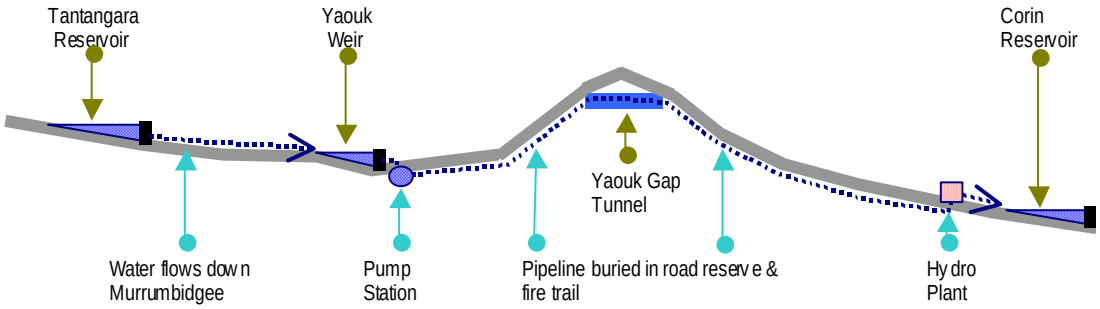


Figure 7.4: Pumping Main with Tunnel (pipeline via Yaouk Valley and Namadgi NP)

7.5.3 Short Tunnel with Gravity Main Alternative

This alternative includes a weir 16 km downstream of Tantangara linking into Cribbs Creek via a 12 km tunnel beneath Kosciuszko and Namadgi National Parks with a 12 km buried pipeline traversing Namadgi National Park. Yaouk Valley impacts are negligible but this alternative would still have significant effects on amenity, recreation values, landscape values, threatened species, and heritage values within Namadgi National Park.

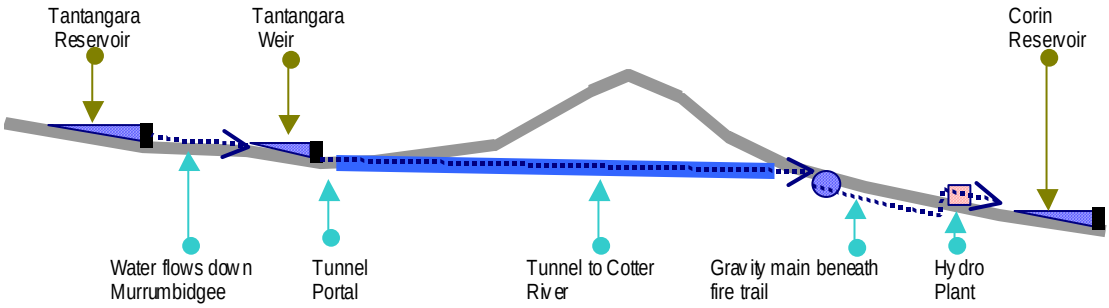


Figure 7.5: Short Tunnel with Gravity Main (via Namadgi National Park)

7.5.4 Long Tunnel Alternative

This alternative includes a weir 16 km downstream of Tantangara linking into Cribbs Creek via a 20 km tunnel beneath Kosciuszko and Namadgi National Parks. Yaouk Valley and most upper Cotter impacts are minimised but this alternative would still have some effects on amenity, recreation values, landscape values, threatened species, and heritage values within Namadgi National Park and of Corin Dam.

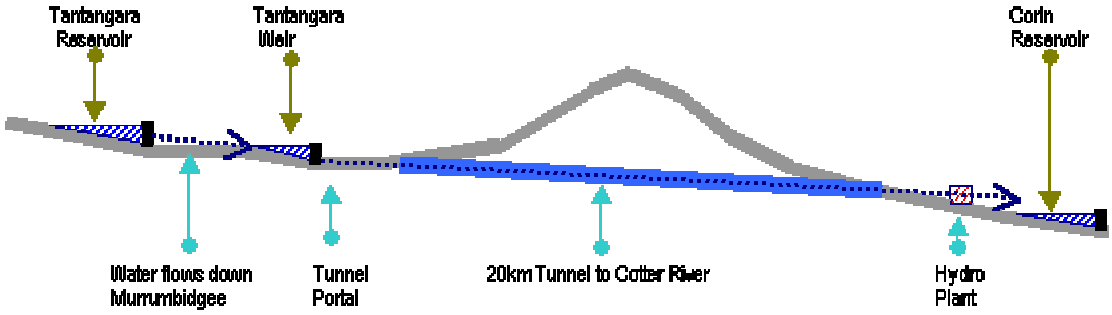


Figure 7.6: Long Tunnel (discharge to Cribbs Creek)

7.6 Preferred Alternative

This alternative includes a release down the Murrumbidgee River to a weir 100km downstream near Angle Crossing and linking into Googong reservoir via a pipeline beneath road reserves to Burra Creek. All the impacts associated with the other pipeline and tunnel alternatives impacts are avoided but this alternative would still have some minor effects on amenity, landscape values, ecology, and heritage values associated with the weir and pipeline works. These impacts could be mitigated with site controls.

The transfer of water along the Murrumbidgee River into the ACT from Tantangara Dam is relatively inexpensive and has significantly lower environmental risks. The Murrumbidgee River flow alternative in this incarnation would utilise the same infrastructure as is proposed for the Virtual Tennent Dam.

Under the current trading regime Tantangara water is currently controlled by NSW. This could mean ACT is denied water at a crucial time when supplies are most limited. Assuming ACT signed up to the “Cap” and the trading scheme was established, even high security ACT entitlements may be rationed amongst equally secured users during intense droughts. Notwithstanding the challenges imposed by participation in the National Water Initiative and the Murray Darling Basin “Cap”, this alternative remains very cost effective. Figure 7.7 shows the preferred, Murrumbidgee River flow alternative.

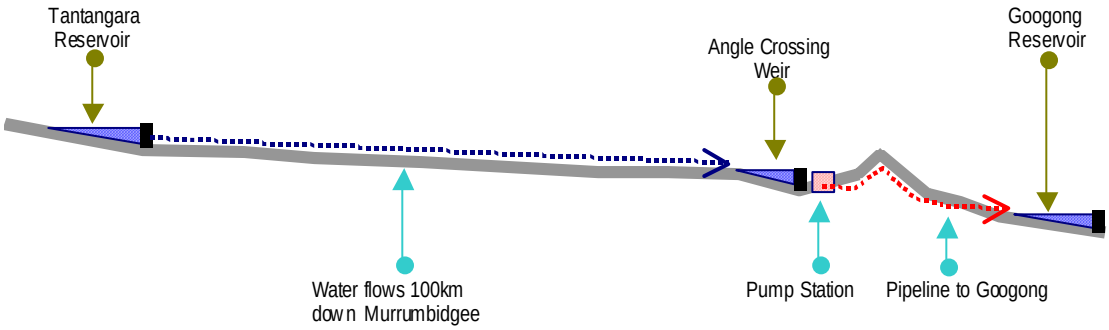


Figure 7.7: Murrumbidgee River Flow Alternative

7.7 Water Transfer Arrangements

ACTEW would need to be able to transfer water from interstate (probably NSW) into the ACT.

ACTEW can purchase (and hold) NSW water entitlements from downstream users in the following ways:

- purchase entitlements via a water broker;
- purchase an irrigation property with its attached water entitlement;
- purchase via electronic exchanges; and
- bilateral (government to government) negotiation.

Under the proposed (still under review) Murrumbidgee Water Sharing Plan (WSP) and NSW *Water Management Act (2000),* ACTEW could obtain a holding licence with:

- approval for the purchase (subject to trading rules) from a private extractor; or
- approval for the purchase from a single privatised irrigation district.

The Murray-Darling Basin Ministerial Council established the Cap on Murray Darling Basin water extraction principally to limit extraction of water from rivers. It is based on the amount of water that could have been diverted from rivers for irrigation in 1993/94. The determination of this Cap on water diversions is a requirement:

- for the ACT to fully participate in the Murray Darling Basin Commission; and
- the development of a water-trading regime to be implemented under COAG's National Water Initiative.

The ACT's water strategy, *Think water, act water*, states that by December 2005, the ACT will *"aim to complete a Memorandum of Understanding with the New South Wales Government and the Commonwealth Government that will include provision for a water Cap".*

If the ACT had a Cap on water diversions it could purchase "Cap water" from NSW, Victoria or South Australia, transfer that water, and permanently hold the water rights under ACT control. In other words, the purchase would increase the ACT Cap.

Tantangara has the capacity to store ACT water without fundamentally changing the reservoir. Subject to negotiation with NSW and Snowy Hydro, this water could be stored within Tantangara and still meet existing and proposed operational rules, and statutory obligations.

Negotiations for storage and release would be subject to the NSW environmental flows strategy due to be implemented in 2005. These negotiations could involve other stakeholders including environmental agencies and downstream catchment management authorities.

ACTEW's purchase of a general security water entitlement would need conversion to a high security entitlement. High security entitlements provide virtually guaranteed water access (currently subject to the NSW Minister's discretion). It is possible, however, that even with high security entitlements the ACT may not have complete access to its water. This situation could occur when extreme drought conditions left a shortfall of high security water to be spread amongst competing high security users. Under this situation, water access would be rationed between users.

Converting entitlements from another jurisdiction to an ACT entitlement and their respective conversion rates are subject to:

- NSW Department and Minister's explicit approval of conversion rates under a trading regime;
- ACT ratification of the National Water Initiative; and
- participation by ACT in the Murray-Darling Basin Cap so it was able to convert NSW entitlements to ACT entitlements.

The NSW Minister must approve a water transfer from the lower Murrumbidgee (which is covered by the Murrumbidgee Water Sharing Plan) to Tantangara because it lies outside the Water Sharing Plan boundary.

NSW controls water entitlement volumes in Snowy catchments but Snowy Hydro has obligations and rights in the collection, storage and timing of water releases[59]. Under the *Corporatisation Act*, Snowy Hydro must consider requests for water but Snowy Hydro must also release a minimum 1,026 GL annually for the Murrumbidgee via the Tumut River. Snowy Hydro may also release discretionary volumes averaging about 254 GL per year.

Under the *Snowy Hydro Corporatisation Act 1997 [NSW]* extractive entitlements to water stored in the Snowy Scheme can only be granted by the NSW Water Ministerial Corporation. The *Act* enables Snowy Hydro to charge a fee for taking extractive water that can either be negotiated with the extractor or determined by the NSW Water Ministerial Corporation.

7.8 Risk Assessment

A qualitative risk assessment of the preferred Tantangara alternative identified potential risk sources should that alternative be implemented on its own. Section 3.2 of this report outlined the risk level categories used in the assessment and the required actions that would be taken to control the risk situation. Those risk sources that pose the greatest level of risk for the Tantangara Option are listed below and outlined in the risk assessment report[60].

The major inherent risk sources, should the Tantangara Option be implemented on its own, are:

- very high inherent risk that the reliability of supply expected, if this option were implemented on its own, would lead to an occasional need for stage 4 or 5 restrictions and frequent need for stage 3 restrictions.

[59] New South Wales Government, *Snowy Hydro Corporatisation Act*, 1997.
[60] URS (2005), *Future Water Options Risk Assessment*, April 2005.

- high inherent risk from transferring a high security water right into the ACT.

7.8.1 Control Measures

The inherent risk that the reliability of supply provided by the Tantangara Option would lead to an unacceptable amount of time in stage 3 restrictions or worse, can only be mitigated by implementing the Tantangara Option in combination with other supply options. If the Tantangara Option was combined and assessed with other options it is expected that this inherent risk would be reduced to a moderate level.

There is a particular 'sovereign' risk with any of the options that include releases from Tantangara Reservoir. A high security water allocation would need to be sought from another state in the Murray Darling Basin and traded across the border into ACT. There is currently no water trading market to enable an interstate water allocation to be permanently transferred across the border into an ACT allocation. To enable this, the ACT would need to agree to a water Cap with other Basin States to allow the water right to be transferred for use in the ACT. For example, in NSW the current statutory arrangements allow the NSW Minister to allocate water to NSW users based on their total water rights and the total water available. Any water right that the ACT obtains would follow the same process to determine allocations. In times of drought when NSW water users would be seeking maximum allocations when water is limited, there may be more political pressure on NSW to provide water to NSW water users over the ACT. There also may not be a full allocation granted to all the high security users. This risk would need to be managed through legally binding and effective relationships with NSW and perhaps the other Basin States.

8 Providing a Reliable Water Supply for the ACT Region

The discussion in Chapter 2 established that the need for new water supply for Canberra – in the light of climate change, bushfire recovery and the impact of environmental flow guidelines – has already passed (unless long periods of restrictions are acceptable). The soonest practical time a new dam could be operational, however, is about 2011 even if approval was immediately forthcoming. Therefore the potential for immediate measures has been assessed to examine what could be achieved to keep water restrictions within reasonable bounds.

In the December report to the ACT Government, ACTEW examined ways to increase the efficiency of the existing infrastructure. The use of the existing Cotter reservoir has already been initiated following the completion of the Stromlo water treatment plant upgrade. This has increased the amount of water available to Canberra and Queanbeyan by up to 50 ML/day.

Drought Planning

In addition, pumping from the Murrumbidgee River near the Cotter Pump Station is now also being implemented as a drought contingency measure. This is not seen as a permanent long-term measure.

Increasing Storage and/or Yield.

A reliable water supply can be achieved through providing additional storage – or more correctly providing additional yield. Increasing yield is achieved through more storage, or by increasing inflows to the existing storage. This has recently been achieved in Sydney where additional flows from the Shoalhaven River are pumped into Lake Burragorang (Warragamba Dam) – no additional storage infrastructure (in terms of a dam) but more water is able to be stored as more water flows into the reservoir.

8.1 Efficient Use of Existing Infrastructure

Permanent Water Conservation Measures

In *Think water, act water*, the ACT Government committed to introducing Permanent Water Conservation Measures. ACTEW has been working with Government Agencies to develop these measures.

8.1.1 Stromlo to Googong Reticulation Transfer

In addition to examining options for future water supply, ACTEW has also reviewed the use of the existing infrastructure, building on the work completed in the December report. To use the existing infrastructure more efficiently, this proposal examined the opportunity to move “surplus” water from the Cotter catchment, when it is available, to Googong reservoir, when available storage capacity exists, via Canberra’s reticulation system. This has been dubbed the Stromlo to Googong Reticulation Transfer. This option is relatively cheap and quick to implement.

On average, over the past 40 years, some 29 GL has spilt from the Bendora and Cotter dams each year[61]. This Stromlo to Googong Reticulation Transfer involves capturing some of these spills and transferring the water to Googong reservoir. Essentially, water would pass from Bendora reservoir via the gravity main to Mt Stromlo water treatment plant, and be supplemented with water from the Cotter reservoir (when available) so that Mt Stromlo water

[61] ACTEW (2005), Spills from Cotter River Storages, March 2005.

treatment plant could operate near maximum capacity. Any water not required by Canberra and Queanbeyan would be transferred via the existing water mains, bypass the Googong Treatment Plant and pass into Googong reservoir. Chlorine would be removed from the water before discharge into Googong reservoir. The Stromlo to Googong Reticulation Transfer is shown schematically in Figure 8-1.

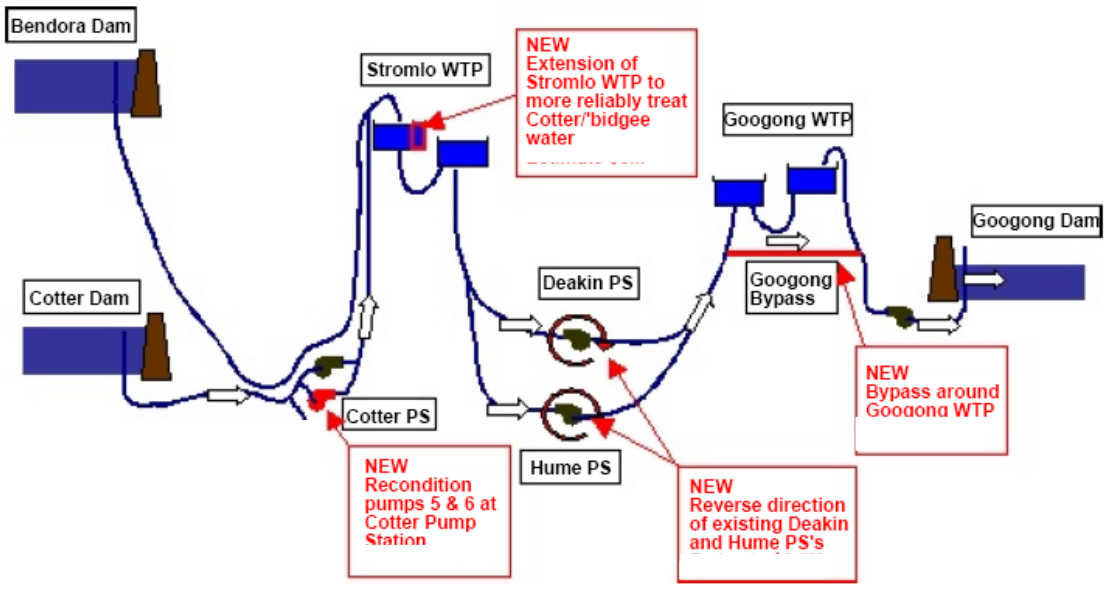


Figure 8.1: Stromlo to Googong Reticulation Transfer.

The modelling suggests that up to 12 GL per year could be obtained from the Stromlo to Googong Reticulation Transfer at a capital cost of about $20 million[62]. The downside is that higher pumping costs are incurred. The advantage is that it is estimated that for this modest cost, some additional 12 GL of water can be stored and the required infrastructure be operational within 12 months. ACTEW has already commenced the implementation of this transfer option.

8.2 Further Supply Measures

Based on the analysis in the previous three chapters, the Angle Crossing Option can be implemented much more quickly than any of the other future water supply options.

8.2.1 Angle Crossing Option (formally known as the Virtual Tennent Option)

The Angle Crossing Option (Virtual Tennent) involves the transfer of water that notionally would have been stored in a Tennent Dam if it existed, from the Murrumbidgee River into the Googong reservoir via a weir, pump and pipeline. Several sites have been examined to determine the best location for a weir and pump, with a weir near Angle Crossing being the preferred site.

[62] ActewAGL (2005), *ACT Future Water Options Water Resources Modelling report – Volume 1*, April 2005.

Two pumping rates, at 60 and 180 ML/day, have been modelled ensuring the lower flows in the Murrumbidgee River are preserved for environmental purposes. All flows lower than this would not be extracted.

The expected annual water harvest from these two pumping rates, based on proposed operational rules and subject to environmental constraints, would be about 12 GL and 17 GL respectively. The capital cost for the 60 ML/day option would be about $35 to $40 million, compared to $65 million for the 180 ML/day option. In addition a larger pumping station would be needed for the higher pumping rate. Taking all of these factors into account, the 60 ML/day pumping rate is the preferable solution.

This option could be operational in two to three years assuming twenty months of construction as advised by GHD[63].

In combination with the Stromlo to Googong Reticulation Transfer and the proposed new environmental flow guidelines[64], the Angle Crossing Option should provide sufficient reliable water for the ACT and region until 2023 (Figure 8.2). At this time additional supply would then be required. This is shown when the red line (which is the water used by Canberra and the region) is above the various blue yield lines – the water available to the city (as a long term average).

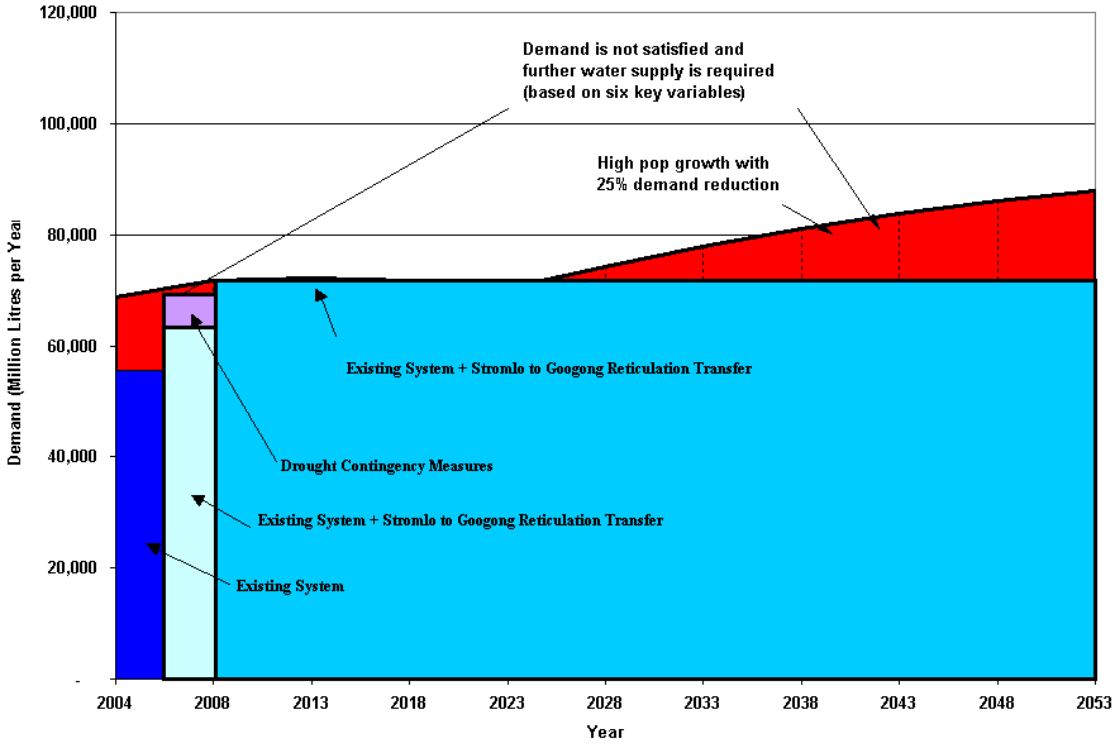


Figure 8.2: Additional supply to meet future water demand

[63] GHD (2005), *Cotter, Tennent and Coree Options (Engineering) Report*, April 2005.
[64] Environment ACT (2005), Correspondence to ACTEW on revised environmental flows, January and February 2005.

8.2.2 Next Supply Measure

The best option for Tantangara is to transfer 20 GL of water each year (as needed) to the ACT via the Murrumbidgee River (see chapter 7).

The best option for Tennent is to construct the small Tennent Dam in conjunction with other infrastructure (43 GL) or build the larger dam if required (see chapter 6).

The best option for the Cotter is to construct a 78 GL dam (see chapter 5).

8.2.3 Examining the Tantangara Option.

The cost of this option is relatively modest. The infrastructure to transfer water to Googong is $35 to $40 million and will already be in place if the Angle Crossing Option is built. A cost of about $30 million to purchase an interstate water right and annual operating costs of about $5 million to be paid to Snowy Hydro. The net benefit is higher than many other options, although not as high as a combination of the Angle Crossing Option and the enlarged Cotter Dam[65]. There are few environmental costs and some benefits with this option. From a social perspective there may be some effects on local landholders, as essentially the whole of the Upper Murrumbidgee catchment will become part of the Canberra region drinking water supply catchment, which may require a re-assessment of catchment activities and appropriate management practices. This option would also provide some risk to water quality, as a contamination event might occur in this catchment without notification to ACTEW.

There is currently no water trading scheme in place in the Murray-Darling Basin that would allow the transfer of a NSW water right to the ACT, although this is likely to occur at some time in the relatively near future under the National Water Initiative[66]. This means that the ACT would have to purchase an existing water right from a NSW irrigator and be dependent upon the State of NSW not to interfere with this right[67]. Because such non-interference cannot be guaranteed, obtaining water from NSW under this option implies a lower level of security than using water that is already controlled by the ACT. To purchase water and hold an ACT water right, the ACT will need to set an agreed water Cap with the Murray-Darling Basin Ministerial Council.

Further, an agreement would need to be made with Snowy Hydro regarding water storage, management arrangements and payment to offset revenue for generation of electricity that would be lost to Snowy Hydro for water purchased by the ACT. While such an agreement could be negotiated with Snowy Hydro, the future costs are unlikely to be uncertain due to the volatility of the energy market.

Once a mature water market is established, the ACT has set its water Cap and the security of supply can be guaranteed, this option will have more appeal. This should occur before 2023 when the next supply option would be required. In addition, if the Angle Crossing Option is implemented, the infrastructure will be in place to transfer water from Tantangara to Googong Reservoir in the future.

8.2.4 Examining the Storage Options

The hydrology analysis suggests that the 43 GL Tennent Dam provides about the same amount of water to the region, on an average annual basis, as the 78 GL Cotter Dam. The Tennent Option, however, has more significant environmental consequences. The key concern is the

[65] Centre for International Economics (2005), *Economic benefit-cost analysis of new water supply options*, April 2005.
[66] http://www.dpmc.gov.au/nwi/index.cfm.
[67] Marsden Jacob Associates (2004), *Briefing note on Tantangara high security water rights*, August 2004.

damming of an unregulated river and flooding of the Yellow Box woodland. There are also social issues such as the need to move all 14 lessees from the catchment to provide protection to the reservoir. Catchment remediation is also required to further protect water quality. The small Tennent option is about $65 million more expensive then the enlarged Cotter Option, whereas the large Tennent Option is $130 million more expensive. The net benefits of the enlarged Cotter Dam plus the Virtual Tennent Option are slightly higher than the small Tennent Dam plus the Angle Crossing Option[68].

The 78 GL Cotter Dam would obtain better utilisation from the ACT's most reliable water catchment in terms of rainfall. It would enhance the habitat for threatened native fish populations, and entail a more straightforward approvals process, given that the catchment is already designated for water supply. The main disadvantages are associated with sediment discharge in the lower Cotter catchment (where damage following the January 2003 bushfires has accentuated an existing catchment erosion problem, necessitating considerable remediation of the catchment) and associated water quality problems. With appropriate catchment remediation (which will be required regardless of whether the enlarged Cotter Dam is built or not) and treatment of Cotter water at the new Mt Stromlo treatment plant, it is expected that these problems will be manageable. Because of its relatively low elevation, the enlarged Cotter Dam would involve additional operational costs to pump water to the Mt Stromlo treatment plant.

8.3 Assessing Future Supply Measures

Based on the analysis presented in Section 8.1 and 8.2 the new water supply system would therefore be reliable (as assessed against the definition presented earlier) until at least 2023 if the Angle Crossing Option were implemented. Beyond that time, and if the six key planning variables are met, then additional supply would be needed. This could come from an enlarged Cotter Dam, a new Tennent Dam or using Tantangara and transferring water via the Murrumbidgee River.

Prior to 2023, there is a need to prepare for the next supply option. The following actions are required.

8.3.1 Monitor the six key planning variables

The six variables that form the basis of the report, that is:

Government Planning Parameters

- population in the ACT will grow to 500,000 persons in 2032 some of NSW;
- meeting the water use efficiency targets;

Natural Environmental Risks

- climate variability and climate change;
- bushfires;

Factors Set by Government

- environmental flow requirements; and
- water restrictions during times of drought:

[68] Centre for International Economics (2005), *Economic benefit-cost analysis of new water supply options*, April 2005.

all have some degree of judgement and uncertainty attached to them. ACTEW will need to implement a formal process for regularly reviewing the six variables and assessing whether they are working out as predicted. The monitoring results will be reported annually by ACTEW.

8.3.2 Environmental flows

The ACT's environmental flows are currently being reviewed, and further reviews are expected every five years. As new knowledge becomes available it is expected that the environmental flows will continue to change and thus affect the amount of water available to Canberra and the region for human consumption.

8.3.3 Cotter Catchment

The Cotter catchment has been significantly impacted by the bushfires. Careful management and appropriate monitoring is required to ensure that the catchment is able to supply high quality water for use in the ACT and region.

Prior to the January 2003 bushfires, the Cotter precinct was a favourite recreation area for Canberrans, especially families. In *Shaping Our Territory* (the report of the Non-Urban Study Steering Committee), reconstruction of the Cotter precinct was seen as an important task, and a number of options were put forward.[69] The significant features of the precinct were seen as:

- readily accessible picnic areas, opportunities for swimming and walking tracks;
- forest and areas of native vegetation that offered diverse road, walking and picnic activities;
- healthy, outdoors oriented and lifestyle related recreational pursuits; and
- accommodation facilities at venues such as Camp Sturt, Camp Cottermouth and Greenhills.

A year later, Revitalising the Cotter[70] was published, summarising the work that had by then been completed (replacement of basic infrastructure, some walking tracks, bridges, playgrounds and camp grounds) and foreshadowing further enhancement work and possibly more major projects, that would be driven mainly by private sector investments.

Obviously, these activities, especially those that might occur at or close to the reservoir, would need to be consistent with the primacy of water quality considerations. Careful attention will be needed on these issues, so that it is clear what will, and will not be, conducive with the principal use of the Cotter River as a water supply catchment.

8.3.4 Tennent Catchment

The Naas and Gudgenby provide the next best water supply catchment for the ACT based on the analysis presented in this report and previously in ACTEW's report of the larger list of options[71]. At the very least, the site needs to be preserved as a future water source and certain actions are recommended.

[69] Non Urban Study Steering Committee (2003), *Shaping Our Territory – Opportunities for Non Urban ACT,* final report, November 2003.
[70] Shaping Our Territory Working Group (2004), *Revitalising the Cotter – action to date and future opportunities,* September 2004.
[71] ACTEW (2004), *Options for the Next ACT Water Source*, April 2004.

The National Capital Plan identifies the Tennent Dam catchment as suitable for a future water source. There are some environmental values that could be protected and enhanced. There are significant Yellow Box grassy woodlands that could be improved and better wildlife corridors can be provided over the next several decades to provide a better catchment from an environmental perspective, as well as preparing the catchment as a future water supply. This approach is consistent with the National Capital Plan, that states:

> *"Run-off in the case of the Gudgenby (Tennent Reservoir) catchment is of a high quality, reflecting the forest and grass character of the catchment, soil stability and limited human activity. Water from Tennent Reservoir would be fed, after treatment, directly into the water distribution system. As some habitation and a wide usage of the catchment for recreation, camping and nature study is proposed, extensive buffer storage and water clarification and disinfection would be required at Tennent Reservoir to ensure adequate protection of public health. The adequacy of this system of protection would be dependent on the maintenance of the high physical and chemical quality of raw water, and on careful control on bacteria discharged in wastewater in the catchment. The continuation of rural activities in the Naas and Gudgenby valleys is compatible with the planning intentions in the interim, although ultimately these leases would need to be withdrawn, as they would be largely inundated by the reservoir. It would not be appropriate, however, to permit substantial capital development, which to be economically justified, would need to be viable beyond the construction date of the reservoir. In summary, restricted use is possible in the …..Gudgenby catchment" (pending construction of a dam).*[72]

In undertaking this rehabilitation, however, the future inundation areas need to be identified to ensure they are protected. Better wildlife corridors, and improvements to the Yellow Box woodland should occur above the proposed high water mark of the large Tennent reservoir.

There are 14 rural lessees in the catchment of the proposed Tennent Dam. There are some inconsistencies in the conditions and terms of the leases. It is suggested that the existing leases are reviewed and a more common approach is taken.

8.4 Further Prudent Planning

Of the future water options assessed, it has been demonstrated that each of them could potentially be implemented given the right circumstances, and taking account the constraints previously identified in this report. These are:

- the Tantangara options have been proven to be feasible on the proviso of the opening up of the National Water Market;
- the Tennent option would be the best solution for a high population growth scenario; and
- the Cotter option would be optimal given a low to medium growth scenario and pending the stabilisation and remediation of the catchment.

Given the above, additional technical analysis should be undertaken for the each of the dam options, including refining the dam design, further detailed examination of pipeline routes and

[72] Adapted from National Capital Plan, Appendix G: Requirements for Namadgi National Park and Adjacent Areas.

additional examination of the benefits of building a new water treatment plant near the Tennent Dam versus transferring transfer water from the Tennent Dam into the Mt Stromlo water treatment plant. In addition the following needs to be done.

- a review of the Tennent rural lease arrangements in order to ensure consistency in leasing arrangements;
- carry out a detailed study of the yellow box grassy woodlands in the Naas Valley in order to develop strategies for remediation, enhancement of wildlife corridors, and develop a more comprehensive data base of the presence of endangered species;
- carry out detailed cultural, heritage analysis of the Naas Valley and areas affected by the Tantangara options in an effort to fill gaps in current knowledge. More extensive consultation with Aboriginal groups should be done as part of this exercise;
- carry out quantitative social research testing the outcomes of the future water options process on a broader sample of the ACT community;
- further technical studies on the remediation of the Cotter catchment should be initiated in conjunction with relevant ACT Government agencies such as Environment ACT and ACT Forests; and
- further work on the revitalisation of the Cotter area as an important recreation resource for the ACT Community, recognising the primacy of water quality considerations.

9 Recommendation

Because of the availability of the Stromlo to Googong reticulation transfer, it is now possible to initiate a strategy for water supply for the ACT and region that was not previously available. That strategy is a phased one, which would:

- require the immediate building of the infrastructure necessary to provide a reliable water supply for a substantial period ahead; and
- allow sufficient time to deliver any of the bigger infrastructure options, if necessary, in the light of more definite information.

Consistent with this strategy, ACTEW recommends the following.

1. ***It is recommended that*** *implementation of the option to pump water from the Murrumbidgee River near Angle Crossing to Googong Reservoir (formerly known as the Virtual Tennent Option) commence immediately.*

2. ***It is recommended that***

(i) *the remaining options of an enlarged Cotter Dam to 78 GL, a small (43 GL) or a large (159 GL) Tennent Dam and transferring water from Tantangara Dam down the Murrumbidgee River into the ACT be retained as future viable options; and*

(ii) *ACTEW be ready to implement one of these options without delay, if required, through the development of a work program, implementation of formal processes for regularly reviewing the six assumptions, and completing analysis, design and other relevant technical studies for an approval process.*

3. ***It is recommended that*** *additional technical analysis be undertaken for the each of the dam options, including refining the dam design, further detailed examination of pipeline routes and additional examination of the benefits of building a new water treatment plant near the Tennent Dam versus transferring water from the Tennent Dam into the Mt Stromlo water treatment plant.*

9.1 Immediate Action

Based upon the six assumptions, the Angle Crossing Option, together with the soon to be implemented Stromlo to Googong Reticulation Transfer, it is expected that the ACT would have a reliable water supply until about 2023 without the need for prolonged restrictions. It is anticipated that water pumped near Angle Crossing would be allocated from the Gudgenby catchment.

This project will need to be completed in close co-operation with NSW agencies and the Greater Queanbeyan Council. It is estimated this will cost in the vicinity of $35 to $40 million and be completed within two to three years.

9.2 Future Actions

The Angle Crossing Option allows a much better decision to implement, if needed, one or more of the larger infrastructure options later because better experience and knowledge will be available about whether the six key assumptions are actually working out in practice.

It should be recalled that the Future Water Options project commenced with three options, but this was further expanded to some 26 alternatives once a variety of ways of delivering each of the options was developed. In addition, many other suggestions were brought to the attention of the project team and considered. This process also encouraged people to look at the way the current water supply system is operated and to examine more efficient ways of delivering water.

The development of the reticulation transfer option was a result of this process and provides a relatively cheap way to increase the amount of water available to Canberra and the region.

There are many different scenarios that could eventuate over the next 15 years. For example:

a) if high population growth together with climate change and significant bushfires impacts were to occur, the next preferred option would likely be to build the large Tennent Dam. If a lower population growth were to occur, or if climate change and the bushfire impacts are not as severe as is currently thought an enlarged Cotter Dam would most likely be preferred. The ACT's population growth over the past year was about 0.2 per cent and if this were to continue there may not be a need for additional water at all. One of the virtues of making the next decision in some 15 years is that this will bring the Tantangara Option into play. When a robust water trading scheme is established in the Murray-Darling Basin transferring water from Tantangara to Googong Reservoir becomes more viable due to its low cost and the environmental benefits that would be gained in the Murrumbidgee River;

b) considering the water efficiency program, if larger savings are obtained more quickly, again there may not be a need for additional water supply. On the other hand, if the efficiency targets are not met and population growth occurs more quickly than per capita water reduction, there would be a need for a large Tennent Dam;

c) between now and 2023, it is likely that three more reviews of the environmental flow guidelines will occur. As a better understanding of river ecology is obtained through the monitoring and management of environmental flows, the volume and type of flows are also likely to change;

d) it is likely that permanent water conservation measures will be introduced into the ACT. This will require that the ACT's water restriction scheme is also reviewed.

The analysis undertaken for this project has provided the tools and knowledge so that a decision on the next supply option, if needed, can now be made more quickly.

9.2.1 Future Analysis

Additional technical analysis should be undertaken for the each of the dam options, including refining the dam design, further detailed examination of pipeline routes and additional examination of the benefits of building a new water treatment plant near the Tennent Dam versus transferring transfer water from the Tennent Dam into the Mt Stromlo water treatment plant.

The Cotter catchment has been significantly impacted by the bushfires. Careful management and appropriate monitoring is required to ensure that the catchment is able to supply high quality water for use in the ACT and region.

The Naas and Gudgenby provide the next best water supply catchments for the ACT based on the analysis presented in this report and previously in ACTEW's report of the larger list of options. The site needs to be preserved as a future water source. There are some environmental values that could be protected and enhanced. There are significant Yellow Box grassy woodlands that could be improved and better wildlife corridors can be provided over the next several years to provide a better catchment from an environmental perspective, as well as positioning the catchment as a future water supply. This approach is consistent with the National Capital Plan. In undertaking this rehabilitation, however, the future inundation areas need to be identified to ensure they are protected. Better wildlife corridors, and improvements to

the Yellow Box woodland should occur above the proposed high water mark of the large Tennent reservoir.

There are 14 rural lessees in the catchment of the proposed Tennent Dam. There are some inconsistencies in the conditions and terms of the leases. It is recommended that the existing leases are reviewed and a more common approach taken.

There are also residual cultural heritage uncertainties. A detailed analysis of the Naas Valley and areas affected by the Tantangara option would contribute to filling gaps in current knowledge. Further consultation with Aboriginal groups should be done as part of this exercise.

The Tantangara Option should be kept under review, as water policy initiatives mature. Having the Angle Crossing weir and associated pumps and pipeline in place would facilitate its later adoption, as the major infrastructure would be in place. ACTEW will continue to participate and support actions under the National Water Initiative including the development of a robust water trading scheme. In addition, ACTEW will continue to contribute to the development of an ACT water Cap.

10 Implementation Strategy

The report "*Assessment of the Need to Increase the ACT's Water Storage*"[73], identified the need for additional water supply sooner than was originally expected unless long periods of restrictions are acceptable. This finding was based on a range of factors including population growth, climate change, the amount of time in water restrictions and water efficiency targets. A staged approach will deliver sufficient supply to meet the community's needs, as it is required.

ACTEW and the ACT Government have already implemented the Drought Contingency Plan. The plan, which involves drawing water from the existing Cotter reservoir and pumping water from the Murrumbidgee River at the old Cotter Pumping Station, has the capacity to supplement Canberra's water supply by up 50 ML per day.

Section 8.1 outlined the approach to supplement the water supply further by implementing the Stromlo to Googong Reticulation Transfer. ACTEW has commenced the implementation of this activity. In addition to these activities, the Virtual Tennent Option is recommended.

10.1 Angle Crossing Option

ACTEW's recommendation to the ACT Government is to implement the Angle Crossing (Virtual Tennent) Option, including the construction of a weir in the vicinity of Angle Crossing on the Murrumbidgee River, a pump station and a pipeline from the river to Burra Creek. This will require the following:

- engagement of a consulting engineer and project planner to carry out all design works and preliminary investigations. This will include the identification of the preferred route based on engineering issues, flora, fauna and heritage issues, land owner assessment, and a detailed, construction standard design of the weir, pump station and pipeline;
- negotiation with the NSW Department of Infrastructure, Planning and Natural Resources, other relevant NSW agencies, the Queanbeyan City Council and ACT Government agencies concerning relevant approvals and environmental assessments;
- preparation of a Preliminary Assessment (PA) and Report on Environmental Factors, lodgement of a development application (DA) in accordance with ACT and NSW planning statutory requirements. It is likely that 12 months will be required to prepare and have approved all necessary documentation; and
- A construction period of up to 20 months is envisaged. A major factor influencing this is the supply of pipe for the project. Mechanisms for compressing this timeframe, including early ordering of pipe, will be investigated.

Given the above, a likely timeframe from commencement to completion of the Angle Crossing Option is approximately two to three years.

[73] ACTEW (2004), *An Assessment of the Need to Increase the ACT's Water Storage,* December 2004.

Further Information

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