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CENTRAL NSW COUNCILS

CENTROC WATER SECURITY STUDY

COMPONENT 2: OPTIONS PAPER FINAL

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29 OCTOBER 2009

REVISION SCHEDULE

REV. NO.	DATE	DESCRIPTION	PREPARED BY	REVIEWED BY	APPROVED BY
0	8/10/2009	Draft	G. Hadiardja E. Pryor R. Beatty	R. Beatty P. Coombes P. Kozarovski	E. Pryor
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EXECUTIVE SUMMARY

In response to the worst drought on record for the region, Centroc (Central NSW Councils) undertook to complete a Water Security Study to investigate and recommend solutions to improve water supply security across the Centroc region. The study had two components:

1. Component 1: An audit of existing infrastructure for bulk water supply; and
2. Component 2: An options paper for improving water supply security.

The Component 1 report characterised the current bulk water supply assets and infrastructure of the region. The Component 1 report was finalised in August 2009.

This report (the Component 2 report) documents the options for improving town water supply security across the region.

The approach to this study was built on three key principles:

1. Stakeholder engagement – consultation was undertaken to seek the views of stakeholders in order to improve study outcomes. Stakeholders were consulted in setting the objectives and criteria for this project as well as in defining and assessing the options and strategies that have been studied;
2. Consideration of the economic, social, environmental (triple bottom line – TBL) impacts of the choices for water security improvement to inform decision making. This framework was used by the project team and stakeholders to understand the relative performance of options and strategies as well as the trade-offs in decision-making; and
3. The integration of the management of water resources, recognising the need for holistic approaches to water management.

Establishing the extent of the need for water security improvement was the first step necessary to develop an effective long term, region-wide water security strategy for the Centroc region. Three main steps were taken to establish the need for water security improvement:

1. Forecasts of the expected demands for water from each of the towns for the next 50 years (until 2059) were developed. Forecasts took into account expected growth in each town and the potential to improve the efficiency of urban water use;
2. A model of the surface and groundwater resources of the region was developed. The model was designed to be able to determine the likely water resources available under both the current climate sequence and the changes in this sequence that may come about as a result of climate change.
3. The integration of the demand for water and the availability of water in the model to assess the level of water supply security for each town under both current climate and a climate change impacted sequence.

As a result of this assessment, it was determined that, over the 50 year planning horizon, the following towns require a water security improvement:

- Condobolin
- Cowra
- Koorawatha
- Bendick Murrell
- Brundah
- Greenethorpe
- Mogongong
- Wattamondara
- Cumnock
- Yeoval
- Forbes
- Bogan Gate
- Tottenham
- Trundle
- Tullamore
- Lake Cargelligo
- Murrin Bridge
- Tullibigeal
- Lithgow
- Portland
- Oberon
- Orange
- Clifton Grove
- Parkes
- Peak Hill
- Wellington
- Geurie
- Mumbil
- Nanima

Identifying and assessing the relative performance of options to improve water security for the next 50 years was the second step necessary to develop an effective long term, region-wide town water security strategy for the Centroc region. Five main steps were taken to establish the most appropriate options for water security improvement:

1. A long-list of potential options was identified with stakeholder input. In consultation with stakeholders, over 80 individual options were developed for consideration. Options considered included demand management programs as well as infrastructure options including dams, pipelines and pumps. In addition, options that had mutual benefit to other water users, such as the irrigation and mining industries, were also identified.
2. A short-list of options for further investigation was determined utilising the TBL criteria, and the input of stakeholders.
3. Scenarios (themed groupings of short-listed options) were developed to allow comparisons between approaches for water security improvement to be made.
4. Developing region-wide strategies based on the outcomes of each of the preceding steps.
5. Sensitivity testing the preferred region-wide strategy to understand the impact of climate change, potential increases in the cost of energy, potentially greater populations, potential differences in infrastructure costs and the potential of demands from other sectors (such as mining) on the preferred strategy.

Water Conservation and Demand Management

Underpinning each of the strategies developed was the need for efficient town water demands. The following program of water conservation measures is recommended as the basis for a region-wide water conservation and demand management strategy:

- Residential retrofit of inefficient water fixtures, including providing customer support for replacements;
- Continuation of the Water Efficiency Labelling and Standards Scheme (WELS);
- Implementation of Permanent Low Level Restrictions on outdoor water use;
- Continuation of the BASIX program for new residential developments;
- Continuation or expansion of Water Conservation Education programs to improve efficient water use;
- Audit of Non-Residential Water Users to identify leaks and potential areas for improvement in efficiency;
- System Water Loss Management which aims to identify and repair leaks in water supply and distribution system; and
- Review of water supply and sewerage services pricing structure to follow the best-practice guideline of 25:75 Fixed to Variable Charge Ratio.

It is important to note that some of the elements of this program are already in place in a number of the member Council areas (compare the baseline against the current programs) and this has been taken into consideration in deriving the forecasts. These Councils may be able to take a lead role in assisting with the design and implementation of this program across the region.

The water demand forecasting and conservation modelling work demonstrated that it is expected that this water efficiency program will offset the additional water demands associated with growth across the Centroc region. The costs associated with implementing this program are expected to be offset by the savings in avoided capital expenditure and in the reduction in operating costs associated with less treatment and transfer requirement.

In addition, it is recommended that a program of uniform (across-connected supplies) water restrictions be put in place. For the river towns[1], restrictions will be triggered when the storages of Wyangala or Burrendong reach a set trigger level (i.e. that level representing the lowest 10% of years). In this way, the towns will enter restriction regimes in manner that is sympathetic with allocation reductions on other water users but is consistent with best drought management practice in urban areas.

Recommended Infrastructure

Following assessment, two region-wide strategies emerged as potential solutions to improve water supply security in the Centroc region which were very close on the TBL assessment. Both options involved a core regional supply and distribution network to provide for the supplementary water requirements of the towns of Cowra, Forbes, Orange and Parkes sourcing water from either:

- An augmented Lake Rowlands (from current capacity of 4,500 ML to 26,500 ML) (Region-wide Strategy 2a); or
- The existing Chifley Dam (Region-wide Strategy 3a).

Both core supply and distribution network options have the potential to meet additional mining demand of up to 10 ML/d at Cadia Hill.

In addition to the core supply and distribution network, water security to other urban centres is also addressed in both strategies through:

- Pipeline connection between Bathurst and Oberon to provide supplementary water for Oberon and reduce pressure on the Fish River Water Supply, improving outcomes for Lithgow as a result;
- Pipelines from the storages of Burrendong and Chifley dams to Wellington and Bathurst respectively are recommended to save water lost in the delivery of these supplies through river channels.
- A series of local solutions, including new minor storages at Cumnock, Condobolin, Lake Cargelligo and Yeoval are recommended.

The recommended option for the supply of the core distribution network is the amplification of Lake Rowlands (Strategy 2a). Whilst more expensive than Strategy 3a, the amplification of Lake Rowlands is preferred on the following basis:

- Lake Rowlands is significantly higher in elevation than Chifley Dam (~170m), thus reducing the energy and greenhouse gas emissions associated with moving water to points of need in the region. The costs of energy are expected to rise significantly into the future and on this basis, sensitivity testing favoured Strategy 2a;
- If population growth is greater than assumed, the augmented Lake Rowlands supply is better placed to support the greater associated demands;
- Assessments of the costs of augmenting Lake Rowlands vary. The costs adopted in the TBL assessment are higher than some existing estimates. The adoption of the existing estimates in the sensitivity testing supports the adoption of Strategy 2a.
- This strategy has greater social acceptability.

The recommended region-wide strategy (2a) includes (see Figure Ex-1 for map layout of the strategy):

- Lake Rowlands Augmentation;

[1] River towns are defined here to mean those towns sourcing directly from the Macquarie River or the Lachlan River.

- Lake Rowlands-Millthorpe Pipeline (CTW Trunk Mains D and F duplication)[2];
- CTW-Orange Pipeline via Millthorpe;
- Lake Rowlands to Gooloogong Pipeline (CTW Trunk Mains P and C duplication);
- Gooloogong-Forbes Pipeline (including connection to Parkes);
- Woodstock-Cowra Pipeline (presently in planning);
- Orange-Molong Creek Dam pipeline (lower priority action resulting from the level of surety around the security of Molong. There is an existing pipeline from Molong Creek Dam into which this new pipeline would connect);
- New minor storage and water treatment facilities at Cumnock;
- New minor storage water treatment facilities at Yeoval;
- New minor storage at Condobolin (off-stream from Lachlan River);
- New pipeline replacing existing channel and minor storage at Lake Cargelligo;
- Burrendong-Wellington Pipeline;
- Chifley-Bathurst Pipeline;
- Chifley-Oberon Pipeline; and
- Belubula Creek-Cadia Hill pipeline (already available).

As the augmentation of Lake Rowlands is a key recommendation to improve security, it is a high priority action and planning for this work needs to commence as a priority. It is anticipated that the augmentation of Lake Rowlands, and the subsequent time for the storage to fill, will be the elements of the strategy which have the longest implementation timeframes. The approval and design (3-4 years) and delivery (4-5 years) of a new storage generally take between 7-10 years. Additional time would need to be allowed for the dam to fill and therefore become fully operational.

Whilst it may take up to 10 years before the augmented Lake Rowlands will be completed, other elements of the strategy can be advanced quickly.

Priority elements include the connection between Bathurst and Oberon, the provision of a Lachlan River connection to Lake Cargelligo and the connection between CTW and Cowra which is already in planning as well as the storages for Cumnock, Condobolin, Lake Cargelligo and Yeoval.

Continued Best-Practice Management

The implementation of the recommended region-wide strategy is in addition to:

- The ongoing management and maintenance of the existing water supplies of each town;
- The ongoing implementation of the best-practice demand management programs of each council; and
- The ongoing development and implementation of the existing Integrated Water Cycle Management Strategies completed by a number of the member council's including Bathurst, CTW, Orange and Parkes.

[2] It has been assumed that all duplicated lines associated with the regional network carry raw water. The costs of additional treatment have not been estimated as these are sunk costs given the utilities would need to provide this capacity to meet growth irrespective of the choice of strategy. There may be benefits of centralising additional water treatment requirements, but this would require further examination.

Impact of Climate Change

When examining the impact of climate change on water supply security, there needs to be consideration of the change in rainfall, temperature and evaporation regimes. These changes are forecast and then the impact on streamflows and demand sequences are inputs to supply security estimates.

The expected impacts of climate change in the Lachlan and Macquarie catchments includes increases in temperature from 0.7°C to 5.6°C and changes in rainfall from +20% to -40% by 2070[3].

Climate change is expected to result in decreased water availability and increased water demands. As such, the sensitivity testing illustrated that connection between the Upper Macquarie River Catchment and the Upper Lachlan Catchment may be required to ensure regional water supply security. This link would increase the supply security of both the Chifley and Lake Rowlands systems by creating the opportunity to transfer water in both directions in times of need.

Benefits to Other Sectors

Security improvement may be obtained through the partnering of towns with local irrigation operations. In return for up-front investment to assist irrigators to become more water efficient, towns would share in the resulting water saved and use this to supplement their supplies. However, there is considerable uncertainty about the reliability of this option for security improvement. As a result, it is the recommendation of this study that improvements in irrigation efficiency be considered primarily as an offsetting mechanism for new infrastructure, particularly where that infrastructure will inherently remove additional water from river systems.

In addition, the recommended strategy reduces the dependence of river-side towns on the Lachlan and Macquarie rivers through the provision of new additional town water storage and a regional network of pipes. This will reduce the need to manage the major dams in relation to town water supplies in times of drought.

There may be mutual benefit in considering the provision of some of the region's mining related water demands in association with the recommended strategy. For the mining demands identified, the combination of the augmented Lake Rowlands and Chifley Dam are able to contribute significantly to providing these demands, although this does increase the risk of supply failure if not properly managed. However, if Chifley Dam were not available to supplement supply from Lake Rowlands, and to help avoid the supply risk failure, additional mining demands would need to be met from either increasing the planned size of the amplification of Lake Rowlands, or by supply from the major dams (Wyangala or Burrendong). This would also impact on the sizing (and therefore costs) of the raw water transfer network included in the recommended strategy.

Financial commitment would need to be sought from the mining sector prior to investment in larger assets and this assessment does not consider the need for the mining sector to acquire additional water allocations.

Details of the Recommended Strategy

The components of the recommended region-wide strategy, are set out on a Council by Council basis below.

Council	Region-Wide Strategy Implementation
Centroc	Commence an Expression of Interest (EoI) process to identify potential irrigation operations to partner with the Centroc Councils to improve water efficiency on farm and share the resulting water savings. Initiate the implementation of a Regional Water Conservation and Demand Management Program with the benefit of sharing resources.

[3] CSIRO (2007) Climate change in the Lachlan and Central West Catchments.

Council	Region-Wide Strategy Implementation
	Develop and implement a uniform drought restrictions regime based on the source of supply.
	Provided the State with advice regarding the recommendations of this report for consideration in their current determination of the way forward for water utilities management in Central NSW.
Bathurst	Commence approval, consultation, planning and design processes for the construction of the Chifley Dam to Bathurst pipeline.
	Develop a Water Sharing Plan for water users below Chifley Dam.
	Commence work with Oberon Council in the approvals, consultation and planning and design processes for the construction of the Chifley Dam to Oberon pipeline.
Blayney	See Central Tablelands Water
Boorowa	Undertake further investigations to close data gaps and confirm the results of the high level water security analysis undertaken for this study.
Cabonne	Commence approval, consultation, planning and design processes for the construction of the bulk water supply storage and water treatment facilities for Cumnock and Yeoval.
	Commence preliminary planning for the potential need to link to the CTW system between Orange and the existing Molong Creek Dam pipeline.
Cowra	Continue with implementation of link between Cowra and to CTW supply.
Forbes	Commence approvals, consultation, planning, design and operating regimes of Lake Rowlands to Forbes Pipeline via Gooloogong (including connection to Parkes).
Harden	Commence further investigations to close data gaps and consider the possible mutual benefits of a link to the Central Tablelands supply system.
Lachlan	Commence approval, consultation, planning and design processes for the construction of the integrated pipeline and storage system for Lake Cargelligo
	Commence approval, consultation, planning and design processes for the construction of the off-stream storage facility at Condobolin
Lithgow	Benefits indirectly through the provision of alternative supply to Oberon as this relieves pressure on the Fish River Water Supply.
Oberon	Commence approval, consultation, planning and design processes for the construction of the Chifley to Oberon pipeline – including liaison with Bathurst Council.
Orange	Commence approvals, consultation, planning, design and operating regimes of the Lake Rowlands to Orange Pipeline via Milthorpe.
Parkes	Commence approvals, consultation, planning, design and operating regimes of the Lake Rowlands to Parkes Pipeline via Gooloogong.
Upper Lachlan	Undertake further investigations to close data gaps and confirm results high level water security analysis undertaken for this study
Weddin	See Central Tablelands Water
Wellington	Commence approval, consultation, planning and design processes for the construction of the Lake Burrendong to Wellington pipeline.
Young	Undertake further investigations to close data gaps and consider the possible mutual benefits of a link to the Central Tablelands supply system.

Council	Region-Wide Strategy Implementation
Central Tablelands Water	Commence approval, consultation, planning and design processes for the construction of the augmentation of Lake Rowlands and associated pipeline links to Orange, Forbes and Parkes.

Details of the costs of infrastructure are set out in Section 5.

Contingency Actions for Emergency Situations

Approvals and stakeholder engagement process are critical elements in planning timeframes for infrastructure delivery. This will be particularly the case for the augmentation of Lake Rowlands, but also for all other recommended elements of the strategy. As a result, the on-going maintenance of existing emergency bores for Wellington, Yeoval, Blayney, Bangaroo, Gooloogong, and Crookwell is recommended.

In addition, contingent on the development of an emergency situation, the following actions should be considered:

- The emergency development of the groundwater resources of Forbes, Wellington, Condobolin and Lake Cargelligo
- The construction of the pipeline connection between Orange and the Macquarie River.

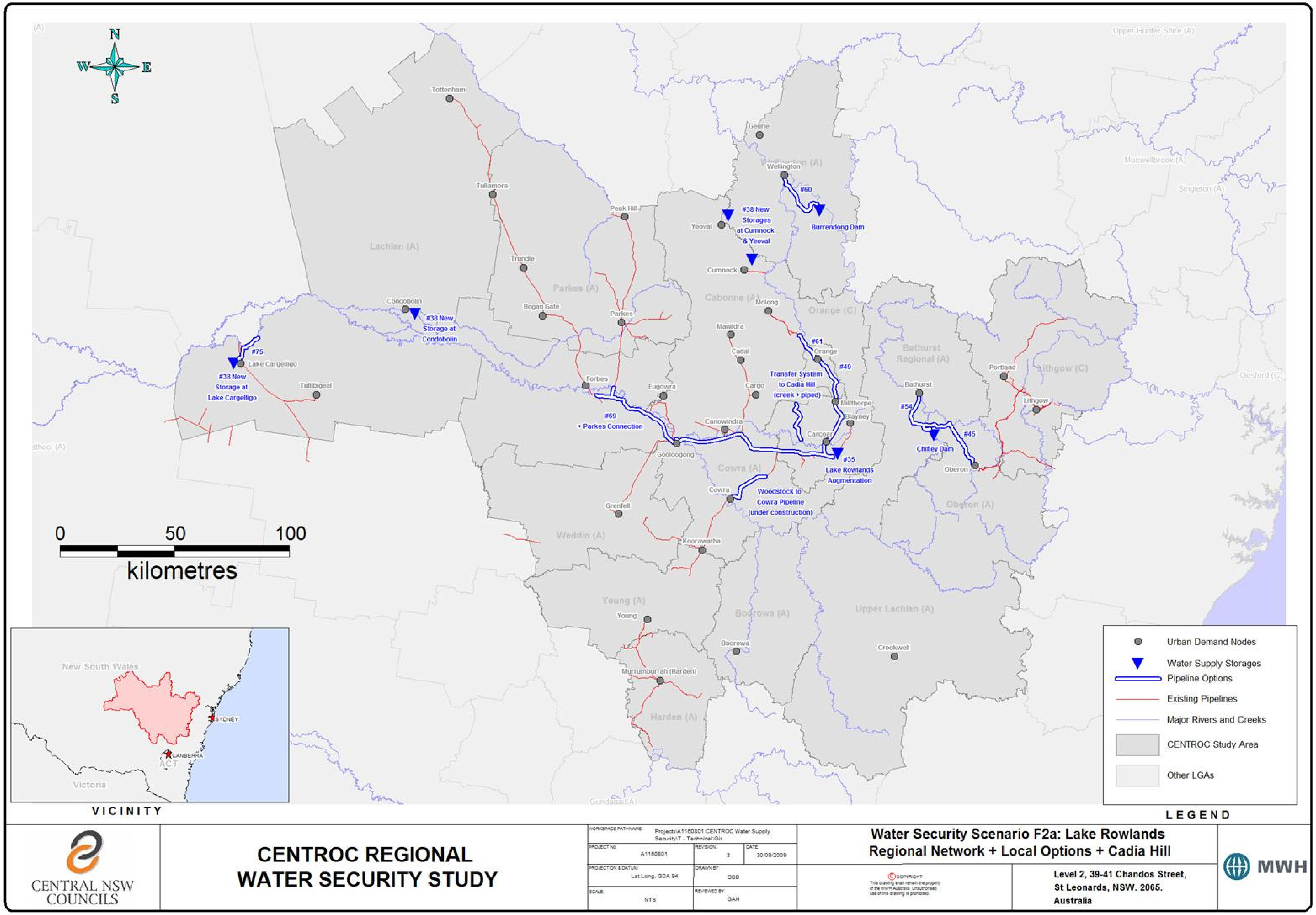

Figure Ex-1: A Layout of the Preferred Region-Wide Water Security Strategy

LIST OF ACRONYMS

ACRONYM	DEFINITION
BRC	Bathurst Regional Council
BSC	Blayney Shire Council
BWSC	Boorowa Shire Council
Centroc	Central NSW Regional Organisation of Councils
CSC	Cabonne Shire Council
CTW	Central Tablelands Water
CWSC	Cowra Shire Council
DECCW	NSW Department of Environment, Climate Change & Water (formerly DWE)
DoP	NSW Department of Planning (now part of the Department of Planning & Local Government)
FSC	Forbes Shire Council
HSC	Harden Shire Council
LCC	Lithgow City Council
LGA	Local Government Area
LSC	Lachlan Shire Council
LWU	Local Water Utility
MDB	Murray-Darling Basin
NWC	National Water Commission
NWI	National Water Initiative
OC	Oberon Council
OCC	Orange City Council
PRG	Project Reference Group
PSC	Parkes Shire Council
PSC	Project Steering Committee
PTC	Project Technical Committee
TBL	Triple Bottom Line
ULSC	Upper Lachlan Shire Council
WLSC	Wellington Shire Council
WRI	Western Research Institute
WSC	Weddin Shire Council
YSC	Young Shire Council

GLOSSARY[4]

TERM	DEFINITION
BASIX	A planning tool developed by the NSW Government that is used by development applicants to measure their compliance with environmental guidelines covering water and greenhouse gas efficiency and other related building aspects. Required for building and renovation approval.
Demand management	Measures, programs or strategies aimed at reducing the consumption of water by reducing the demand for it.
Emergency Drought Circumstances	Derived from the NSW Government Drought Relief program which supports declared emergency capital works including investigations, design and construction. There are no defined trigger points for declaring action.
Environmental Flows	River flows, or characteristics of the river flow pattern that are either protected or created for an environmental purpose, usually the protection of habitat or an ecological process.
Groundwater	Underground water filling the voids in rocks; water in the zone of saturation in the earth's crust. See also aquifer.
Integrated Water Cycle Management (IWCM)	Planning approach that aims to optimise water, sewer and stormwater management through assessing the urban water system components as interrelated parts of a cycle. DECCW Best-Practice requirement.
Integrated Water Resource Management	Planning approach that considers all potential sources of water to develop a region-wide strategy to improve water supply.
Node	A point in a model containing information that represents the water demand of one or more towns and villages.
Option	A water planning initiative that addresses the need for water security improvement in the study area. An option is also a component of a scenario or water security strategy.
Reliability of Supply	The percentage of time with an uninterrupted water supply (i.e. no restrictions on use).
Recycled water	Sewage effluent or treated stormwater that has been treated to a level where it can be reused.
Scenario	Complementary bundles of integrated water planning initiatives that were used to evaluate various themed approaches to improve water security in the study area.
Security of Supply	The ability of the supply system to meet demands at any time and represents the chance of running out of water.
Strategy	A package of regional and local integrated water planning initiatives that addresses the short- to long-term water security improvement needs of all demand centres in the study area.
Stormwater	Rainfall that flows over hard surfaces in urban areas and is collected in drainage systems for disposal.
Surface water	Water on the surface of the land, for example in rivers, creeks, lakes and dams.
Triple Bottom Line Analysis	Consideration of the economic, social and environmental outcome in decision-making.
Water demand	The water needs of a town including homes, commercial and industrial enterprises or businesses and public organisations.
Water supply	The available water sources, water extraction, storage, transfer and treatment systems to supply town water.
WELS	Water Efficiency Labelling and Standards Scheme introduced by the Australian Government.

[4] The terms in this glossary are found in the main body of the report. Where additional technical terms require explanation to assist in understanding the material contained in appendices, a separate listing of terms has been provided at the beginning of the relevant appendix.

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CENTROC WATER SECURITY STUDY

COMPONENT 2: OPTIONS PAPER FINAL

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1. INTRODUCTION

In response to the worst drought on record for the region, Centroc (Central NSW Councils) undertook to complete a Water Security Study to investigate and recommend solutions to improve water supply security across the Centroc region. The study had two components:

1. Component 1: An audit of existing infrastructure for bulk water supply; and
2. Component 2: An options paper for improving water supply security.

The Component 1 report characterised the current bulk water supply assets and infrastructure of the region. The Component 1 report was finalised in August 2009.

Adequate water supply infrastructure in the Centroc Region is required for sustainable regional growth and development.

This report (the Component 2 report) documents the options for improving water supply security across the region for a planning horizon of 50 years.

1.1 CONTEXT

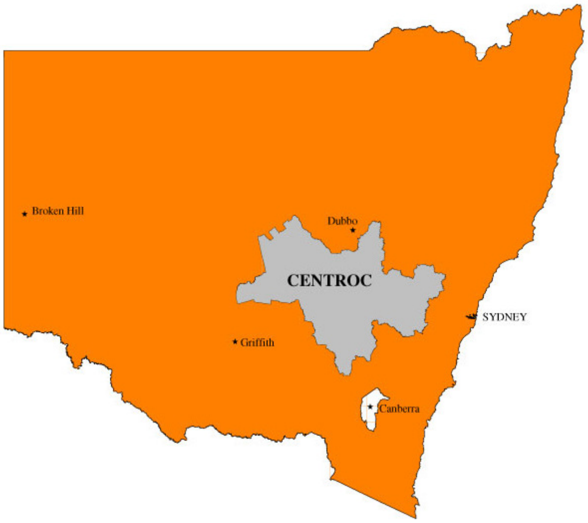
Centroc represents the Central NSW Councils (Figure 1) of:

- Bathurst Regional Council,
- Blayney Shire Council,
- Boorowa Shire Council,
- Cabonne Council,
- Cowra Shire Council,
- Forbes Shire Council,
- Harden Shire Council,
- Lachlan Shire Council,
- Lithgow City Council,
- Oberon Council,
- Orange City Council,
- Parkes Shire Council,
- Upper Lachlan Shire Council
- Weddin Shire Council,
- Wellington Council,
- Young Shire Council and
- Central Tablelands Water County Council.

Figure 2 illustrates the major cities and towns within the local government areas serviced by member councils.

Central NSW is recognised as vital to the sustainable future of New South Wales and Australia. Centroc is recognised as the lead organisation advocating on agreed regional positions and priorities for Central NSW whilst providing a forum for facilitating regional cooperation and sharing of knowledge, expertise and resources. The provision of adequate water supply infrastructure for maintaining acceptable standards of health and living as well as sustainable regional growth and development is an advocacy priority for Centroc.

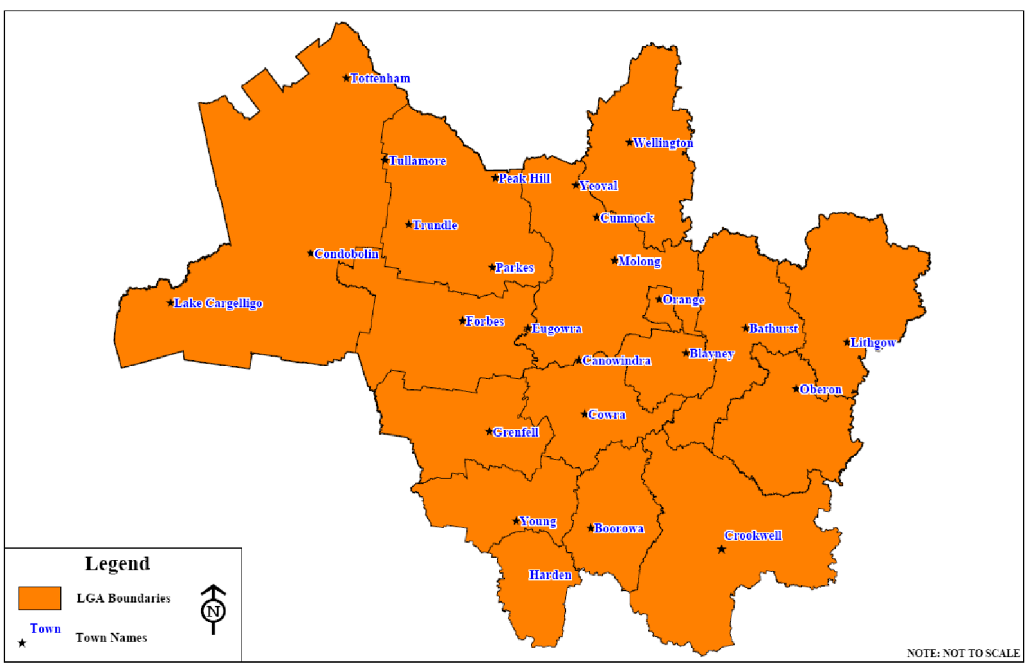
Figure 1: Central NSW Region (Source: Centroc)[5]



This study has been developed in response to the worst drought on record.

Centroc seeks support from the State and Federal governments to assure an adequate level of water security. In support of the Mid Lachlan Alliance of Councils concerns regarding drought, Centroc commenced seeking support for a Water Security Study in 2006. Centroc was successful in accessing funding from the NSW Department of Environment, Climate Change & Water (DECCW) for the preparation of the Centroc Water Security Study. The study has been developed in response to the worst drought on record in the region and local communities seeking a higher level of water security. Based on the outcomes of this study, Centroc will work on ways to improve water security in the region including seeking funding for appropriate infrastructure solutions.

Figure 2: Central NSW Councils (Source: Centroc)



[5] Since these diagrams were produced, Upper Lachlan Shire Council has joined Centroc. This is not show in Figure 1.

1.2 PURPOSE AND SCOPE OF THIS REPORT

The cities and towns of Central NSW, as well as the irrigation and mining sectors of the region, are dependent on the security of water for their social, environmental and economic viability.

Central NSW, and the Murray Darling Basin in which it is situated, is experiencing an extended drought that has raised concerns about the security of town water supplies. In addition, over-allocation of water resources throughout the Murray Darling Basin has been an issue leading to a broader concern about the security of water allocations to other sectors. Similar consequences have been felt in terms of the availability of environmental water and the availability of water for other economic activities including irrigation and mining.

In this context, climate change, which may result in higher temperatures and changes in rainfall and runoff patterns, represents an additional risk to the security of water resources in the region.

This study establishes the need for water security improvement and recommends a region-wide strategy which achieves the required security improvement taking into account economic, social and environmental considerations.

Continued water supply security is necessary for maintaining acceptable standards of health and living for the community and to ensure sustainable long term growth and development in the region.

The Component 2 report of the Centroc Water Security Study aims to:

- Establish the need for water security improvement for town water supplies. This is discussed in Section 3.
- Identify and evaluate options to improve town water supply security across the region, taking into account complementary opportunities to improve water security outcomes for other sectors (see Section 4).
- Recommend a regional water security strategy which achieves the required security improvement taking into account economic, social and environmental considerations (see Section 5).
- Set out a plan of action for implementing the recommended strategy including the management of potential implementation risks (see Section 5).

To achieve these aims, an integrated water resource management approach has been adopted to promote the efficient and effective management of water resources. This is discussed in Section 2.

2. THE STUDY APPROACH

The approach to this study was built on three key principles:

1. Stakeholder engagement – consultation was undertaken to seek the views of stakeholders in order to improve study outcomes;
2. Consideration of the economic, social, environmental (triple bottom line – TBL) impacts of the choices for water security improvement to inform decision making; and
3. The integration of the management of water resources, recognising the need for holistic approaches to water management.

These are discussed in the following sections.

2.1 STAKEHOLDER ENGAGEMENT

As this study was a high level, regionally focussed, feasibility investigation, consultation was undertaken to seek the views of stakeholders in order to improve study outcomes and to create stakeholder involvement and ownership of the study outcomes. The goal of the consultation approach was to obtain stakeholder feedback on analysis, alternatives and/or decisions. To support this goal, the project team made a commitment to ensure stakeholders were kept informed, listened to and their concerns and aspirations acknowledged and feedback provided on how their input influenced the decision.

Who has Been Involved in this Project?

Stakeholder engagement in the planning process for this study recognises and respects the value of input from the **Mayors, elected representatives** and **General Managers** of the Centroc Board. These stakeholders are significant repositories of information and knowledge about community values and the local government areas represented, particularly around water resources and their management.

The Project Steering Committee comprised General Managers, **Directors and Senior Managers in Engineering** as well as representation from the State **Dept of Environment, Climate Change and Water.**

Technical input was provided by **staff slated with responsibility for water supply** for the 17 member Councils.

The broader **community** was engaged in two main ways.

- Formal engagement was undertaken with the Project Reference Group which included members from irrigation, stock and domestic, environmental, indigenous, mining and the community sectors.
- The community was engaged through the media and by self selecting for information by direct contact with project personnel.

Engagement with community, irrigation and mining sector stakeholders underpinned the development and assessment of water security options.

Key internal stakeholders engaged throughout the process included:

- Centroc: including the Project Steering Committee (PSC) and other elements of the Centroc governance structure such as the Centroc Board. The PSC was engaged through a process of fortnightly meetings with the project manager to review the project and discuss issues. The PSC also attended the engagement workshops discussed below. The Centroc board was engaged through the PSC representatives and through a number of presentations on the project as it progressed.
- DECCW who were represented on the PSC.

- The local water utilities of the Centroc region. This group was engaged in the process through the formation of a Project Technical Committee (PTC). This group met in two formal workshops: firstly to review the study objectives and data requirements; and secondly, to review preliminary options assessments. The PTC was also engaged in a series of telephone interviews to confirm the long list of options and in reviewing and providing comments on the Component 1 and 2 reports.

Other key stakeholders included:

- The communities represented by the Centroc member Councils;
- Water using economic entities including irrigation and mining entities;
- Catchment managers for the Lachlan and Macquarie rivers representing environmental interests including environmental water; and
- Indigenous communities within the Centroc region.

These stakeholders were represented by the Project Reference Group (PRG). The members of the PRG were identified and invited to participate by the Centroc Board. The PRG met through the study in a series of facilitated workshops:

1. Workshop 1: Setting Goals. This workshop involved the PRG determining the project objectives and the criteria by which they would be measured (see Section 2.2) and identifying water management issues across the Centroc region;
2. Workshop 2: Reviewing the Long-List of Options. This workshop involved presenting to and taking feedback from the PRG on the long-list of options (see Section 4.1) with the potential to improve water supply security and to address the issues raised in the first workshop.
3. Workshop 3: Scenario Assessment. This workshop involved presenting the preliminary water security improvement strategies, which were formulated in response to the issues identified in the first workshop and considering the options discussed and the second workshop, to the PRG for feedback.

The planning approach took account of the potential economic, social and environmental outcomes associated with options.

Stakeholder engagement assisted in defining the study objectives, and provided critical local knowledge into the evaluation of potential solutions and final strategies to improve the outcomes of the study. Further details of the stakeholder engagement process are set out in Appendix A.

2.2 TRIPLE BOTTOM LINE ASSESSMENT

A key outcome of this study was the need to recommend the most appropriate strategy for improving water security across the Centroc region. In order to do this, a framework to guide decision making was developed. Key to the framework was the need to understand the economic, social and environmental outcomes (both positive and negative) associated with decisions. Consideration of these three elements is often referred to as taking a TBL approach to decision making.

A TBL assessment does not provide a ‘right or ‘wrong’ answer. The assessment is used to understand the factors for consideration in coming to a decision and to make trade-offs. The different options under consideration will have different social, environmental and economic consequences. These will need to be traded-off in coming to a final conclusion.

Together with the PRG and the PSC, the TBL objectives and assessment criteria set out in Table 2-1 were defined for this study.

Table 2-1: Study Objectives and TBL Assessment Criteria

OBJECTIVE	CATEGORY	CRITERIA
Protection of water for the environment	Environmental	Annual Water Consumption (ML/a)
		Requirement for Additional Entitlements
Minimise Infrastructure Footprint		Land use (ha)
Efficient water usage	Economic	Water Saving (ML)[6] Cost per percentage point improvement in reliability ($/% improvement)[7]
Efficient energy usage		Unit Energy Consumption (kWh/ML)
Minimise Financial Burden		Cost to Households ($/household)
Equity and acceptability: looking for win-win opportunities	Social	Subjective scale of 1-5 to be developed with PRG
Cost effectiveness of management options		Cost per Unit of Water Provided ($/kL)
Improvement to Urban Water Reliability		Percentage of Node(s) Water Demand Met (%)

These objectives and criteria were used at three key points in the study process:

- To complete the preliminary short-listing of options contained on the long-list of potential options (see Section 4.2) to improve water supply security. Engineering feasibility and design considerations were also taken into account in determining the short list (see 4.2 for details);
- To understand the relative performance of scenarios. Scenarios are themed groupings of short-listed options (see Section 4.3). Grouping options into themes allowed, for example, a comparison between the idea of a regional water grid and the region-wide application of recycling and stormwater harvesting to be made. Scenarios did not necessarily fully address the need for water security improvement for each town. For instance, in the recycling and stormwater harvesting scenario, it was found that this approach would not be sufficient to meet the long-term needs of some towns.
- To assess the relative performance of region-wide strategies for improving water security (see Section 0). Region-wide strategies were comprised of a mixture of the short-listed options including, for instance, combinations of new storage, transfer pipes and recycling. The key difference between scenarios and region-wide strategies is that the region-wide strategies identify feasible options to improve the water supply security of each town. In some cases, the region-wide strategies also identified benefits to the environment, irrigation and mining sectors as well.

2.3 INTEGRATED WATER RESOURCE MANAGEMENT

An important part of identifying feasible options for improving water supply security is recognition of the full list of potential sources of water:

[6] Used for options assessment

[7] Used for scenario and strategy assessments

- Water can be saved by ensuring towns and other users are efficient in their use of water;
- Water can also be saved by improving the operation of existing supplies and systems to reduce evaporative losses from dams, river transfer systems and on-farm applications;
- Alternatives for drinking water can be found for some uses. For instance, new development may represent the opportunity to use recycled water or rainwater to meet some part of the demand for water; and
- In some cases, such as groundwater reserves, new sources of water may be able to be developed.

Adopting the integrated approach to planning ensured that all potential sources of water were taken into account when developing the recommended region-wide strategy to improve water supply security in the Centroc region.

2.4 SUMMARISING THE PLANNING PROCESS

Using the three principles (stakeholder engagement, triple bottom line assessment and integrated water resource planning) discussed above, the planning process set out in Figure 3 on the following page was applied to develop the recommendations of this study. The left hand side of the figure illustrates the application of the stakeholder engagement process. The right side of the figure illustrates the application of the TBL and integrated water resource management principles to the planning process. The planning process involved:

- The development of a project vision, objectives assessment criteria and water management issues to be addressed in consultation with stakeholders (see Section 2.1);
- The preparation of forecasts (referred to as the baseline) of water supply demand for each town over the next 50 years (see Section 3.1);
- The development of a long-list of possible options to improve water supply security in the region in consultation with stakeholders (see Section 4.1);
- The preliminary short-listing of options (see Section 4.2), using the TBL assessment approach, stakeholder feedback and engineering assessments to eliminate any options that are either unfeasible or unacceptable;
- The bundling of short-listed options into thematic scenarios (see Section 4.3) and assessing the TBL outcomes of these scenarios;
- Development of region-wide strategies (see Section 0), by analysing the outcomes of the scenario assessment and considering stakeholder feedback, to determine the most appropriate combination of options to improve the water security outcomes for each of the towns in the region;
- Sensitivity testing to determine the impact of key assumptions, such as the cost of energy, and the vulnerability of the region-wide strategies to climate change. Climate change scenarios were applied only at the sensitivity testing stage as it was important to firstly understand the prevalent climate trends for the region, in the absence of climate change, in order to project accurate baseline forecasts;
- The selection of the preferred region-wide strategy, considering the feedback of stakeholders and the examination of trade-offs between competing economic, social and environmental outcomes.

Water conservation and managing the risk of climate change through source diversification were important considerations in developing the plan.

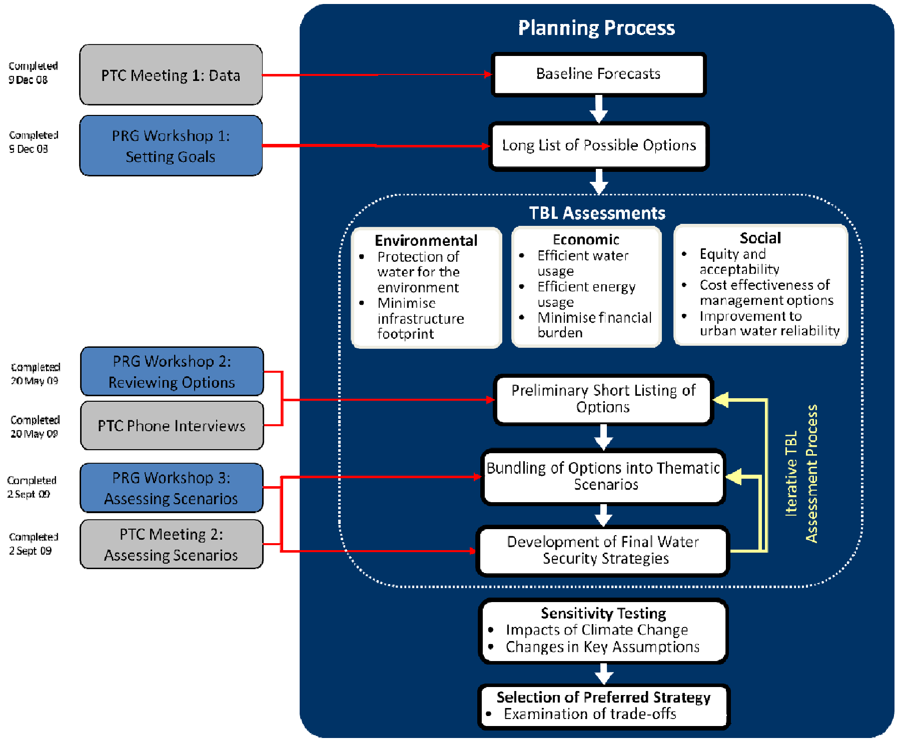


Figure 3: The Integrated Water Security Strategy Planning Process

A Leading Approach to Water Security Modelling

Determining water supply security involves making assessments of expected future water demand and streamflows. In this study, these assessments have been made using climate records that are consistent with historical records in space and in time to generate both streamflow and demand "replicates". Replicates are theoretical sequences of data which are based on, and have identical statistical characteristics to, the historical records of streamflow and demand. These replicates represent the random fluctuations observed in historical data and allow these to be considered in determining the security of the water supply.

Using these climate dependent water demands ensures we have captured high water demands in dry periods and low water demands in wet periods rather than averages.

This is a leading modelling approach that is essential for a robust understanding of local and regional water security.

3. THE NEED FOR WATER SECURITY IMPROVEMENT

Establishing the extent of the need for water security improvement was the first step necessary to develop an effective long term, region-wide water security strategy for the Centroc region. Three main steps were taken to establish the need for water security improvement:

1. Forecasts of the expected demands for water from each of the towns for the next 50 years were developed. Forecasts took into account expected growth in each town and the potential to improve the efficiency of water demand;
2. A model of the surface and groundwater resources of the region was built. The model was designed to be able to determine the likely water resources available under both the current climate sequence and the changes in this sequence that may come about as a result of climate change.
3. The integration of the demand for water and the availability of water in the model to assess the level of water supply security for each town under both current climate and a climate change impacted sequence.

These steps are discussed in the following sections.

3.1 FORECASTING DEMAND FOR WATER

Modelling the water demands of the towns of the Centroc region is a complex undertaking. To simplify the modelling process and improve the reliability of outcomes, the demands of neighbouring towns and villages are sometimes treated as a single modelling “node”. The demand nodes, and the towns and villages they represent, are outlined in Table 3-1. Other smaller towns, largely dependent on rainwater tanks or minor surface and groundwater supplies, were excluded from the modelling. For more information on these towns, see Appendix B.

Forecasts of the water demands for each of the towns for the next 50 years were developed taking into account expected growth and the potential to conserve water.

Table 3-1: Water Demand Nodes Modelled

DEMAND NODE	WATER SUPPLY SCHEME	LWU/COUNCIL	URBAN CENTRES INCLUDED
Bathurst	Bathurst	Bathurst Regional Council	Bathurst
Blayney - Carcoar	Central Tablelands Water	Blayney Shire Council, Bathurst Regional Council	Blayney, Millthorpe, Carcoar, Lyndhurst, Mandurama, Garland
Boorowa	Boorowa	Boorowa Council	Boorowa
Canowindra	Central Tablelands Water	Cabonne Shire Council	Canowindra, Woodstock
Condobolin	Lachlan	Lachlan Shire Council	Condobolin
Cowra - Koorawatha	Cowra	Cowra Shire Council, Young Shire Council, Weddin Shire Council	Cowra, Koorawatha, Bendick Murrell, Brundah, Greenethorpe, Mogongong, Wattamondara
Crookwell	Upper Lachlan	Upper Lachlan Council	Crookwell
Cudal/ Cargo/ Manildra	Central Tablelands Water	Cabonne Shire Council	Cudal, Cargo, Manildra
Cumnock - Yeoval	Cumnock	Cabonne Shire Council	Cumnock, Yeoval

DEMAND NODE	WATER SUPPLY SCHEME	LWU/COUNCIL	URBAN CENTRES INCLUDED
Forbes	Forbes	Forbes Shire Council	Forbes
Gooloogong-Eugowra	Central Tablelands Water	Cowra Shire Council, Cabonne Shire Council	Gooloogong, Eugowra
Grenfell	Central Tablelands Water	Weddin Shire Council	Grenfell
Lake Cargelligo	Lachlan	Lachlan Shire Council, Tullibigeal	Lake Cargelligo, Murrin Bridge, Tullibigeal
Lithgow - Portland	Fish River, Lithgow	Lithgow Shire Council	Lithgow and Portland
Molong	Molong	Cabonne Shire Council	Molong
Murrumburrah (Harden)	Harden, Goldenfields Water County Council	Harden Shire Council	Galong, Murrumburrah, Jugiong, Wombat
Oberon	Oberon	Oberon Council	Oberon, Oberon timber industry
Orange	Orange	Orange Shire Council	Orange, Clifton Grove
Parkes	Parkes	Parkes Shire Council	Parkes, Peak Hill, NorthParkes Mine
Wellington - Geurie	Wellington	Wellington Council	Wellington, Geurie, Nanima
Young	Young	Young Shire Council	Young

Key factors considered in forecasting demand included:

- Determining the current level of water demand in each town taking into account the impact of water restrictions, climate and water pricing structures;
- Determining the impact of key drivers of future water demand including:
  - Population growth projections;
  - Trends in household size;
  - Trends in the uptake of water efficient fixtures and appliances;
  - Existing demand management programs;
  - The impact of demand management programs and planning policies such as BASIX and Water Sensitive Urban Design; and
  - The potential impact of climate change.

The population growth rates applied across the region were based on Scenario C of the 2006-2031 population demographic projection report completed by the Western Research Institute for Centroc. These projections are similar to those prepared by the Department of Planning.

Using a series of specialist demand models that account for each of the factors above, daily forecasts of the demands for households, commercial, industrial and other water users associated with each of the towns were developed. These baseline forecasts are summarised in Table 3-2 in terms of the average annual demand. Importantly, these forecasts include the expected impact of the water efficiency programs that each of the member Council's has already committed to putting in place across the region.

Table 3-2: Summary of Water Demand Forecasts

DEMAND NODE	POPULATION SERVED WITH WATER		BASELINE AVE ANNUAL DEMAND (ML)	
	2009	2059	2009	2059
Bathurst	30,054	32,749	6,420	7,618
Blayney - Carcoar	4,143	4,464	907	1,044
Boorowa	1,075	954	178	172
Canowindra	1,519	1,637	332	385
Condobolin	2,882	3,581	883	1,291
Cowra - Koorawatha	8,837	9,687	2,836	3,494
Crookwell[8]	1,999	1,936	331	335
Cudal/ Cargo/ Manildra	1,187	1,279	260	302
Cumnock - Yeoval	601	618	177	201
Forbes	8,161	8,499	2,761	3,074
Gooloogong-Eugowra	713	768	156	180
Grenfell	2,018	2,174	441	513
Lake Cargelligo	1,397	1737	428	626
Lithgow - Portland	11,379	11,301	1,794	2,069
Molong	1,586	1769	278	387
Murrumburrah (Harden)	2,243	2,249	792	863
Oberon	2,514	2,667	839	960
Orange	36,766	42,107	5,837	7,373
Parkes[9]	11,203	14,118	6,731	8,150
Wellington - Geurie	5,245	6,304	1,348	1,946
Young	7,373	8,590	1,618	2,039

The available water resource was determined by modelling the existing water supply systems.

In the absence of any demand management effort the water demand in the urban communities considered in the study can be expected to rise approximately 22% over the 50 year planning horizon. A significant proportion of this growth (over one half) can be offset with the continued implementation of existing demand management programs and the introduction of new programs.

Further details of the demand analysis and forecasting process, assumptions and outcomes are set out in Appendix B.

[8] Insufficient data was available to assess the demands of Taralga and Gunning.
[9] Demand including Northparkes mines

3.2 DETERMINING THE AVAILABLE WATER RESOURCE

Utilising the outcomes of the Component 1 Infrastructure Audit, the existing water supplies for each of the towns, including the State Water storages of Wyangala and Burrendong Dams, were incorporated in a region-wide model of the surface and groundwater resources. This model is designed for assessing town water supply security options, but is not complete for the purposes of water sharing activities. Similarly, as only limited models do exist for groundwater in the region, much of the groundwater assessment undertaken was based on desktop assessment.

The existing water supply sources are set out in Table 3-3. Emergency back-up supplies, such as a number of bores in the region, were not included in the models. These supplies are suitable for contingent service provision rather than as elements of regular supply.

Table 3-3: Existing Water Supply Sources

DEMAND NODE	SOURCE SUPPLYING	STORAGE (ML @ FSL)	EXTENT OF USE
Bathurst	Chifley Dam	30,800	Chifley Dam is used for water supply about 50% of the time from about November to April.
	Macquarie River Weir	1,700	Fish River is the main source from May to October (with only riparian release during this time from Chifley).
Blayney – Carcoar	Lake Rowlands	4,500	Lake Rowlands is the main source of water supply operating all year round.
Boorowa[10]	Boorowa Dam	335	Boorowa Dam is the main source of water supply operating all year round.
Canowindra	Lake Rowlands	4,500	Lake Rowlands is the main source of water supply operating all year round.
Condobolin	Goobang Creek Weir	-	Goobang Creek Weir is the main source of water supply operating all year round.
Cowra - Koorawatha	Wyangala Dam	1,220,000	Wyangala Dam is the main source of water supply operating all year round.
Crookwell[10]	Crookwell (Kentgrove) Dam	450	Crookwell Dam is the main source of water supply operating all year round.
Cudal/ Cargo/ Manildra	Lake Rowlands	4,500	Lake Rowlands is the main source of water supply operating all year round.
Cumnock – Yeoval	Bell River and Buckinbah Creek Weir	23 (Cumnock storage)	A pump well structure on the bank of Bell River and an earthen storage dam provides the main source of water supply to Cumnock operating all year round. Buckinbah Creek Weir is the main source of water supply for Yeoval operating all year round.

[10] Limited data was available on the operation and nature of this supply. As a result, the modelling is not conclusive. There is a difference of opinion at the state and local government level about the level of security of this supply. Although sought, during the timeframes of this study, no additional data was available. It is recommended additional work be undertaken to clarify the security of this system.

DEMAND NODE	SOURCE SUPPLYING	STORAGE (ML @ FSL)	EXTENT OF USE
Forbes	Wyangala Dam	1,220,000	The Lachlan River offtake is the primary source of water supply for Forbes operating all year round. The river offtake also provides water supply for the Forbes-Tottenham network. Wyangala Dam is the main bulk water storage located in the upper Lachlan River that controls releases downstream.
	Hillston Weir (Lachlan River)	-	
Gooloogong-Eugowra	Lake Rowlands	4,500	Lake Rowlands is the main source of water supply operating all year round.
Grenfell	Lake Rowlands	4,500	Lake Rowlands is the main source of water supply operating all year round.
Lake Cargelligo	Lachlan River Weir Pool	-	Lake storage at Lake Cargelligo is the main source of water supply operating all year round. The lake is fed by a weir pool on the offtake of the Lachlan River.
Lithgow - Portland	Farmers Creek Dam (also known as Lithgow No.1)	77	Farmers Creek No. 1 Dam is no longer used for water supply but has been utilised for flood retention purposes.
	Farmers Creek No.2	440	Farmers Creek No. 2 Dam is the main source of water supply operating all year round and supplemented by the Clarence Colliery Transfer System or the Fish River Water Scheme when the Dam is below 88%. The choice of supply is dependent on climate and other factors.
Molong	Molong Creek Dam	1,000	Molong Creek Dam is the main source of water supply operating all year round for the full range of water restrictions until the source becomes exhausted or water quality prohibits its use.
	Borenore Creek Dam	230	Borenore Creek Dam is the secondary source of water supply and is used under level 5 restrictions the source become exhausted or until water quality prohibits its use.
Murrumburrah (Harden)	Jugiong (Goldenfields Water County Council - GWCC)	-	The GWCC network provides the main source of water supply via Jugiong all year round.
Oberon	Oberon Dam	45,400	Oberon Dam is the main source of water supply operated through the Fish River Water Scheme all year round.
Orange	Suma Park Dam	18,000	Suma Park Dam is the main source of water supply operating all year round.
	Spring Creek Dam	4,500	Use presently operationally constrained. Treatment plant has been mothballed due to excess capacity at the main plant.
Parkes	Bogan River Weir @ Peak Hill	-	Bogan River Weir provides secondary water supply to supplement Peak Hill demand when required.

DEMAND NODE	SOURCE SUPPLYING	STORAGE (ML @ FSL)	EXTENT OF USE
	Lake Endeavour	2,400	Lake Endeavour and Lake Metcalfe are utilised until 65% capacity and then held for summer demand.
	Beargamil Dam (Lake Metcalfe)	480	
	Parkes Borefield (Upper Lachlan Alluvium)	-	Parkes borefield is the main water supply source operating all year round to supply the Northparkes Mine.
	Lachlan River offtake	-	The Lachlan River offtake is the second main source of supply to Parkes.
Wellington - Geurie	Burrendong	1,188,000	Burrendong Dam is the main source of water supply operating all year round.
Young	Jugiong (GWCC)	-	The GWCC network provides the main source of water supply via Jugiong all year round.

In determining the available water resource, the model takes into account:

- Expected temperature, rainfall and evaporation;
- Land-use in the catchment;
- Operational rules for storages and systems;
- Groundwater sources, recharge and interaction with surface water flows where detailed models were already available.

Further details of the water resource modelling approach are set out in Appendix C.

3.3 SUMMARISING THE KEY WATER SECURITY IMPROVEMENT NEEDS

The key water security improvement needs for the Centroc region are set out in Figure 4 and Table 3-4. There are two key concepts in water security assessment: reliability and security. Reliability of supply is defined as a percentage of time with an uninterrupted water supply (i.e. no restrictions on use). Security of supply is the ability of the supply system to meet demands at any time and represents the chance of running out of water. For details of the modelling undertaken to make this assessment, see Appendix C.

How is Water Supply Security Determined?

Historically, the secure yield of a water supply has been determined using the “5, 10, 20 rule”. This rule is an accepted guideline, not a standard. This rule states that the secure yield is the annual demand that can be supplied:

- Without restrictions of any kind applied for more than 5% of the time (the “5” element);
- Where restrictions are applied, they should not be imposed more than one year in ten on average (the “10” element); and
- The system should be able to supply 80% of normal demand (i.e. 20% reduction in consumption) through a repeat of the worst drought on record (the “20” element).

It is important to note, that, even with this rule, there are financial (affordability), social and environmental reasons why this level of service may not be provided in all areas.

Secure yield determination is based on historical events. This approach is considered to be "static" and "deterministic" modelling as it considers non-varying future annual demand and one possible "reality" i.e. the past.

Yield is not static. It changes depending on inflows, infrastructure and operating rules and therefore needs to be reviewed frequently. Demand is not static as it changes in response to climate variation, dryer years have higher demands and vice versa, wetter years have lower demands.

In recent years, with improvements in computational modelling, a more dynamic approach to water supply security assessment has been adopted. This approach is "stochastic". This approach allows for estimating the probability of supply coming under threat (i.e. moving into restrictions and failure) under potential future conditions. These models allow for the possibility of a series of potential outcomes, each with a different probability of occurring. The process is based on replicating the random fluctuations observed in historical data.

This modelling approach does not use the "5, 10, 20 rule". Instead, this process considers the probability of certain outcomes. In this type of analysis, there are two key concepts: security and reliability. The security of a supply is the probability that a system will run out of water. The reliability of a supply is the likelihood that restriction on demand will be required.

Determining the security and reliability of a water supply system also needs to take into account design criteria. For instance, whilst it is not acceptable to run out of water, the reasonable restriction of water demand during droughts is acceptable. Similarly, the assessment should also consider expected reductions in demand as a result of water conservation activities. The key objectives of this study are:

Based on a reliability criteria of 90% (as adopted by major cities in Australia for stochastic modelling)

- Security: that water supply storages do not empty more often than 0.1% of the time.
- Reliability: that restrictions (of any duration) do not occur more in greater than 10% of years (ie, that restrictions are not too frequent – the same as the "10" element in the old rule).

Initially the reliability and security of an existing water supply system is assessed and then if the objectives are not satisfied the required changes to infrastructure and/or demand management are determined. Relaxing these objectives would reduce the reliability and/or security of supply, while reducing the required expenditure and vice versa, tightening these criteria increase the level of expenditure on new infrastructure for water supply, potentially to levels that are not affordable.

In this study, the stochastic Water Headworks Network (WATHNET) software package has been used. Historical and synthetic information have been used to simulate the system and generate a range of potential outcomes to help better assess the reliability and security of supply.

Towns that were considered secure meet the following criteria:

1. The probability of requiring water restriction is less than 10% (i.e. less than one chance every ten years. This is a generally accepted criteria for reliability); and
2. The probability of total water supply system failure is less than 0.1% (security).

All other towns were considered to require a security improvement.

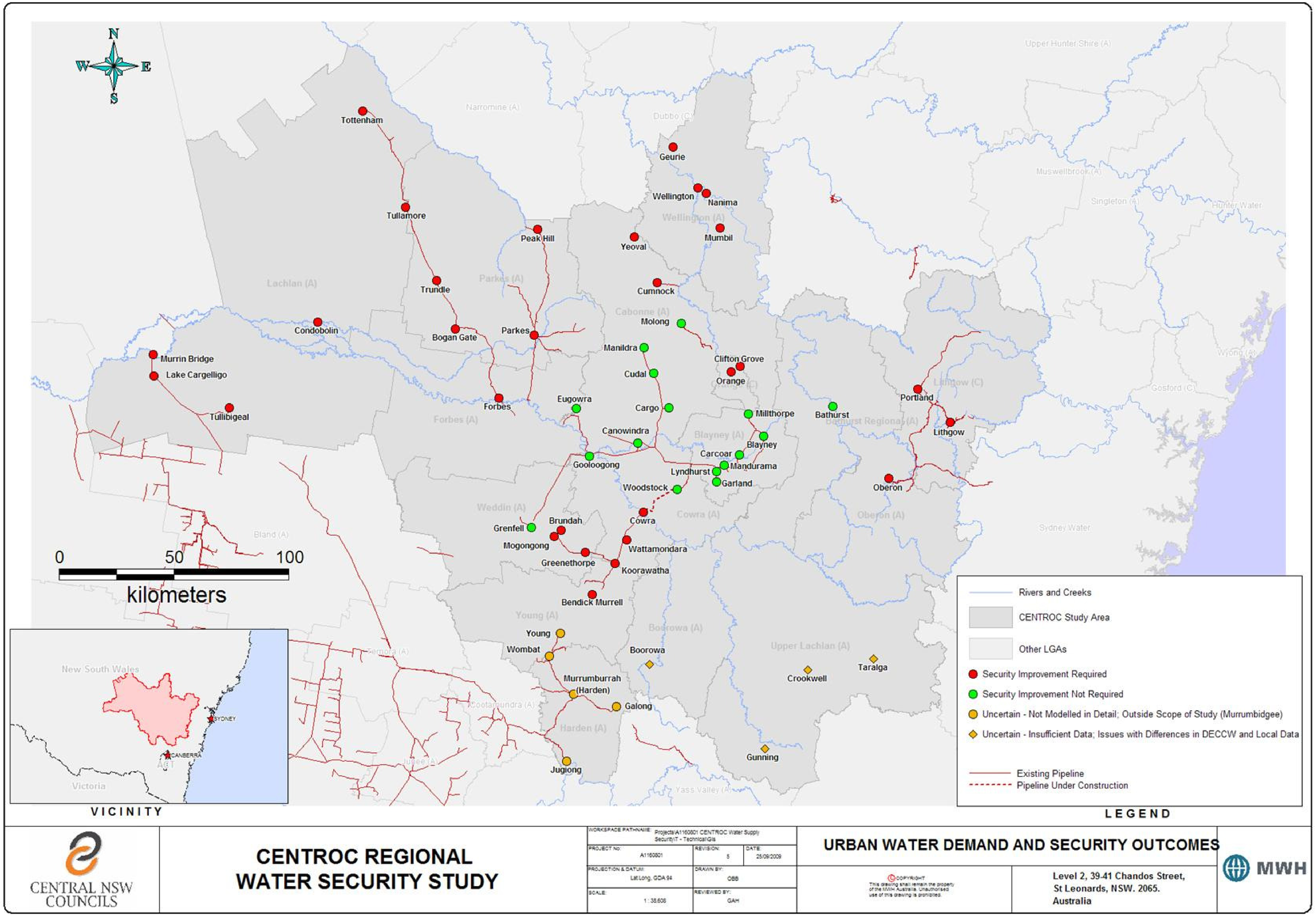


Figure 4: Water Security Outcomes of Urban Demand Nodes in the Centroc Region

Table 3-4: Summary of Water Security Improvement Requirements

DEMAND NODE	TOWNS	SOURCE SUPPLYING	PROBABILITY OF LEVEL 1 RESTRICTIONS	PROBABILITY OF TOTAL SYSTEM FAILURE	SECURITY IMPROVEMENT REQUIRED?
Bathurst	Bathurst	Chifley Dam Macquarie River Weir	1.45%	<0.1%	No
Blayney - Carcoar	Blayney, Millthorpe, Carcoar, Lyndhurst, Mandurama, Garland	Lake Rowlands	Less than 0.5%	<0.1%	No
Boorowa	Boorowa	Boorowa Dam	Less than 0.5%	<0.1%	No. However, limited data was available for the assessment.
Canowindra	Canowindra, Woodstock	Lake Rowlands	Less than 0.5%	<0.1%	No
Condobolin	Condobolin	Goobang Creek Weir	10%[11]	0.4%	Yes
Cowra - Koorawatha	Cowra, Koorawatha, Bendick Murrell, Brundah, Greenethorpe, Mogongong, Wattamondara	Wyangala Dam	10%[11]	0.4%	Yes
Crookwell	Crookwell	Crookwell (Kentgrove) Dam	Less than 0.5%	<0.1%	No. However, limited data was available for the assessment.
Cudal/ Cargo/ Manildra	Cudal, Cargo, Manildra	Lake Rowlands	Less than 0.5%	<0.1%	No
Cumnock - Yeoval	Cumnock, Yeoval	Bell River and Buckinbah Creek Weir	18% Cumnock[12] Up to 32% Yeoval	14% Cumnock Up to 27% Yeoval	Yes
Forbes	Forbes	Wyangala Dam Hillston Weir (Lachlan River)	10%[11]	0.4%	Yes
Gooloogong-Eugowra	Gooloogong, Eugowra	Lake Rowlands	Less than 0.5%	<0.1%	No

The following towns require a water security improvement:

Condobolin
Cowra
Koorawatha
Bendick Murrell
Brundah
Greenethorpe
Mogongong
Wattamondara
Cumnock
Yeoval
Forbes
Bogan Gate
Tottenham
Trundle
Tullamore
Lake Cargelligo
Murrin Bridge
Tullibigeal
Lithgow
Portland
Oberon
Orange
Clifton Grove
Parkes
Peak Hill
Wellington
Geurie
Mumbil
Nanima

[11] While Town Security water users theoretically have no water restrictions under water sharing plans, it is a recommendation of this study that water restrictions should be in place in 10% of years. This would involve initiating restrictions at the ten percentile water level in Lake Burrendong and Wyangala Dam.

[12] Water supplies for Cumnock and Yeoval are assumed to service the full urban demand for both centres.

DEMAND NODE	TOWNS	SOURCE SUPPLYING	PROBABILITY OF LEVEL 1 RESTRICTIONS	PROBABILITY OF TOTAL SYSTEM FAILURE	SECURITY IMPROVEMENT REQUIRED
Grenfell	Grenfell	Lake Rowlands	Less than 0.5%	<0.1%	No
Lake Cargelligo	Lake Cargelligo, Murrin Bridge, Tullibigeal	Terminal Lake 15 ML (Located within Lake Cargelligo)	10%[11]	0.4%	Yes
Lithgow - Portland[13]	Lithgow and Portland	Farmers Creek Dam (Lithgow No.1)	Up to 100%	0.4%	Yes
Molong	Molong	Molong Creek Dam Borenore Creek Dam	Less than 0.5%	0.0%	No. However some uncertainty remains around the hydrology of Molong.
Murrumburrah (Harden)	Galong, Murrumburrah, Jugiong, Wombat	Jugiong (GWCC)	Not modelled as the Murrumbidgee system was outside of project scope, however desktop assessment shows supply likely to be secure.		
Oberon[1]	Oberon, Oberon timber industry	Oberon Dam	Up to 100%	0.9%	Yes
Orange	Orange, Clifton Grove	Suma Park Dam Spring Creek Dam (limited use)	10%[11]	0.6%	Yes
Parkes	Parkes, Peak Hill, NorthParkes Mine	Bogan River Weir @ Peak Hill Lake Endeavour Beargamil Dam (Lake Metcalfe) Parkes Borefield Lachlan River offtake	11%	<0.1%	Yes
Wellington - Geurie	Wellington, Geurie, Nanima	Burrendong	10%[11]	4.4%	Yes

[13] The Fish River has been modelled as a single supply scheme with shared security for all users. At the current time, the water supply to Lithgow does not contribute to the security of the Fish River Water Supply.

Presently, there is an understanding by Council that should the supply in this dam reach less than 5%, Delta Electricity would not be able to access this supply. However, this compromises significant power supply in the region. As a result, it is recommended that the assessment of Oberon security improvement requirements does not take into account this potential action.

Young	Young	Jugiong (GWCC)	Not modelled as the Murrumbidgee system was outside of project scope, however desktop assessment shows supply likely to be secure.

Understanding the Fish River Water Supply and the Impact on Lithgow and Oberon Water Security

The Fish River Water Supply (FRWS) sources raw water from the Oberon Dam (45,400 ML) and Duckmaloi Weir (20 ML) to provide water supply to four major customers:

- Lithgow City Council: the villages of Wallerawang, Portland, Glen Davis and Cullen Bullen receive water from Oberon Dam. Emergency works are currently underway to connect these villages to Lithgow's Farmers Creek System;
- Oberon Council (treated at Oberon WTP and including water for the Oberon Timber Complex);
- Delta Electricity (DE): the electricity utility has its own pipeline connection and sources raw water from Oberon Dam; and
- The Sydney Catchment Authority (SCA): which also sources raw water from Oberon Dam.

Modelling of the FRWS was beyond the scope of this regional water security study. However it is clear that, as the primary provider of water supply to Lithgow and Oberon, the scheme plays a significant role in determining their water security.

DE, a major industrial presence in the region and part of the State energy supply, is presently reliant on the FRWS and this has potential impacts on the reliability of water supply to Lithgow and Oberon. Some potential for DE to utilise alternative water supply sources, such as recycled water from Lithgow and accessing local groundwater pockets has been identified, but would require further investigation and consultation work outside of the scope of this study.

Therefore, as part of this study, options that provide Oberon and Lithgow with alternatives have been investigated. Options considered included the connection of Oberon to the Bathurst water supply system using a pipeline from the Chifley Dam and for Lithgow to utilise the Clarence Colliery Transfer System to supplement its water supply. These options have the potential to reduce the competition for water from the FRWS and therefore improve security.

4. OPPORTUNITIES TO IMPROVE WATER SECURITY

Identifying and assessing the relative performance of options to improve water security improvement was the second step necessary to develop an effective long term, region-wide town water security strategy for the Centroc region. Five main steps were taken to establish the most appropriate options for water security improvement:

1. A long-list of potential options was identified with stakeholder input.
2. A short-list of options for further investigation was determined utilising the TBL criteria, and the input of stakeholders.
3. Scenarios (themed groupings of short-listed options) were developed to allow comparisons between approaches for water security improvement to be made.
4. Developing region-wide strategies based on the outcomes of each of the preceding steps.
5. Sensitivity testing the preferred region-wide strategy to understand the impact of climate change, potential increases in the cost of energy and the impact of demands from other sectors such as the mining sector.

These steps are discussed in the following sections. Although set out as a logical sequence of steps, it is important to note that the process of evaluating options was complex, and iterative. It is also important to note, that additional information on key aspects of the system (including the reliability of Lake Rowlands, the operation of the Fish River system and data on town demands) was provided during the final stakeholder consultation meeting. This information was reviewed in finalising the study.

4.1 LONG LIST OF POTENTIAL OPTIONS

In consultation with stakeholders, over eighty (80) options to manage water demand, diversify water supply sources and improve system operation and connectivity to improve water security were identified. For the full list of options considered, see Appendix D, Table D -2.

Options to improve water supply security include policies on water conservation and demand management as well as infrastructure to recycle, amplify supply, transfer water and access groundwater.

The potential options were determined in the context of water use in the total system and considered opportunities that may benefit water-using sectors like irrigation and mining in the region as well as the environment. The list contained all potential solutions generated during the study, as well as those that had been not been assessed previously or had been assessed as unfeasible in earlier studies.

The options encompass infrastructure and non-infrastructure solutions and were developed and finalised in consultation with the PSC, PRG, PTC and Centroc Board. The options fall broadly into the following categories:

- Policies, Water Conservation and Demand Management.
- Infrastructure:
  - Recycling;
  - Groundwater;
  - Supply Amplification; and
  - Transfer Systems.

4.2 SHORT-LISTING OF OPTIONS

A preliminary screening process, utilising the TBL decision-making framework (see Section 2.2) in consultation with stakeholders, was used to determine a short-list of potentially feasible options for water security improvement. A desktop feasibility assessment of each option needed to be undertaken to characterise the potential options prior to the TBL assessment and screening process. An option characterisation spreadsheet, which provided preliminary estimations of water and energy usage and costs for each option, was developed for this purpose. Engineering feasibility and design considerations were also taken into account in determining the short list. Detailed information on the outcomes of the options characterisation and the TBL assessment are set out in Appendix D. A summary of the TBL assessment results is presented in Table 4-1. The PSC, PRG and PTC were consulted on this assessment.

It should be noted that all cost estimates provided in this document are strategic planning level assessments that would require further refinement during concept and detailed design phases. As such, they should only be relied upon for the purposes of making comparisons between options.

How to Read Table 7

Using economic, social and environmental criteria, each of the options under consideration was ranked. The ranking was achieved by assigning each of the options a relative score from -3 to +3 for each criterion, where -3 represented the worst possible outcome for the criterion and +3 represented the most favourable.

+3	Significant positive contribution to achieving the objective
+2	Moderate positive contribution to achieving the objective
+1	Minimal positive contribution to achieving the objective
0	No influence on achieving the objective
-1	Minimal negative contribution to achieving the objective
-2	Moderate negative contribution to achieving the objective
-3	Significant negative contribution to achieving the objective

For example, for the Cost Effectiveness criterion, the option with the highest cost per kL of water provided is scored a -3, while the cheapest scoring a +3 and the median cost scoring a 0.

The Screening column at the end of Table 4-1 identifies the outcomes of the preliminary options assessment. For each option, the column notes whether a particular option has been

- Included for short-listing (+) and modelling; and/or
- Not included for short-listing:
    - As it is considered unfeasible (X); and/or
    - Additional information/investigation is required due to uncertainty (U); and/or
    - Better alternative(s) exists (B); and/or
    - Local/decentralised options are more appropriate (L or D);
    - The source is a potential emergency water supply only (E); and/or
- Would need to be considered on a case by case basis due to the opportunistic nature of the option (C).

Options were short-listed based on their economic, social and environmental outcomes as well as engineering feasibility and design considerations.

The column also identifies the options that may potentially form a region-wide town water grid (R). Options that are marked with “R, X” or “R, X, B” denote those that are unfeasible when evaluated independently, but may be considered effective as part of a regional water grid.

To aid in understanding the options, the Cost Effectiveness dollar figure for each option is shown as an absolute value in its own column in Table 4-1.

In looking at the results, it is important to note a number of points relating to their interpretation and derivation:

- The TBL assessment does not provide a ‘right or ‘wrong’ answer – the scores have been used by the project team as a tool to provide summary information about a large number of options against a range of criteria that help to inform decision-making;
- The scores are not directly comparable between different option groups due to complex differences in characteristics and relative contribution to water security;
- The final score set obtained from the TBL assessment do not by themselves determine the ‘best’ options for short-listing, but rather act as one of many indicators of the extent to which a particular option fulfils the criteria relative to other similar options; and
- The cost efficiency or cost per unit volume of water delivered for any particular options should not be interpreted as the cost of supply from that option – the preliminary screening has assumed in most cases that water is only provided during times of drought and thus results in much higher unit costs than for full-time supply.

The short-list contains some options that were discounted on a stand alone basis as they may form a critical link in options such as a regional water grid.

On an engineering feasibility basis options were considered for short listing if:

- They have the potential to contribute towards improving local water security; or
- They are a critical link to a region-wide strategy such as a regional water grid; and
- They are cost effective (<$5.00/kL of water supplied) to implement and in their provision of water security.

The short-list of options was carried forward for detailed analysis which is discussed in the following section.

Table 4-1: TBL Assessment Results and Preliminary Screening of the Long List of Options

No	Option	Raw or Treated Water? (Pipeline Options Only)	Environmental		1	Economic		1	Social		1	Score	Cost per kL($)	Screening[14]
			Protection of Water for Environment	Infrastructure Footprint (Ha)	Purchase of Additional Entitlements	Efficient Water Usage	Efficient Energy Usage	Financial Burden ($ per Household)	Equity and Acceptability	Cost Effectiveness	Improvement to Urban Water Reliability			
Non-Infrastructure - Policies, Water Conservation and Demand Management														
2	Improved Metering of Water Consumption	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	2.0	**2.33**	**N/A**	**+**
7	Demand Management	N/A	3.0	0.0	3.0	3.0	3.0	3.0	3.0	2.0	1.0	**2.33**	**N/A**	**+**
4	Regional Water Conservation Implementation	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	1.0	**2.22**	**N/A**	**+**
11	Permanent Water Saving Rules	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	1.0	**2.22**	**N/A**	**+**
1	Irrigation Efficiency – Shared Benefits	N/A	3.0	0.0	3.0	3.0	2.0	2.0	3.0	2.0	1.0	**2.11**	**N/A**	**+, I**
5	Appropriate and Full Cost Recovery Pricing of Water Products	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	0.0	**2.11**	**N/A**	**+**
3	Uniform Restriction Regime	N/A	2.0	0.0	3.0	3.0	2.0	3.0	3.0	1.0	1.0	**2.00**	**N/A**	**+**
8	Shared Water Efficiency Savings Between Water Users	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	0.0	1.0	**2.00**	**N/A**	**+**
10	Restriction Policies Balancing	N/A	1.0	0.0	3.0	3.0	2.0	3.0	2.0	2.0	1.0	**1.89**	**N/A**	**C**
9	Scarcity Pricing	N/A	2.0	0.0	3.0	3.0	2.0	3.0	-1.0	3.0	1.0	**1.78**	**N/A**	**U, B**
6	Caps on Water Extraction	N/A	3.0	0.0	3.0	3.0	2.0	3.0	-3.0	3.0	1.0	**1.67**	**N/A**	**X**
12	Off-Grid Energy Sourcing	N/A	3.0	0.0	3.0	0.0	3.0	0.0	2.0	-2.0	0.0	**1.00**	**N/A**	**C**
Infrastructure – Recycling														
26	Recycling Water - Mining	N/A	N/A	N/A	0.0	0.0	N/A	N/A	2.0	N/A	N/A	**N/A**	**N/A**	**C, M**
27	Offset Schemes	N/A	N/A	N/A	0.0	0.0	N/A	N/A	2.0	N/A	N/A	**N/A**	**N/A**	**C, I**
13	Recycling Water - New Development - Bathurst	N/A	2.9	-0.6	0.0	0.0	-0.33	-0.48	2.0	1.4	2.1	**0.79**	**$2.03**	**+**
17	Recycling Water - New Development - Orange	N/A	3.0	-0.9	0.0	0.0	-0.33	-0.81	2.0	1.7	2.1	**0.75**	**$1.83**	**+**
15	Recycling Water - New Development - Forbes	N/A	2.6	-0.4	0.0	0.0	-0.33	-1.41	2.0	1.8	2.1	**0.72**	**$1.70**	**+**
16	Recycling Water - New Development - Lithgow	N/A	2.5	-0.4	0.0	0.0	-0.33	-0.56	2.0	1.1	2.1	**0.72**	**$2.90**	**+**
19	Recycling Water - New Development - Young	N/A	2.9	-0.6	0.0	0.0	-0.33	-1.63	2.0	2.0	2.1	**0.71**	**$1.65**	**+**
32	Lithgow Runoff Harvesting	N/A	-1.7	-0.1	0.0	0.0	0.85	-0.07	2.0	2.9	1.9	**0.64**	**$0.43**	**+**
18	Recycling Water - New Development - Wellington	N/A	2.7	-0.6	0.0	0.0	-0.33	-2.07	2.0	1.7	2.1	**0.62**	**$1.78**	**+**
14	Recycling Water - New Development - Condobolin	N/A	2.6	-0.4	0.0	0.0	-0.33	-1.78	2.0	1.3	2.1	**0.61**	**$2.40**	**+**
21	Recycling Water - Existing (Retrofit) - Parkes	N/A	2.8	-0.6	0.0	0.0	-0.33	-1.89	2.0	1.2	2.1	**0.59**	**$2.58**	**+**
24	Recycling Water - Existing (Retrofit) - Tottenham	N/A	2.1	-0.1	0.0	0.0	-0.33	-1.07	2.0	0.2	2.1	**0.55**	**$6.56**	**+**
23	Recycling Water - Existing (Retrofit) - Condobolin	N/A	2.4	-0.1	0.0	0.0	-0.33	-1.15	2.0	-0.3	2.1	**0.52**	**$7.82**	**+**
22	Recycling Water - Existing (Retrofit) - Lake Cargelligo	N/A	2.3	-0.1	0.0	0.0	-0.33	-1.22	2.0	-0.4	2.1	**0.50**	**$8.75**	**+**
20	Recycling Water - Existing (Retrofit) - Oberon	N/A	2.3	-0.1	0.0	0.0	-0.33	-1.22	2.0	-0.4	2.1	**0.50**	**$8.75**	**+**
25	Recycling Water - Existing (Retrofit) - Yeoval	N/A	2.2	-0.1	0.0	0.0	-0.33	-1.96	2.0	0.3	2.1	**0.47**	**$6.10**	**+**
29	Orange Stormwater Harvesting	N/A	-2.3	-0.9	0.0	0.0	0.93	-0.37	2.0	2.6	1.9	**0.42**	**$0.74**	**+**
30	Oberon Stormwater Harvesting	N/A	-1.0	-0.4	0.0	0.0	0.93	-2.00	2.0	2.0	1.9	**0.39**	**$1.60**	**+**
28	Bathurst Stormwater Harvesting	N/A	-2.4	-0.9	0.0	0.0	0.93	-0.52	2.0	2.4	1.9	**0.38**	**$0.79**	**X**
29A	Orange Stormwater Harvesting - Additional Catchments	N/A	-2.6	-1.2	0.0	0.0	0.93	-0.96	2.0	2.8	2.1	**0.35**	**$0.60**	**+**
31	Parkes Stormwater Harvesting	N/A	-2.5	-0.9	0.0	0.0	0.93	-2.04	2.0	2.5	1.9	**0.21**	**$0.76**	**+**
Infrastructure – Groundwater														
34	Accessing Groundwater Pockets - Orange	N/A	0.0	-0.1	0.0	0.0	-1.81	0.00	-2.0	2.1	2.1	**0.05**	**$1.51**	**L, E**
34	Accessing Groundwater Pockets - Forbes	N/A	-1.5	-1.1	0.0	0.0	-1.81	-1.52	-2.0	0.9	0.9	**-0.68**	**$2.97**	**L, E**
33	Managed Aquifer Recharge	N/A	1.0	-0.5	0.0	-1.0	-1.0	-1.0	-2.0	-2.0	0.0	**-0.72**	**N/A**	**C**
34	Accessing Groundwater Pockets - Lake Cargelligo	N/A	-1.6	-1.5	0.0	0.0	-2.63	-2.48	-2.0	1.2	2.1	**-0.76**	**$2.77**	**L, E**
Infrastructure - Supply Amplification														
37	Recommissioning Recreational Dams for Water Supply Use in Orange[15]	N/A	N/A	N/A	0.0	0.0	N/A	N/A	-1.0	N/A	N/A	**N/A**	**N/A**	**E**
43	Improving Water Security and Quality of Lake Cargelligo's Lakes - Compartmentalising Storage	N/A	N/A	N/A	0.0	0.0	N/A	N/A	2.0	N/A	N/A	**N/A**	**N/A**	**U, L**
44	Regional Pipe Network to Replace Farm Dams with Town Water Supply	Raw	N/A	N/A	0.0	0.0	N/A	N/A	-1.0	N/A	N/A	**N/A**	**N/A**	**X, I**
38	New Bulk Water Storage - Condobolin	N/A	-2.3	-0.6	0.0	0.0	2.04	-0.78	-3.0	3.0	2.1	**0.06**	**$0.29**	**L**
42	Off-Stream Buckinbah Creek Storage	N/A	0.6	-2.7	0.0	0.0	2.26	-2.41	1.0	0.0	0.9	**-0.04**	**$7.00**	**U, L**

[14] X = Not feasible, excluded from short list; + = Included in WATHNET model; U = Uncertain, further information/investigation required; L = Excluded from WATHNET model, local approach instead; B = Better alternative(s) available; D = Consider decentralised options; R = Part of regional water grid bundle; E = potential emergency supply; C = considered on a case by case basis; M = potential mutual benefits with mining activities; I = potential mutual benefits with irrigation

[15] Works to be commenced at Suma Park dam in 2010 are for dam safety purposes. Although capacity will be increased, previous assessments completed for this work indicated it is not expected to result in significant increased yield.

No	Option	Raw or Treated Water? (Pipeline Options Only)	Environmental		1	Economic		1	Social		1	Score	Cost per kL($)	Screening[14]
			Protection of Water for Environment	Infrastructure Footprint (Ha)	Purchase of Additional Entitlements	Efficient Water Usage	Efficient Energy Usage	Financial Burden ($ per Household)	Equity and Acceptability	Cost Effectiveness	Improvement to Urban Water Reliability			
38	New Bulk Water Storage - Wellington	N/A	-0.7	-0.9	0.0	0.0	1.75	-0.92	-3.0	1.9	0.9	**-0.11**	**$1.69**	**L**
38	New Bulk Water Storage - Cumnock	N/A	-1.1	-0.4	0.0	0.0	2.11	-2.74	-3.0	1.6	2.1	**-0.15**	**$1.99**	**L**
38	New Bulk Water Storage - Yeoval	N/A	-1.1	-0.4	0.0	0.0	2.11	-2.74	-3.0	1.6	2.1	**-0.15**	**$1.99**	**L**
41	Molong Creek Dam Augmentation	N/A	0.0	-2.7	0.0	0.0	3.00	-0.59	-1.0	-1.2	0.9	**-0.18**	**$17.91**	**X**
38	New Bulk Water Storage - Lake Cargelligo	N/A	0.3	-0.6	0.0	0.0	1.82	-1.55	-3.0	0.5	0.9	**-0.19**	**$5.22**	**L**
38	New Bulk Water Storage - Cowra	N/A	0.3	-0.6	0.0	0.0	1.82	-2.11	-3.0	-0.1	0.9	**-0.32**	**$7.63**	**L**
35	Lake Rowlands Augmentation	N/A	-2.6	-2.8	0.0	0.0	3.00	-2.33	-1.0	0.7	1.8	**-0.36**	**$3.21**	**R, +**
38	New Bulk Water Storage - Forbes	N/A	0.3	-0.6	0.0	0.0	1.82	-2.26	-3.0	-0.6	0.9	**-0.39**	**$10.00**	**L**
36	Chifley Dam Augmentation	N/A	-1.9	-2.8	0.0	0.0	3.00	-2.18	-2.0	0.3	0.9	**-0.52**	**$5.99**	**+**
40	Replacing Duckmaloi Weir with a Dam	N/A	-0.2	-2.9	0.0	0.0	3.00	-2.96	-1.0	-2.7	0.9	**-0.64**	**$92.16**	**U**
39	New Bulk Water Storage Upstream of Chifley	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-2.5	-0.9	0.9	**-0.77**	**$15.80**	**X, B**
38	New Bulk Water Storage - Abercrombie	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-3.0	-0.9	0.9	**-0.82**	**$15.80**	**X**
38	New Bulk Water Storage - Needles	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-3.0	-0.9	0.9	**-0.82**	**$15.80**	**X**
38	New Bulk Water Storage - Cranky Rock	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-3.0	-0.9	0.9	**-0.82**	**$15.80**	**X**
Infrastructure - Transfer Systems														
49	CTW-Orange Pipeline via Millthorpe	Raw	-0.8	0.0	0.0	0.0	3.00	-0.11	1.0	1.4	1.6	**0.67**	**$2.36**	**R, +**
75	Lachlan River-Lake Cargelligo Pipeline	Raw	-1.8	-1.1	0.0	0.0	1.30	-1.92	1.0	2.7	2.1	**0.26**	**$0.60**	**U**
53	Winburndale-Bathurst Pipeline	Raw	-1.7	-1.5	0.0	0.0	-1.07	-0.15	2.0	2.3	2.1	**0.22**	**$1.27**	**X, B**
54	Chifley-Bathurst Pipeline	Raw	-2.9	-1.3	0.0	0.0	0.78	-1.67	1.0	2.9	2.1	**0.11**	**$0.39**	**+**
68	Parkes-Forbes Pipeline	Raw	0.5	-1.4	0.0	0.0	1.37	-0.33	1.0	-0.8	0.1	**0.05**	**$11.72**	**X, B**
83	Woodstock-Cowra Pipeline	Treated	-0.1	-1.3	0.0	0.0	1.60	-0.70	1.0	-0.2	0.1	**0.05**	**$7.67**	**R, +**
78	Goldenfields Water-Burcher Pipeline	Treated	2.0	0.0	0.0	0.0	3.00	-2.93	1.0	-2.9	0.1	**0.03**	**$2,096.85**	**+**
55	Chifley-Bathurst-Orange Pipeline	Raw	-3.0	-2.5	0.0	0.0	0.71	-0.85	1.0	2.6	1.7	**-0.03**	**$0.64**	**X, D**
76	Lake Cargelligo-Euabalong Pipeline	Raw	1.9	-0.1	0.0	0.0	1.67	-2.52	1.0	-2.9	0.1	**-0.09**	**$311.94**	**X, B**
73	Bogan Gate-Condobolin Pipeline	Raw	1.5	-1.3	0.0	0.0	1.45	-1.11	1.0	-2.5	0.1	**-0.09**	**$72.10**	**R, X, B**
61	Molong Creek-Orange Pipeline	Raw	-0.3	-2.0	0.0	0.0	-1.22	-0.04	1.0	0.6	0.6	**-0.14**	**$4.59**	**R, X, B**
61A	Molong Creek Dam Augmentation + Molong Creek-Orange Pipeline	Raw	-0.3	-2.7	0.0	0.0	0.63	-0.22	1.0	-0.6	0.7	**-0.16**	**$8.76**	**X, B**
47	Chifley to Orange - Supply CTW + Cowra + Orange	Raw	-0.4	-2.3	0.0	0.0	-0.77	-0.29	1.0	0.1	0.8	**-0.20**	**$6.63**	**X, B**
52	Macquarie River-Orange Pipeline	Raw	-0.8	-2.0	0.0	0.0	-1.74	-0.44	1.0	0.6	1.6	**-0.21**	**$4.90**	**U, E**
71	Parkes-Bogan Gate Pipeline	Raw	1.5	-1.1	0.0	0.0	-0.70	-0.63	1.0	-2.1	0.1	**-0.22**	**$43.95**	**R, X, B**
58	Wyangala-CTW Pipeline via Cowra	Raw	-2.6	-1.9	0.0	0.0	-1.59	-1.30	1.0	2.3	1.8	**-0.25**	**$1.20**	**+**
50	Lake Rowlands Augmentation + to Blayney - Supply Bathurst + Orange	Raw	-0.6	-2.3	0.0	0.0	1.52	-1.00	1.0	-1.9	0.7	**-0.28**	**$31.75**	**X, B**
67	Eugowra-Forbes Pipeline	Raw	1.0	-1.2	0.0	0.0	-0.48	-1.19	1.0	-1.8	0.1	**-0.29**	**$29.93**	**X**
82	Goulburn-Crookwell Pipeline	Raw	1.2	-1.9	0.0	0.0	-1.15	-1.04	1.0	-1.7	0.6	**-0.33**	**$29.52**	**X**
79	Young-Bendick Murrell Pipeline	Treated	0.9	-1.8	0.0	0.0	-1.44	-0.26	1.0	-1.4	0.0	**-0.34**	**$25.42**	**U, X**
64	Wellington-Yeoval-Cumnock Pipeline	Raw	-1.1	-2.6	0.0	0.0	-0.85	-2.81	1.0	1.0	2.1	**-0.36**	**$2.97**	**R, +**
48	Bathurst - CTW via Blayney Pipeline	Raw	-0.5	-2.2	0.0	0.0	-2.11	-0.18	1.0	-0.3	0.8	**-0.38**	**$7.81**	**X, B**
64A	Wellington-Yeoval Pipeline	Raw	-1.1	-1.8	0.0	0.0	-1.66	-2.85	1.0	0.8	2.1	**-0.38**	**$3.20**	**X, B**
77	Ungarie-Weethalle Pipeline	Treated	1.6	-1.6	0.0	0.0	-1.37	-0.89	1.0	-2.3	0.1	**-0.39**	**$63.80**	**X**
57	Wyangala-CTW Pipeline near Mandurama	Raw	-2.6	-2.2	0.0	0.0	-2.03	-1.59	1.0	2.2	1.8	**-0.39**	**$1.39**	**+**
62	Molong-Manildra Pipeline	Treated	1.7	-1.7	0.0	0.0	-1.52	-0.67	1.0	-2.4	0.0	**-0.39**	**$67.68**	**R, X**
51	Lake Rowlands-Orange Pipeline	Raw	-1.4	-2.1	0.0	0.0	-1.96	-0.74	1.0	0.0	1.6	**-0.41**	**$6.94**	**R, X, B**
69	Gooloogong-Forbes Pipeline	Raw	1.0	-1.6	0.0	0.0	-0.55	-1.74	1.0	-2.0	0.1	**-0.41**	**$38.49**	**X, B**
45	Chifley-Oberon Pipeline	Raw	0.8	-1.7	0.0	0.0	-2.26	-1.81	1.0	-0.8	0.9	**-0.44**	**$13.27**	**X, B**
63	Manildra-Cumnock-Yeoval Pipeline	Raw	-1.1	-2.6	0.0	0.0	-1.00	-2.89	1.0	0.4	2.1	**-0.44**	**$5.40**	**R, X, B**
80	Young-Grenfell Pipeline	Treated	1.7	-1.9	0.0	0.0	-0.92	-1.44	1.0	-2.6	0.0	**-0.47**	**$88.99**	**X, B**
70	Trangie-Tottenham Pipeline	Raw	1.8	-1.4	0.0	0.0	-0.62	-2.44	1.0	-2.8	0.1	**-0.48**	**$252.92**	**X**
72	Fifield-Bogan Gate Pipeline	Raw	2.0	-1.4	0.0	0.0	-0.40	-3.00	1.0	-3.0	0.1	**-0.51**	**$4,607.78**	**X, D**
66	Manildra-Parkes-Bogan Gate Pipeline	Raw	0.4	-2.1	0.0	0.0	-1.30	-1.37	1.0	-1.7	0.1	**-0.54**	**$29.27**	**X, B**
60	Burrendong-Wellington Pipeline	Raw	1.4	-1.7	0.0	0.0	-2.18	-1.48	1.0	-2.2	0.1	**-0.57**	**$49.03**	**X, B**
46	Chifley to Blayney - Supply CTW	Raw	0.6	-2.1	0.0	0.0	-2.41	-1.70	1.0	-1.5	0.9	**-0.59**	**$28.70**	**U**
74	Condobolin-Tullibigeal Pipeline	Raw	1.2	-1.6	0.0	0.0	-2.48	-2.22	1.0	-2.0	0.9	**-0.59**	**$43.42**	**X**
45B	Winburndale-Lithgow Pipeline	Raw	0.3	-2.3	0.0	0.0	-2.92	-1.33	1.0	-1.4	0.9	**-0.63**	**$22.79**	**U**
54A	Bathurst-Orange Pipeline	Raw	-0.6	-2.4	0.0	0.0	-2.55	-0.41	0.0	-0.7	0.8	**-0.66**	**$11.58**	**R, +**
65	Lake Endeavour-Manildra Pipeline - Supply CTW	Raw	1.1	-2.0	0.0	0.0	-2.33	-1.85	1.0	-2.3	0.1	**-0.69**	**$61.66**	**X, B**

No	Option	Raw or Treated Water? (Pipeline Options Only)	Environmental		1	Economic		1	Social		1	Score	Cost per kL($)	Screening[14]
			Protection of Water for Environment	Infrastructure Footprint (Ha)	Purchase of Additional Entitlements	Efficient Water Usage	Efficient Energy Usage	Financial Burden ($ per Household)	Equity and Acceptability	Cost Effectiveness	Improvement to Urban Water Reliability			
59	Wyangala-CTW Pipeline via Carcoar	Raw	-2.6	-2.4	0.0	0.0	-2.85	-2.30	1.0	0.9	1.8	**-0.72**	**$2.98**	**+**
45A	Winburndale-Oberon Pipeline	Raw	0.8	-2.6	0.0	0.0	-2.77	-2.37	1.0	-1.6	0.9	**-0.74**	**$29.12**	**U**
81	Wyangala-Crookwell Pipeline	Raw	1.3	-2.4	0.0	0.0	-2.70	-2.55	1.0	-2.6	0.9	**-0.78**	**$84.74**	**X, B**
56	Burrendong-Orange Pipeline	Raw	-0.8	-2.5	0.0	0.0	-2.99	-2.15	1.0	-1.3	1.6	**-0.79**	**$20.43**	**X, B**

4.3 DEVELOPING SCENARIOS

A series of themed scenarios were formed from the short listed options (Table 4-2). Each of the scenarios embodied a particular theme, ranging from a region-wide water grid to various sub-modules of the grid to water recycling and stormwater harvesting at major urban centres. Each of these scenarios was modelled to test the relative water security improvement outcomes from each. This assessment enabled the project team to gain understanding of the relative costs and benefit of various scenarios. The PSC, PRG and PTC were consulted on this assessment.

Underpinning each of the scenarios represented below is the need for efficient town water demands. Based on the results of the screening process discussed in Section 4.2, the following program of water conservation measures is recommended as the basis for any region-wide strategy:

- Residential retrofit of inefficient water fixtures, including providing customer support for replacements;
- Continuation of the Water Efficiency Labelling and Standards Scheme (WELS);
- Implementation of Permanent Low Level Restrictions on outdoor water use;
- Continuation of the BASIX program for new developments;
- Continuation or expansion of Water Conservation Education programs to improve efficient water use;
- Audit of Non-Residential Water Use to identify leaks and potential areas for improvement in efficiency;
- System Water Loss Management which aims to identify and repair leaks in water supply and distribution system; and
- Review of water supply and sewerage services pricing structure to follow the best-practice guideline of 25:75 Fixed to Variable Charge Ratio.

It is recommended that a region-wide enhanced water conservation program and a uniform approach to water restrictions tied to storage levels be adopted.

The expected impact of this program is set out in Table 4-3. This table also illustrates the expected impact of climate change on demands. It is important to note that some of the elements of this program are already in place in a number of the member Council areas (compare the baseline against the current programs) and this has been taken into consideration in deriving the forecasts. These Councils may be able to take a lead role in assisting with the design and implementation of this program across the region.

The water demand forecasting and conservation modelling work demonstrated that it is expected that this water efficiency program will offset the additional water demands associated with growth across the Centroc region. The costs associated with implementing this program are expected to be offset by the savings in avoided capital expenditure and in the reduction in operating costs associated with less treatment and transfer requirement.

In addition, it is recommended that a program of uniform (across-connected supplies) water restrictions be put in place. For the river towns[16], restrictions will be triggered when the storages of Wyangala or Burrendong reach a set trigger level (i.e. that level representing the lowest 10% of years). In this way, the towns will enter restriction regimes in manner that is sympathetic with allocation reductions on other water users. For further details of the assessment to determine these recommendations, see Appendix B.

[16] River towns are defined here to mean those towns sourcing directly from the Macquarie River or the Lachlan River.

Table 4-2: Thematic Scenarios

#	SCENARIOS	DESCRIPTION	OPTIONS INVOLVED
1	Regional Water Grid	Formation of region-wide pipeline network to enable water supply transfer between urban centres that is reasonably cost effective.	• Lake Rowlands Augmentation • Chifley-Oberon Pipeline • Chifley-Bathurst Pipeline • Chifley to CTW Pipeline via Blayney • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Orange-Molong Creek Pipeline • Molong-Manildra Pipeline • Manildra-Cumnock-Yeoval Pipeline • Yeoval-Wellington Pipeline • Manildra-Parkes Pipeline • Parkes-Bogan Gate Pipeline • Bogan Gate-Condobolin Pipeline • Lake Rowlands to Forbes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline (under construction)
2	Recycled Water for Major Towns + Opportunistic Stormwater Harvesting	Recycled water scheme for towns with >500 new development lots expected within the forecast horizon, as well as those identified to have the potential for retrofitting existing developments. Stormwater harvesting considered for Lithgow, Orange, Parkes and Oberon, where water storages are located in close proximity to the stormwater source.	• Recycling Water – New Development – Bathurst, Condobolin, Forbes, Lithgow, Orange, Wellington, Young • Recycling Water – Retrofitting – Oberon, Parkes, Lake Cargelligo, Condobolin, Tottenham, Yeoval • Stormwater Harvesting – Orange (additional catchments), Oberon, Parkes, Lithgow
3	Lake Rowlands Regional Network	Augmentation of Lake Rowlands to cater for pipeline water supply to Central Tablelands Water network, Orange, Cowra, Parkes and Forbes.	• Lake Rowlands Augmentation • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline (under construction)
4	Chifley Dam Regional Network	Pipeline water supply from Chifley Dam to Bathurst, Central Tablelands Water network, Cowra and Orange.	• Chifley-Bathurst Pipeline • Chifley to CTW Pipeline via Blayney • Blayney-Millthorpe Pipeline (CTW Trunk Mains X and F duplication) • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Woodstock-Cowra Pipeline (under construction)
5	Irrigation Efficiency – Shared Benefits	Investment into improved irrigation efficiency systems by Centroc to share the savings in water with the irrigation industry.	• Irrigation Efficiency – Shared Benefits

#	SCENARIOS	DESCRIPTION	OPTIONS INVOLVED
6	Preferred Local Options	Preferred selection of local options aimed at filling water security gaps arising from the regional approach. Modelling has determined the reliability of local supply system and identified the appropriate local options to be included in the suite for final recommendation.	• Chifley Dam-Oberon Pipeline • New minor storages at Cumnock, Yeoval, Condobolin, Lake Cargelligo, Forbes, Cowra, Wellington • Lachlan River-Lake Cargelligo Pipeline • Woodstock-Cowra Pipeline (under construction)

Table 4-3: Impact of Demand Management and Climate Change on Demand Forecasts

DEMAND NODE	BASELINE		AVE ANNUAL DEMAND – CURRENT DEMAND MANAGEMENT PROGRAMS IN PLACE (ML)		AVE ANNUAL DEMAND – RECOMMENDED ADDITIONAL CONSERVATION PROGRAM (ML)		AVE ANNUAL DEMAND – CLIMATE CHANGE[17]
	2009	2059	2009	2059	2009	2059	2050
Bathurst	6,420	7,618	6,402	6,597	6,402	6,501	6,694
Blayney - Carcoar	907	1,044	905	1,003	905	970	1,070
Boorowa	178	172	177	162	177	157	159
Canowindra	332	385	331	368	331	357	385
Condobolin	883	1,291	880	1,116	880	1,090	1,282
Cowra - Koorawatha	2,836	3,494	2,826	3,191	2,826	3,105	3,245
Crookwell[18]	331	335	330	307	330	299	300
Cudal/ Cargo/ Manildra	260	302	259	288	259	279	290
Cumnock - Yeoval	177	201	176	184	176	180	186
Forbes	2,761	3,074	2,755	2,917	2,755	2,822	3,021
Gooloogong-Eugowra	156	180	155	172	155	167	171
Grenfell	441	513	440	490	440	475	513
Lake Cargelligo	428	626	427	540	427	527	648
Lithgow - Portland	1,794	2,069	1,788	1,940	1,788	1,903	2,002
Molong	278	387	277	338	277	333	359
Murrumburrah (Harden)	792	863	790	826	790	796	849

[17] The climate change demand forecasts include the impact of the additional conservation program.

[18] Insufficient data was available to assess the demands of Taralga and Gunning.

DEMAND NODE	BASELINE		AVE ANNUAL DEMAND – CURRENT DEMAND MANAGEMENT PROGRAMS IN PLACE (ML)		AVE ANNUAL DEMAND – RECOMMENDED ADDITIONAL CONSERVATION PROGRAM (ML)		AVE ANNUAL DEMAND – CLIMATE CHANGE[17]
	2009	2059	2009	2059	2009	2059	2050
Oberon	839	960	837	918	837	889	949
Orange	5,837	7,373	5,818	6,395	5,818	6,174	6,543
Parkes[19]	6,731	8,150	6,731	7,527	6,731	7,436	7,982
Wellington - Geurie	1,348	1,946	1,342	1,754	1,342	1,718	1,889
Young	1,617	2,039	1,614	1,968	1,614	1,913	2,032

A TBL assessment approach similar to that used to complete the preliminary screening of the long list of options was used to evaluate the scenarios. The results of the water security modelling assessment (see Appendix C) and the assessment of the capital and operating costs of each option were important inputs to the TBL process.

Lake Rowlands and Chifley Dam are sources that may be able to supplement the needs of towns, including Cowra, Orange, Parkes and Forbes. This reduces the likely need to provide lengthy pipe connections, with large energy needs to transfer water, to the storages of Wyangala and Burrendong.

There were a number of key findings of the surface water assessment:

- An augmented Lake Rowlands Dam and Chifley Dam contain significant water resources that are able to address the supplementary needs of towns including Cowra, Orange, Parkes and Forbes (providing pipeline connection is made) in addition to the towns they already supply.
- As a result, the costs and timeframes associated with developing additional new sources in the Macquarie River catchment appear unwarranted and in most cases, not cost-effective.
- Similarly, the need to provide additional pipeline connection to the storages of Wyangala and Burrendong appears unwarranted. These storages are at considerably lower elevations (446 mAHD and 344 mAHD respectively) than Lake Rowlands and Chifley Dam (875 mAHD and 707 mAHD respectively) and hence would require significant expenditure on transfer infrastructure. These storages are primarily for irrigation purposes and this is fundamental in their operation. The impact of reform to water sharing processes has not been considered as part of this study.

The Link between Evaporation, System Management and Water Saving

Water can be saved by reducing the substantial evaporation losses of water stored in dams. Deep dams and ones with small surface areas are generally more efficient at storing water (i.e., have less losses) than shallow dams or ones with large surface areas. Drawing down dams that are inefficient by using the all of the time and therefore leaving water in efficient dams will result in water savings. However, this efficiency can only be achieved if the dams are connected to the same water supply scheme and if appropriate operating rules are put in place.

If we use the ratio of supplied water from a reservoir and the evaporation loss, in terms of some of the dams in the study area, for example, Farmers Creek is very efficient, Lake Rowlands also and Suma Park not as efficient.

[19] Demand including Northparkes mines

A key finding of the groundwater resource assessment, set out in Appendix C, is that whilst Orange, Forbes and Lake Cargelligo are found to have good prospects, and Wellington possible prospects, each has development and allocation issues. The Forbes borefield is fully allocated, Lake Cargelligo over allocated and Wellington is 150% over-allocated. “Prospects” are the chance of locating adequate individual bore yield for town supply, ignoring competition, licensing, sustainable yield, the current embargo on new licences (now requiring Commonwealth and State consultation (NSW Government 2008)) and allocation issues. These issues tend to mean that access to groundwater may be possible in an emergency situation, but difficult otherwise. In assessing the local options, these findings have been taken into consideration.

Competition, allocation and embargo issues mean that groundwater supplies are best considered an emergency source.

The outcomes of the TBL assessment of the scenarios are set out in Table 4-4. In addition to the nine TBL criteria, the table also highlights the Total Capital NPV, Annualised Total Operation, Maintenance and Depreciation (OM&D) costs, and Cost Effectiveness per unit improvement in reliability for each scenario of options. The PSC, PRG and PTC were consulted on this assessment.

The assessment was aimed at identifying the most suitable long-term regional approach (from Scenarios 1 to 5), and also the preferred mix of local options (Scenario 6) to supplement gaps in the regional solution. Towns that would require localised solutions were identified following iterative testing and comparison of the regional solutions. The needs of these towns were addressed through similar testing of potential local options for each specific demand node (from Scenarios 6a to 6s).

The key outcomes from the TBL assessment of the scenarios are summarised below:

- The Irrigation Efficiency - Shared Benefits scenario performs comparatively well, followed by the Recycling and Stormwater Harvesting scenario. However, the relative certainty of the water security improvement to be obtained is poor for these two scenarios compared to those including regional grids. Nevertheless, an opportunity remains for the opportunistic adoption of a shared benefits approach between individual member Council’s and irrigation interests that may be identified in an Expression of Interest process similar to that implemented by the Commonwealth government. Similarly, the potential to use this option to provide for the environmental requirements downstream of new dams should also be considered in parallel to the design process of any new or augmented storage.

Opportunistically, water security may be improved through town investment in improving irrigation water efficiency on the basis of a sharing of the resulting water.

Using Water Savings for Environmental Flows?

The irrigation efficiency-shared benefits option involves towns and irrigation operations mutually agreeing to partner to help improve on-farm water use efficiency and then each party taking a share in the resulting water savings.

One criticism levelled at buyback schemes, where licences are simply purchased by the Governments and then retired or utilised for environmental flows, is that they reduce the productivity of land use in the region with resulting flow-on effects through the local economy.

Investments in improved efficiency have the potential to increase the land use productivity in the region at the same time as providing water for other uses such as the environment or improved urban water security. In this study, the opportunities for the potential investment by urban water utilities in improving water efficiency has been examined, with the water savings achieved being shared between irrigators and water utilities. The investing water utilities could then utilise the water savings directly for access to additional water, or as offsetting flows to make the impact of new urban water security infrastructure "water neutral".

At the current time, with a severe drought still effecting water security throughout the region, there is considerable uncertainty about how water sharing plans and entitlement regimes will function into the future. It is beyond the scope of the current study to address these issues, which may not be resolved for many years into the future. In this environment it is therefore not possible to simply outline a process for improved water security on the basis of simply gaining additional urban water entitlements on the basis of shared benefits. Even then, unless the urban communities are on run-of river supplies, it is still necessary to provide infrastructure to deliver that additional water security.

As a result, it is the recommendation of this study that improvements in irrigation efficiency be considered primarily as an offsetting mechanism for new infrastructure, particularly where that infrastructure will inherently remove additional water from river systems.

- Comparison of local scenarios identified the preferred options for a number of towns:
    - Chifley Dam to Oberon pipeline (Scenario 6a) is significantly cheaper and more cost effective than the Lithgow stormwater harvesting/water recycling scheme (Scenario 6b). It improves water security of Oberon with the potential to supplement supply to Lithgow. There may also be the opportunity to increase the volume of water supplied to Lithgow from Clarence Colliery, although the potential yields from this option are unclear and this option was not evaluated in this report. There may also be opportunities to supplement supply to power stations from other sources which would reduce the reliance of Delta Electricity on Oberon Dam and improve the security for both Lithgow and Oberon. Further investigation on the Fish River Water Supply would be required to confirm this.

- The construction of minor storages for supply of Cumnock and Yeoval – compared to extending a pipeline link from the CTW network via Manildra. Both Cumnock and Yeoval have sizeable catchment areas which are suitable for locating bulk water storages. The storage options will also include construction of a treatment plant to treat water for the villages.
- Constructing off-stream storages are the preferred local options for river-side towns and villages compared to pipeline links and groundwater solutions. The local water storages should prevent total failure of the supply system by supplementing the provision to towns when water levels in the primary storage reach certain pump marks. This outcome applied to:
    a. Lake Cargelligo – compared to the next highest scoring pipeline from the Lachlan River weir pool to the town's WTP, followed by the groundwater solution which is the most expensive local option for Lake Cargelligo.
    b. Condobolin – the off-stream storage option was the only local option investigated for Condobolin and scores favourably (0.65) against all other local options.
- Pipeline connection from Burrendong Dam to Wellington is the preferred local option for Wellington over the minor off-stream storage.
- Lake Rowlands connection to Orange via Millthorpe, including duplication of CTW's transfer system, provides the greatest improvement in reliability and is the preferred long term solution for Orange. It is costly when considered as a standalone local option but will be incorporated as part of a regional network. The pipeline from Macquarie River off-take and groundwater local options can be considered as short to medium term solutions in the form of emergency supplies. However, as there is considerable uncertainty around the hydrology of both Orange and Molong, consideration has been given to the Molong-Orange connection. At this point it is not clear the link is required, however it should be maintained as a potential option of lower priority for implementation.
- The Lake Rowlands connection to Forbes and Parkes via Gooloogong, including duplication of CTW's transfer system, as part of the regional network is the recommended long term solution. Groundwater may be an option for emergency supplies.

The outcomes of the assessment provided insight into the feasibility and water security improvement capabilities of various regional and local solutions. The project team subsequently utilised this insight to develop viable region-wide strategies to address the water security needs of all the towns with a need for security improvement. This is discussed in the next section.

Table 4-4: TBL Assessment Results for the Thematic Scenarios

Relevant Urban Centres (Comparison of Local Solutions Only)	No	Option	Environmental		1	Economic		1	Social		1	Total Capital NPV	Annualised Total OM&D ($/a)	Cost Effectiveness ($/% improvement in reliability)	Score
			Protection of Water for Environment	Infrastructure Footprint	Purchase of Additional Entitlements?	Cost Effectiveness	Efficient Energy Usage	Cost of Water Supplied ($ per kL)	Equity and Acceptability	Financial Burden on Households	Improvement to Urban Water Reliability				
		Indicator:	Additional Extraction (kL/household/annum)	Hectares	NA	($/% improvement in reliability)	(kWhr/ML)	($ per kL)	NA	($/residential property)	Improvement in Reliability (%)				
Non-Local/ Region-Wide Scenarios	1	Regional Water Grid	0.6	-2.2	0.0	0.1	-0.6	-0.8	-1.0	-0.2	-0.4	$330,295,378	$10,056,584	$1,353	-0.49
	2	Recycling and Stormwater Harvesting	3.0	-1.0	0.0	1.6	1.2	0.8	2.0	1.6	-2.5	$88,033,897	$2,897,468	$864	0.74
	3	Lake Rowlands Regional Network	-1.8	-2.0	-1.0	-1.1	-1.0	-2.6	-1.0	-2.0	0.8	$227,399,744	$7,912,116	$2,243	-1.29
	4	Chifley Dam Regional Network	-1.4	-0.8	0.0	-0.8	0.4	2.4	-1.0	1.4	2.0	$77,146,652	$4,659,049	$2,139	0.25
	5	Irrigation Efficiency - Shared Benefits	3.0	3.0	0.0	3.0	3.0	3.0	2.0	3.0	-0.1	$2,098,692	-	$35	2.21
	6	Preferred Local Options	-2.0	-1.2	0.0	N/A[20]	-1.2	2.2	0.0	-0.8	N/A	$43,606,184	$2,548,641	N/A	-0.33
Oberon and Lithgow	6a	Chifley Dam to Oberon Pipeline	-1.2	0.4	0.0	2.5	-3.0	-0.4	0.0	-1.8	-3.0	$12,848,202	$1,136,366	$126	-0.72
	6b	Winburndale to Lithgow Pipeline + Recycling + Stormwater Harvesting	2.2	-0.4	0.0	2.3	-1.6	-2.4	0.0	1.0	-2.8	$25,032,414	$657,500	$152	-0.19
Cumnock and Yeoval	6c	Pipelines to Cumnock and Yeoval	-2.6	-0.6	0.0	-3.0	-2.6	-2.2	1.0	-3.0	-2.0	$22,857,419	$545,596	$13,503	-1.67
	6d	New Storages at Cumnock and Yeoval	-3.0	0.2	0.0	-1.8	2.6	-1.4	1.0	-2.8	-2.3	$4,445,174	$174,272	$2,924	-0.83
Orange	6e	Groundwater for Orange	2.4	2.0	0.0	2.8	-2.0	1.0	1.0	2.8	3.0	$698,943	$38,279	$73	1.44
	6f	CTW Connection to Orange	-0.8	1.4	0.0	-1.6	-0.2	-0.2	1.0	-1.0	3.0	$35,115,545	$878,622	$2,836	0.18
	6g	Molong - Orange Link	1.6	-1.8	0.0	0.4	-0.4	-1.2	1.0	2.2	2.3	$23,640,481	$776,517	$1,229	0.45
	6s	Macquarie River offtake to Orange Pipeline	-0.8	0.8	0.0	-1.3	-1.4	0.0	1.0	-0.4	3.0	$24,745,571	$1,300,273	$2,545	0.10
Forbes	6h	CTW Connection to Forbes	2.0	-0.2	0.0	-2.0	-2.4	-2.8	1.0	-2.4	0.1	$44,950,008	$745,717	$4,099	-0.75
	6m	New Storage at Forbes	0.8	1.0	0.0	N/A	2.8	-0.6	1.0	0.6	0.0	$6,617,372	$125,920	N/A	0.62
	6p	Groundwater for Forbes	1.0	1.8	0.0	-0.4	-1.8	-2.0	1.0	-0.6	1.8	$5,692,982	$275,451	$1,397	0.09
Cowra	6i	CTW Connection to Cowra	2.6	1.6	0.0	2.0	1.4	-3.0	1.0	2.6	0.4	$2,466,702	$25,736	$197	0.96
	6n	New Storage at Cowra	1.4	3.0	0.0	N/A	2.4	0.4	1.0	1.8	0.0	$5,577,321	$106,800	N/A	1.11
Lake Cargelligo	6j	Lachlan River to Lake Cargelligo Pipeline + Off Stream Storage	-2.2	0.0	0.0	1.8	1.6	2.6	1.0	0.8	0.6	$4,415,482	$141,542	$5,491	0.69
	6o	New Storage at Lake Cargelligo	1.8	3.0	0.0	N/A	2.0	-1.8	1.0	2.0	0.0	$1,644,151	$26,867	N/A	0.89
	6q	Groundwater for Lake Cargelligo	-1.6	3.0	0.0	-2.8	-2.8	-1.6	1.0	-2.2	1.8	$9,303,814	$278,138	$11,338	-0.57
Wellington	6l	Burrendong to Wellington Pipeline	-2.8	1.2	0.0	-2.3	-2.2	2.0	1.0	-2.6	1.8	$11,660,311	$899,213	$5,483	-0.43
	6r	New Storage at Wellington	1.2	3.0	0.0	N/A	1.8	0.2	1.0	1.2	0.0	$3,046,623	$53,417	N/A	0.93
Condobolin	6k	New Storage at Condobolin	-2.4	0.6	0.0	1.8	2.2	2.8	1.0	2.4	0.6	$2,192,992	$64,712	$839	1.00

[20] Scenarios with N/A marked against their "Cost Effectiveness" criterion contain options that are aimed at preventing water supply systems from being empty. This is achieved by constructing additional storages that will be used to supplement the urban demands when their primary storage reaches 20% capacity in the model. The trade-off between actual pump mark and storage sizes will be determined at the detailed design stage. These options do not reduce the probability of a restriction being imposed on a supply storage and therefore has no score on the particular criterion.

4.4 REGION-WIDE TOWN WATER SECURITY STRATEGIES

The process of assessing the long-list of potential options and evaluating the thematic scenarios culminated in the development of six region-wide town water security strategies (Table 4-5). Each of the strategies addresses the long term water security needs of each of the towns with an identified need for water security improvement. The strategies consider water requirements until the year 2059. Visual representations of the final strategies are presented in Appendix D.

Table 4-5: Region-Wide Town Water Security Strategies

#	STRATEGIES	DESCRIPTION	OPTIONS INVOLVED
F1	Regional Water Grid + Local Options	Region-wide pipeline network to enable water transfer between urban centres that is reasonably cost effective. This strategy includes a local pipeline option at Lake Cargelligo to eliminate water security gap not covered by the regional water grid.	• Lake Rowlands Augmentation • Chifley-Oberon Pipeline • Chifley-Bathurst Pipeline • Chifley to CTW Pipeline via Blayney • Blayney-Millthorpe Pipeline (CTW Trunk Mains X and F duplication) • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Molong-Manildra Pipeline • Manildra-Cumnock-Yeoval Pipeline • Yeoval-Wellington Pipeline • Manildra-Parkes Pipeline • Parkes-Bogan Gate Pipeline • Bogan Gate-Condobolin Pipeline • Lake Rowlands to Forbes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • Lachlan River-Lake Cargelligo Pipeline
F2	Lake Rowlands Regional Network + Local Options	Augmentation of Lake Rowlands to cater for and supplement a regional supply to CTW, Orange, Cowra, Forbes and Parkes. This strategy includes local options to eliminate water security gaps not addressed by the regional pipeline network.	• Lake Rowlands Augmentation • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • Burrendong-Wellington Pipeline • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline

#	STRATEGIES	DESCRIPTION	OPTIONS INVOLVED
F2a	Lake Rowlands Regional Network + Local Options + Cadia Hill	Augmentation of Lake Rowlands to cater for and supplement a regional supply to CTW, Orange, Cowra, Forbes, Parkes, as well as mining water demand at Cadia Hill. Note that the transfer system from Belubula Creek to Cadia Hill has already been invested and is available. This strategy includes local options to eliminate water security gaps not addressed by the regional pipeline network.	• Lake Rowlands Augmentation • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • Burrendong-Wellington Pipeline • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline • Belubula Creek-Cadia Hill pipeline (already available)
F3	Chifley Dam Regional Network + Local Options	Pipeline supply from Chifley Dam to Bathurst and to supplement supplies at CTW, Orange, Cowra, Forbes and Parkes. This strategy includes local options to eliminate water security gaps not addressed by the regional pipeline network.	• Chifley to CTW Pipeline via Blayney • CTW Trunk Mains X and F duplication • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • Burrendong-Wellington Pipeline • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline

#	STRATEGIES	DESCRIPTION	OPTIONS INVOLVED
F3a	Chifley Dam Regional Network + Local Options + Cadia Hill	Pipeline supply from Chifley Dam to Bathurst and to supplement supplies at CTW, Orange, Cowra, Forbes, Parkes, as well as mining water demand at Cadia Hill. Note that the transfer system from Belubula Creek to Cadia Hill has already been invested and is available. This strategy includes local options to eliminate water security gaps not addressed by the regional pipeline network.	• Chifley to CTW Pipeline via Blayney • CTW Trunk Mains X and F duplication • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • Burrendong-Wellington Pipeline • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline • Belubula Creek-Cadia Hill pipeline (already available)
F4	Lake Rowlands & Chifley Dam Regional Network + Local Supply + Cadia Hill	Essentially a combination of strategies F2a and F3a, this strategy includes both the augmented Lake Rowlands and Chifley Dam to supplement supply to CTW, Orange, Cowra, Forbes, Parkes and mining demand at Cadia Hill. This strategy includes local options to eliminate water security gaps not addressed by the regional pipeline network.	• Lake Rowlands Augmentation • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • Burrendong-Wellington Pipeline • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline • Belubula Creek-Cadia Hill pipeline (already available)

The TBL assessment approach was again utilised to evaluate the region-wide town water security strategies. The results are set out in Table 4-6.

The outcomes of the TBL assessment of the region-wide strategies are summarised below:

- Strategy 1, the Regional Water Grid has a negative score, indicating that it does not positively contribute to the achievement of the identified study objectives. This outcome is mainly driven by the performance of this strategy against the economic criteria.
- Whilst the assessment indicates some differential between Strategy 2 and Strategy 3, with a higher score (a better result) for Strategy 3, neither strategies take into account the potential for mutual benefit to the mining sector from the provision of additional water demand requirements to Cadia mine.

- Although Strategy 2a scores marginally better, for the level of accuracy of the inputs to the TBL assessment, Strategies 2a and 3b are very close. Therefore, it is important to consider the driving factors behind scores to understand the trade-offs to be encountered in decision making.
- Both strategies have the same impact on environmental criteria 1 (protection of water for the environment) and environmental criteria 3 (purchase of additional entitlements), which relate to extractions, as the same demands are being met.
- Strategy 3a rates better than Strategy 2a on environmental criteria 2 (infrastructure footprint) as Strategy 2a contains the building of an augmented Lake Rowlands, which will have a significant footprint.
- In terms of economic criteria, Strategy 2a performs significantly better in relation to the efficiency of energy usage criteria (economic criteria 2). This is a result of the fact that significant energy would be required to transfer water between the Upper Macquarie and the Upper Lachlan valleys. The pumping capacity required to transfer the water would need to overcome 180m elevation to transfer the water and this would consume considerable energy. By contrast, Lake Rowlands is 170m higher and would be able to provide water by gravity.
- In terms of the first and third economic criteria, the cost of water supplied, Strategy 3a is cheaper from a cost perspective essentially because it is estimated that the NPV of total costs of providing the pipeline link from Chifley Dam are in the order of $45m lower (base cost with no contingency allowance or escalation) than the costs of building the new dam.
- In terms of the social criteria, the options perform similarly in terms of security improvement, but differ for the equity and acceptability and financial burden to households criteria. While the provision of improved water supply security has benefits for the region as a whole, it is recognized that the connection of the Upper Macquarie to the Upper Lachlan is not socially acceptable for many of the members of Centroc and raises community concerns around the level of service they will receive. Similarly, the provision of water to mining entities is also less socially acceptable in some communities.

In the end, as with any TBL assessment, the results indicate that there are trade-offs between the cost and infrastructure footprint (in favour of Strategy 3a) against the elevation and therefore energy performance of Strategy 2a. The trade-off essentially comes down to the choice of a large new pipeline or an augmented dam.

Although equally weighted here, the energy consumption associated with operating 3a may be of greater concern considering the link between energy consumption, climate change and water supply security and the increasing pressure to regulate to minimise emissions.

In addition, there are implementation issues associated with the transfer pipeline (Strategy 3a) in that new easements (not all of which are expected to be alongside roads) will be required whereas the pipelines required to get extra water from Lake Rowlands (Strategy 2a) into the system (excluding those pipes common to both options like the links to Orange and Forbes) would be aligned with existing easements.

Strategy 4 is essentially the integration of Strategy 2a and 3a. This strategy was prepared in anticipation of the impact of climate change on demand, supply and overall water security. This is discussed in the next section.

Table 4-6: TBL Assessment Results for the Region-Wide Strategies

No	Option	Environmental		1	Economic		1	Social		1	Total Capital NPV	Annualised Total OM&D ($/a)	Cost Effectiveness ($/% improvement in reliability)	Score	Ranking After Sensitivity Analyses
		Protection of Water for Environment	Infrastructure Footprint	Purchase of Additional Entitlements	Cost Effectiveness	Efficient Energy Usage	Cost of Water Supplied ($ per kL)	Equity and Acceptability	Financial Burden on Households	Improvement to Urban Water Reliability					
	Indicators:	Additional Extraction (kL/household/ annum)	Hectares	N/A	($/% improvement in reliability)	(kWhr/ML)	($ per kL)	N/A	($/residential property)	Improvement in Reliability (%)					
F1	Regional Water Grid + Local Options	0.4	-2.4	0.0	-0.6	0.2	-1.0	1.0	0.0	-0.6	$349,481,564	$9,268,433	$1,470	-0.33	6
F2	Lake Rowlands Regional Network + Local Options	0.4	-2.6	0.0	0.6	0.6	0.6	2.0	-1.4	-0.6	$253,101,055	$7,659,179	$1,103	-0.04	3
F3	Chifley Dam Regional Network + Local Options	0.4	-1.4	0.0	1.1	-0.8	1.4	0.0	0.4	-0.6	$194,518,950	$7,450,557	$1,099	0.05	4
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	0.4	-2.8	0.0	0.8	1.0	1.6	2.0	-1.4	-0.6	$261,501,055	$7,797,509	$912	0.12	1
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	0.4	-1.6	0.0	1.3	0.0	1.8	-1.0	0.4	-0.6	$202,918,950	$7,588,888	$905	0.08	2
F4	Lake Rowlands + Chifley Regional Network + Local Options + Cadia Supply	0.4	-3.0	0.0	-0.1	0.8	1.2	0.0	-1.2	-0.6	$324,222,846	$10,120,449	$1,389	-0.28	5

4.5 SENSITIVITY ANALYSIS

The long-term and strategic nature of this study means that there are elements of uncertainty that may influence the water security outcomes modelled and/or the selection of the preferred final strategy. These sources of uncertainty include:

- The potential impact of climate change on temperatures, rainfall and runoff may impact on the nature of water demand and water availability. Climate change is viewed as a significant risk to water resource security and is a required element of consideration for urban water planning consistent with the Federal Government National Water Initiative (see Appendix E);
- The trend of the costs of energy increasing over time may impact on the expected capital and operating costs;
- The potential impact of higher levels of population growth (ie, growth at levels greater than the adopted WRI Scenario C for Centroc) driving greater levels of town water demand;
- Potential variations in the cost estimates of key infrastructure elements.
- The potential need for the strategy to be flexible enough able to accommodate the water needs associated with other sectors, particularly mining, that are likely to arise in the Centroc region.

Sensitivity analyses of the above factors were conducted to investigate their impacts on the modelling outcomes on the preferred strategy. The details of this assessment are set out in Appendix D.

Key findings of the sensitivity analysis are set out in the following sections.

4.5.1 CLIMATE CHANGE

Climate change is expected to increase temperatures and reduce runoff. Similarly, town water supply demands are expected to increase in response to climate change. In this situation, to meet the water security improvement requirements of towns, the interconnection of the Upper Macquarie town supplies and those of the Upper Lachlan may need to be considered as an additional element of the region-wide strategy. More details on this assessment are available in Appendix C.

To manage the risk associated with climate change, a link between the Upper Macquarie and the Upper Lachlan may be warranted.

At this point, the connection provided by the Chifley-CTW via Blayney Pipeline is the recommended approach should it be required under climate change. This link would increase the supply security of both the Chifley and Lake Rowlands systems by creating the opportunity to transfer water in both directions in times of need. However, in the event of an emergency situation in Orange, it may be necessary to put in place the pipeline connection between Orange and the Macquarie River. This may provide an opportunity for an alternative (or additional) pipeline connection as part of the regional scheme following along the Macquarie River.

4.5.2 ENERGY COSTS

The increase in energy costs, whilst considerably small relative to the capital costs and not uniform across the region-wide strategies, can potentially be significant enough to result in the choice of an alternative strategy. Analysis was conducted on average energy increases of 25%, 50% and 100% over the forecast horizon. Outcomes of the analysis are set out in Table D-10 below.

Strategy F3a is less energy efficient and therefore its scores progressively dropped in response to increases in energy costs. Strategy F2a is more energy efficient and this is reflected in its ranking under this sensitivity test.

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Table 4-7: Impact of Energy Cost Increases on Annual OM&D Costs and TBL Assessment

No	Strategy	Annualised Total OM&D ($/a)				Score				% Change in Annualised Total OM&D ($/a)			Ranking
		Base ($0.12/ kWhr)	+25%	+50%	+100%	Base ($0.12/ kWhr)	+25%	+50%	+100%	+25%	+50%	+100%	
F1	Regional Water Grid + Local Options	$9,268,433	$10,008,335	$10,748,238	$12,228,043	-0.33	-0.44	-0.40	-0.35	8%	16%	32%	5
F2	Lake Rowlands Regional Network + Local Options	$7,659,179	$8,429,379	$9,199,579	$10,739,980	-0.04	-0.13	-0.15	-0.15	10%	20%	40%	3
F3	Chifley Dam Regional Network + Local Options	$7,450,557	$8,398,354	$9,346,150	$11,241,742	0.05	-0.08	-0.12	-0.21	13%	25%	51%	4
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	$7,797,509	$8,587,798	$9,378,087	$10,958,665	0.12	0.01	0.03	0.05	10%	20%	41%	1
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	$7,588,888	$8,556,773	$9,524,658	$11,460,428	0.08	-0.01	-0.01	-0.03	13%	26%	51%	2
F4	Lake Rowlands + Chifley Regional Network + Local Options + Cadia Supply	$10,120,449	$11,120,946	$12,121,443	$14,122,437	-0.28	-0.37	-0.37	-0.39	10%	20%	40%	6

4.5.3 POPULATION

Bathurst has completed an Integrated Water Cycle Management Strategy which assumed higher levels of growth than utilised in this region-wide study which adopted the Centroc Board resolved growth forecasts for the region.

Modelling as part of the Bathurst IWCM, which allowed for a population of some 22,000 more people by 2059, demonstrated that this supply remains secure. It is recognised that the community of Bathurst have made an investment in the security of their water supply and there is a community expectation that a high level of service be maintained. Any sharing of this security would need to recoup the investment and have to maintain the surety of the supply to Bathurst and not jeopardise the security of this supply.

Sensitivity testing of the connection between the Upper Macquarie and the Upper Lachlan, sourced from Chifley Dam Bathurst, was conducted as part of this study. The assessment suggests that this source would be less able to meet the supplementary demands of the towns to be connected under Strategy 3a if higher than anticipated growth rates occur. It should be noted however, that the growth expectations of Bathurst significantly exceed those predicted by the NSW Department of Planning and Local Government.

Sensitivity testing was also carried out on Strategy 2a to test the ability of this strategy to support a higher level of growth than anticipated (ie, to mimic a situation closer to the WRI B forecast). The testing indicated, that whilst restrictions may be in place more often, this strategy is still able to deliver considerable security improvement with the greater population.

4.5.4 KEY INFRASTRUCTURE COSTS

The cost estimates provided in this report are suitable for strategic planning purposes only. One of the key areas of uncertainty in the cost estimates, which is difficult to account for at the strategic planning level, are the costs associated with dam construction.

The costs used in the TBL assessment were derived from a survey of industry data for a wide variety of dam types. They were not tailored specifically for conditions at the site of the proposed Lake Rowlands augmentation. CTW provided data which indicates that site specific cost estimates for the upgrade are in the vicinity of $45 million capital ($2006, GHD, 2006).

As illustrated in Table 4-8, this cost difference has a significant impact on the TBL results, favouring options including the augmentation of Lake Rowlands.

Table 4-8: TBL Assessment Results for the Region-Wide Strategies – Sensitivity to Lower Lake Rowlands Augmentation Cost

No	Option	Environmental		1	Economic		1	Social		1	Total Capital NPV	Score	Ranking
		Protection of Water for Environment	Infrastructure Footprint	Purchase of Additional Entitlements	Cost Effectiveness	Efficient Energy Usage	Cost of Water Supplied ($ per kL)	Equity and Acceptability	Financial Burden on Households	Improvement to Urban Water Reliability			
	Indicators:	Additional Extraction (kL/household/annum)	Hectares	N/A	($/% improvement in reliability)	(kWhr/ML)	($ per kL)	N/A	($/residential property)	Improvement in Reliability (%)			
F1	Regional Water Grid + Local Options	0.4	-2.4	0.0	-0.1	0.2	-0.6	1.0	0.6	-0.6	**$285,887,630**	**-0.17**	**6**
F2	Lake Rowlands Regional Network + Local Options	0.4	-2.6	0.0	1.3	0.6	1.4	2.0	-0.8	-0.6	**$189,507,121**	**0.19**	**2**
F3	Chifley Dam Regional Network + Local Options	0.4	-1.4	0.0	0.6	-0.8	1.0	0.0	0.0	-0.6	**$194,518,950**	**-0.09**	**4**
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	0.4	-2.8	0.0	1.6	1.0	2.2	2.0	-0.8	-0.6	**$197,907,121**	**0.33**	**1**
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	0.4	-1.6	0.0	0.8	0.0	1.6	-1.0	0.0	-0.6	**$202,918,950**	**-0.04**	**3**
F4	Lake Rowlands + Chifley Regional Network + Local Options + Cadia Supply	0.4	-3.0	0.0	0.1	0.8	1.2	0.0	-0.4	-0.6	**$260,628,912**	**-0.16**	**5**

4.5.5 MINING

Accurate forecasts of mining water demand over time are commercially sensitive and difficult to make due to the exploratory nature of mine development.

During the course of the study, a number of potential future demands in the mining sector were identified through discussions with the mining representatives on the PRG, the Department of Minerals and mining entities in the region. The volume of these potential demands was estimated on the basis of discussions with the existing and future mining operators in the region. These additional demands and their approximate locations are outlined in Table 4-9.

Table 4-9: Additional Mining Demands in CENTROC Supply Area

APPROXIMATE LOCATION	ANNUAL DEMAND (ML)	DAILY DEMAND (ML)	SUPPLY LOCATION
Orange	15,000	40	Regional water network (Lake Rowlands)
Parkes	4,200	12	Regional water network (Parkes)
Blayney	3,600	10	Regional water network (Lake Rowlands)
Molong	3,000	8	Regional water network (Lake Rowlands)

Under the current climate regime, connection to an augmented Lake Rowlands (Strategy 2a) will meet the needs of an additional 10 ML demand in proximity to the existing CTW system.

The WATHNET model for the core supply system for Strategy 4 (augmented Lake Rowlands plus connection of Chifley Dam) was run, with supply to the core regional network supplying water to:

- Bathurst
- Oberon;
- Lithgow;
- Existing Central Tablelands System;
- Orange;
- Molong;
- Cowra; and
- Parkes.

Water was firstly provided by Lake Rowlands and then by Chifley Dam in the event that Lake Rowlands water was not available. Mining demands were assumed to be unrestricted. The results of the analysis (Table 4-10) suggest that:

1. In the event that the additional mining demands materialised, and augmented Lake Rowlands would have insufficient water without connection to Chifley Dam or some other source;

2. Without a restriction regime on mining operations, there is a significant risk of supply failure – even with Chifley Dam connected to the supply.

In conclusion:

1. If Chifley Dam were not available to supplement supply from Lake Rowlands, and to help avoid the supply risk failure, additional mining demands would need to be met from either increasing the planned size of the amplification of Lake Rowlands[21] or by supply from the major dams (Wyangala or Burrendong). This would also impact on the sizing (and therefore costs) of the raw water transfer network;

2. Mining demands would require an agreed water restriction and supply regime that would balance the benefits of continued operation with the need to maintain water security.

Table 4-10: Impact of Additional Mining Demands on Supply Security for Strategy 4 – Augmented Lake Rowlands and Chifley Dam Regional Supply

SOURCE SUPPLYING	PRIMARY SUPPLY TO	PROBABILITY OF LEVEL 1 RESTRICTIONS IN ANY YEAR	PROBABILITY OF TOTAL SYSTEM FAILURE
Chifley Dam	Bathurst, Oberon (permanent) Lithgow (supplementary)	4.7%	0.4%
Lake Rowlands	Blayney, Millthorpe, Carcoar, Lyndhurst, Mandurama, Garland (permanent) Orange, Molong, Parkes, Forbes, Cowra (supplementary)	4.9%	4.0%

Financial commitment would need to be sought from the mining sector prior to investment in larger assets and this assessment does not consider the need for the mining sector to acquire additional water allocations.

[21] It is important to note that the size of the Lake Rowlands source has not been optimised as part of this study and therefore, if the additional mining demands were confirmed, it may be worth looking at the optimal size of this storage.

5. RECOMMENDATIONS

As a result of the assessment documented in the previous sections, this section of the report sets out the key recommendations of this study.

5.1 REGION-WIDE STRATEGY

The recommended region-wide town water security strategy is F2a: Lake Rowlands Regional Network + Local Options + Cadia Hill (Figure 5).

Table 5-1 sets out the detailed elements of the strategy including recommended approaches to implementation and an indication of timing. The implementation of these actions is in addition to:

- The ongoing management and maintenance of the existing water supplies of each town;
- The ongoing implementation of the best-practice demand management programs of each council; and
- The ongoing development and implementation of the existing Integrated Water Cycle Management Strategies completed by a number of the member council's including Bathurst, CTW, Orange and Parkes.

As the augmentation of Lake Rowlands is a key recommendation to improve security, it is a high priority action and approvals, planning, and design phases for this element needs to commence and continue as an immediate priority. It is anticipated that the augmentation of Lake Rowlands, and the subsequent time for the storage to fill, will be the elements of the strategy which have the longest implementation timeframes. The approval and design (3-4 years)[22] and delivery (4-5 years[23]) of a new storage generally take between 7-10 years. Additional time would need to be allowed for the dam to fill and therefore become fully operational.

As a result, there will be a need for interim measures that are consistent with the overall strategy to be put in place. These are discussed in Section 5.2.

Implementation of the entire strategy, using a specialist program management and delivery approach, is worth considering. This will ensure consistency of outcomes, delivery of all key elements to time imperatives and, as a comprehensive united front to implementation, may also support access to funds.

[22] Recent approval timeframes:

4 years Nathan Dam, Queensland, 1,000,000 ML capacity. Controlled Action under EPBC Act

3 years Traveston Crossing, Queensland 70,000 ML/a. Controlled Action under EPBC Act

3 years Wyaralong Dam, 21,000 ML/a. Controlled Action under EPBC Act

3 years Tilgera Dam Hunter Water 450-gigalitre dam. Part 3A of the Environmental Planning and Assessment Act 1979. Controlled Action under EPBC Act

It should be noted that the dams above have required both state and federal approvals. The approval path for the Lake Rowlands Augmentation has not been assessed. This information is provided for indication purposes only. The State Environmental Planning Policy (Infrastructure) 2007 outlines the approval process and assessment requirements for infrastructure proposals water supply systems. In addition, State Environmental Planning Policy (Major Projects) 2005 also covers water treatment infrastructure of capital investment value of more than $30 million for drinking water. The Minister can declare critical infrastructure in certain circumstances in which case the Part 3A approval process is required. This has only happened in limited circumstances including the Kurnell desalination plant.

[23] The construction period or time to build the dam usually takes from 4 to 5 years and sometimes as long as 7 to 10 years for very large multi purpose dam projects (ICOLD, 2007).

What is the Recommended Region-Wide Strategy?

The recommended strategy includes provision of the supplementary water requirements of the towns of Cowra, Forbes, Orange, Parkes and Young through connection to the Central Tablelands Water system (which will need some amplification) and the augmentation of Lake Rowlands to a capacity of 26,500 ML (See Figure 5 on following page). The augmented Lake Rowlands will also be able to meet up to 10 ML/d of demand at Cadia Hill.

Pipeline connection between Bathurst and Oberon is also recommended as this will provide supplementary water for Oberon and reduce pressure on the Fish River Water Supply, improving outcomes for Lithgow as a result. Pipelines from the storages of Burrendong and Chifley dams to Wellington and Bathurst respectively are recommended to save water lost in the delivery of these supplies through river channels. In addition, a series of local solutions, including new minor storages at Cumnock, Condobolin, Lake Cargelligo and Yeoval are recommended.

Whilst it may take up to 10 years before the augmented Lake Rowlands will be completed and then time to fill to be fully operational, other elements of the strategy can be advanced quickly. Priority elements include the connection between Bathurst and Oberon, the provision of a Lachlan River connection to Lake Cargelligo and the connection between CTW and Cowra which is already in planning as well as the storages for Cumnock, Condobolin, Lake Cargelligo and Yeoval. The region-wide strategy includes:

- Lake Rowlands Augmentation (start approvals and planning as a priority);
- Lake Rowlands-Millthorpe Pipeline (CTW Trunk Mains D and F duplication);[24]
- CTW-Orange Pipeline via Millthorpe;
- Lake Rowlands to Gooloogong Pipeline (CTW Trunk Mains P and C duplication);
- Gooloogong-Forbes Pipeline (including connection to Parkes);
- Woodstock-Cowra Pipeline (presently in planning);
- Orange-Molong Creek Dam pipeline (lower priority action resulting from the level of surety around the security of Molong. There is an existing pipeline from Molong Creek Dam to connect into);
- New minor storage and water treatment facilities at Cumnock;
- New minor storage and water treatment facilities at Yeoval;
- New minor storage at Condobolin (off-stream from Lachlan River);
- New pipeline replacing existing channel and minor storage at Lake Cargelligo;
- Burrendong-Wellington Pipeline;
- Chifley-Bathurst Pipeline;
- Chifley-Oberon Pipeline; and
- Belubula Creek-Cadia Hill pipeline (already available).

The strategy is underpinned by the recommended comprehensive, region-wide, demand management program.

[24] It has been assumed that all duplicated lines associated with the regional network carry raw water. The costs of additional treatment have not been estimated as these are sunk costs given the utilities would need to provide this capacity to meet growth irrespective of the choice of strategy. There may be benefits of centralising additional water treatment requirements, but this would require further examination.

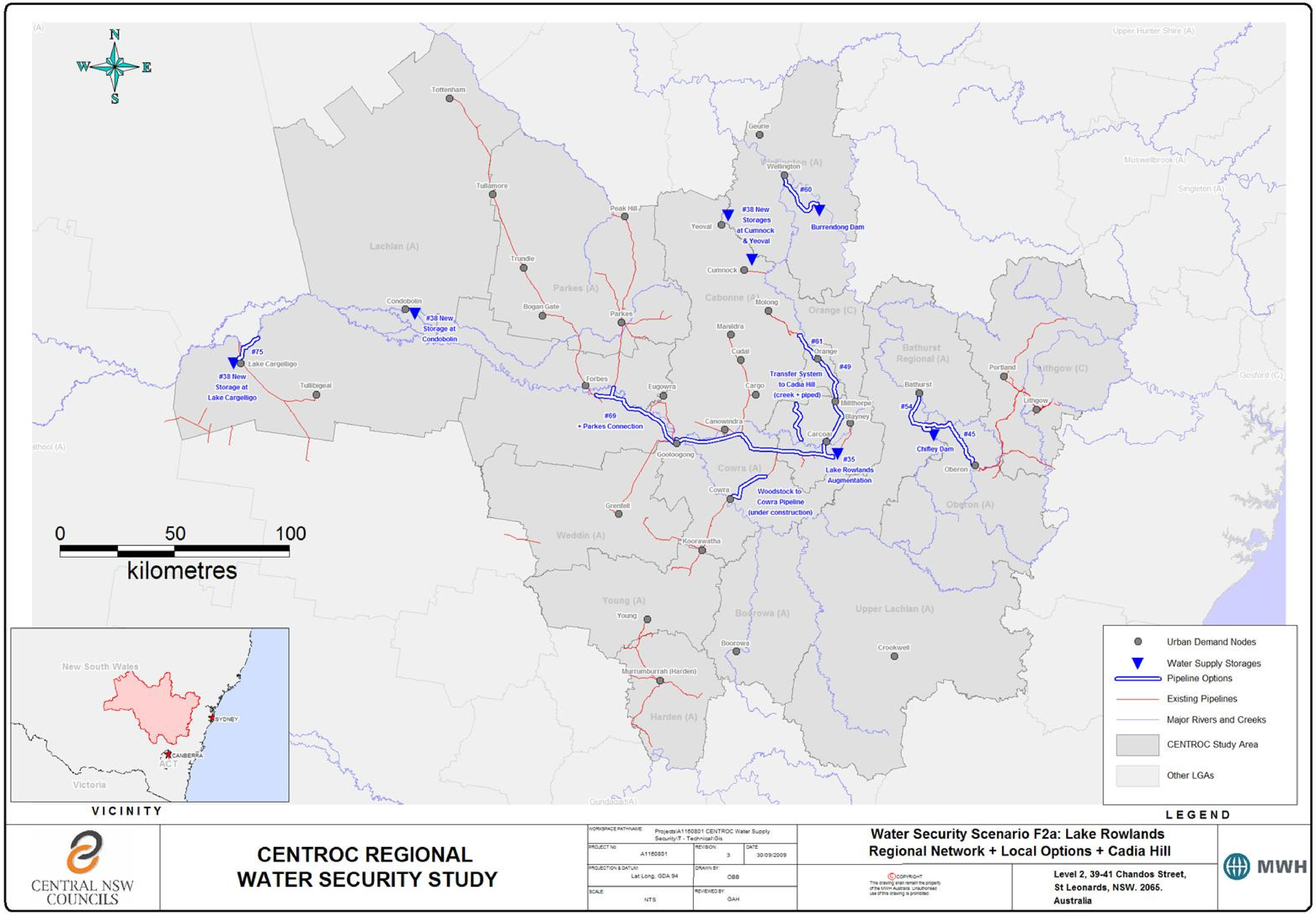

Figure 5: Preferred Region-Wide Strategy F2a – Lake Rowlands Regional Network + Local Options + Cadia Hill

Table 5-1: Timing and Implementation of the Preferred Region-Wide Strategy

LGA	COMPONENTS	DESCRIPTION	CAPITAL COST $2009[25]	OPERATING COSTS	CUSTOMERS SERVED 2059	IMPLEMENTATION	TIMING
Region Wide	Irrigation Efficiency – Shared Benefits	Security improvement may be obtained through the partnering of towns with local irrigation operations. In return for up-front investment to assist irrigators to become more water efficient, towns would share in the resulting water saved and use this to supplement their supplies. Water savings from the initiative could also be used to offset environmental release requirements downstream of new or augmented water supply storages.	Varies by operation and would need to be pursued on a council by council basis.	None.	Varies by operation.	An expression of interest (EoI) process could be used to identify potential irrigation operations that have an interest in partnering with the Centroc Councils to improve water efficiency on farm and share the resulting water. The potential to use water savings from the initiative to offset environmental release requirements downstream of new or augmented water supply storages should also be determined.	The EoI process could be run and negotiations completed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.
	Regional Water Conservation Implementation and Demand Management Program	Implementation of a region-wide water conservation and demand management program including: • Residential retrofit of inefficient water fixtures, including providing customer support for replacements; • Continuation of the Water Efficiency Labelling and Standards Scheme (WELS); • Implementation of Permanent Low Level Restrictions on outdoor water use; • Continuation of the BASIX program for new developments; • Continuation or expansion of Water Conservation Education programs to improve efficient water use; • Audit of Non-Residential Water Use to identify leaks and potential areas for improvement in efficiency; • System Water Loss Management which aims to identify and repair leaks in water supply and distribution system; and • Review of water supply and sewerage services pricing structure to follow the best-practice guideline of 25:75 Fixed to Variable Charge Ratio.	For towns with growth, the costs of this program would be recovered through avoided capital and reduced operational costs in treatment and transfer. For towns without growth, the costs of this program would be recovered through reduced operational costs.		Entire region.	This program could be developed and implemented under the auspices of Centroc as a regional initiative taking advantage of the benefits of scale and opportunities to template the program. The level of savings anticipated from the implementation of this program is anticipated to effectively cancel out the impact of water demand from new growth across the region. As a result, the program is expected to be highly cost effective in that it assists in deferring capital and reducing operating expenses. The expected level of savings is broadly consistent with the level of savings targeted by other communities in Australia with a mix of new growth and existing development. A number of Council's including Bathurst, Orange and Parkes have well established programs that could be leveraged to share the knowledge across the region.	The planning and implementation of this program could be expected to be a condition of approval for the augmentation of Lake Rowlands. This program should be developed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.
	Uniform Restriction Regime	Development of a uniform restriction trigger policy across towns connected to the same water source. For river towns (ie, those connected to the Macquarie River and the Lachlan River directly), this restriction regime would be tied to storage levels in the two main dams of Wyangala and Burrendong. It is proposed that restrictions are implemented when these storages decrease to the 10th%ile storage level. In this way, the river towns go on restriction in a manner consistent with that required of other water users.	None.	Within existing operating expenses for each Council.	Entire region.	This program could be developed and implemented under the auspices of Centroc as a regional initiative taking advantage of the benefits of scale and opportunities to template the program. This component could be implemented in parallel with an expansion of the Bathurst, Orange and Dubbo (BOD) uniform restriction policy system which has been put in place to provide a consistent definition of each level of restriction across these cities. This is an example of effective collaboration between utilities across the region that could be leveraged and held up as an example for NSW.	This component could be developed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.
Bathurst	Chifley Dam to Bathurst Pipeline	This involves the construction of a pipeline (600 mm diameter, 19 km in length) supplying town water demands from Chifley Dam to Bathurst. The pipeline is expected to significantly reduce transmission losses via evaporation and therefore save considerable water which could be used for other purpose.	$20 million	$1.5 million annualised total OM&D costs	32,749	Implementation of this option would require completion of feasibility, concept and detailed design and construction processes. However, piping the transfer from the dam will affect environmental releases and the ability of irrigators to obtain water from the release. A water sharing plan would need to be put in place to manage this impact and successful implementation of this option.	Development of a sharing plan could be commenced immediately.
	Chifley Dam to Oberon Pipeline	This pipeline connection (300 mm diameter, 43 km in length) is expected to supplement the supply at Oberon from Chifley Dam.	$17 million	$1.1 million annualised total OM&D costs	2,667	The connection should be used when water supply from Fish River and Oberon Dam are not sufficient to meet the demand of the town. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.
Blayney	Continued service from the CTW Scheme	Business as usual.	See Central Tablelands Water				

[25] The costs prepared for this study are strategic planning level estimates only. They are derived from the NSW Reference Rates DWE 2007. During concept and detailed design phases, more work would be done to establish exact size and material type etc of infrastructure including pipelines and storages. This would change these estimates. For budgeting purposes, it is appropriate to recognise that potentially significant change in these costs may be realised during concept, detailed design and delivery processes. A contingency of 35% has been applied to the cost estimates in this table.

LGA	COMPONENTS	DESCRIPTION	CAPITAL COST $2009[25]	OPERATING COSTS	CUSTOMERS SERVED 2059	IMPLEMENTATION	TIMING
Boorowa	Lack of information to determine	Although this system was not modelled in detail due to the lack of information, it is expected to be secure and so no options for security improvement were developed as part of the study.	NA	NA	NA	Further investigation studies might be undertaken to fulfil data gaps and confirm the security of this system.	Completion of an independent data gathering study could be commenced immediately.
Cabonne	New minor storage at Cumnock	This new storage of 32 ML located at Cumnock is a cost effective option to secure water for the village from its Bell River supply.	$6 million	$175,000 annualised total OM&D costs	618	The storage should be sized to store water from Bell River and provide sufficient water supply to the village during extended dry periods up to 2 months. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.
	New minor storage at Yeoval	This new water supply storage of 38 ML located at Yeoval is a cost effective option to secure water for the village from its Buckinbah Creek supply.				The storage should be sized to store water from the creek and provide sufficient water supply to the village during extended dry periods up to 2.5 months. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.
	Orange to Molong Creek Dam Pipeline (connecting into the existing pipeline associated with Molong Creek Dam).	Pipeline connection (750 mm diameter, 15 km in length) between Molong Creek dam pipeline and Orange.	$16 million	$185,000 annualised total OM&D costs	1,769	This pipeline connection is a 2-way transfer system, but should primarily be operated to supplement the supply at Orange (see entry in Orange). However, due to uncertainties surrounding the hydrology and security of Molong, there is a potential for the pipeline to be operated in the reverse direction to supplement supply in Molong. At this point it is not clear the link is required, however it should be maintained as a potential option of lower priority for implementation.	This component is a lower priority option and, following liaison with CTW to confirm its need, could be designed and constructed in parallel with the concept and design stages for Lake Rowlands Dam augmentation and the connection from the CTW network to Orange via Millthorpe.
Cowra	Lake Rowlands to Cowra Pipeline via Woodstock	Pipeline connection (150 mm diameter, 20 km in length) between the CTW network and Cowra.	$4 million	$36,000 annualised total OM&D costs	9,687	This pipeline connection between the CTW network and Cowra is currently in planning and shortly for construction and should supplement supply for Cowra, Koorawatha and surrounding communities. The water supply network can be extended to improve water security at Young and Harden through the Young to Bendick Murrell Pipeline (see component under Young).	Planning and construction activities are underway.
Forbes	Lake Rowlands to Forbes Pipeline via Gooloogong (including connection to Parkes)	Pipeline connection (150 mm diameter, 50 km in length) between the CTW network and Forbes and Parkes.	$25 million	$270,000 annualised total OM&D costs	8,499	This pipeline connection to the Central Tablelands Network should be utilised during dry periods only. The connection should be sized at Forbes' peak day demand and is expected to supplement the town's water supply at times when provision from the Lachlan River and groundwater bores are not sufficient to meet its demands. Duplication of CTW's trunk mains P and C will be necessary to supplement supply to Forbes and Parkes (see component under Central Tablelands Water). Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	This component could be designed and constructed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.
Harden	Lack of information to determine	Not modelled as the Murrumbidgee system and the Goldenfields County Council supply was outside of project scope, however desktop assessment shows supply relatively secure.	NA	NA	2,249	Further investigation studies might be undertaken to fulfil data gaps and confirm the security of this system.	Completion of an independent data gathering study could be commenced immediately.
Lachlan	Lachlan River to Lake Cargelligo Pipeline	This pipeline connection (200 mm diameter, 14 km in length) from the Lachlan River weir to Lake Cargelligo is expected to prevent evaporation losses during transmission to the storage at Lake Cargelligo.	$4 million	$100,000 annualised total OM&D costs	1,737	The storage should be sufficiently sized to store water from the Lachlan River and cater for the town's demand during extended dry periods of up to 3 months. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.
	New minor storage at Lake Cargelligo	This new storage of 500 ML at Lake Cargelligo. The storage is also expected to reduce losses due to evaporation currently occurring with lake storage.	$2 million	$40,000 annualised total OM&D costs			
	New minor storage at Condobolin	This new off-steam storage of 500 ML along the Lachlan River is a cost effective option to secure water for Condobolin.	$3 million	$65,000 annualised total OM&D costs	3,581	The storage should be sized to sufficiently store water from the Lachlan River and cater for the town's demand during extended dry periods of up to 3 months. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.

LGA	COMPONENTS	DESCRIPTION	CAPITAL COST $2009[25]	OPERATING COSTS	CUSTOMERS SERVED 2059	IMPLEMENTATION	TIMING
Lithgow	Opportunities identified but not part of preferred region-wide strategy.	Opportunities available to improve the security of Lithgow indirectly through providing alternative supply to Oberon and Delta Electricity. This is expected to relieve pressure on the Fish River Water Scheme and allow for more water resource to be available for Lithgow from the scheme.	See Risk/ Opportunity table in Section 5.2.				
Oberon	Chifley Dam to Oberon Pipeline	This pipeline connection (300 mm diameter, 43 km in length) is expected to supplement the supply at Oberon from Chifley Dam.	$17 million	$1.1 million annualised total OM&D costs	2,667	The connection should be used when water supply from Fish River and Oberon Dam are not sufficient to meet the demand of the town. There is also the potential for the supply to supplement Lithgow. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.
Orange	Lake Rowlands to Orange Pipeline via Millthorpe	This pipeline connection (600 mm diameter, 21 km in length) links the CTW network to Orange to supplement supply, when required, at the city.	$16 million	$117,000 annualised total OM&D costs	42,107	Duplication of CTW's trunk mains F and X will be necessary to cater for the demands at Orange and Molong (see component under Central Tablelands Water). Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	The need to improve the security of supply of this system is relatively urgent. It is recommended approvals, consultation and planning and design activities commence immediately.
	Orange to Molong Creek Dam Pipeline	Pipeline connection (750 mm diameter, 15 km in length) between Molong Creek dam pipeline and Orange.	See entry at Cabonne.				
Parkes	Lake Rowlands to Parkes Pipeline via Gooloogong	Pipeline connection (150 mm diameter, 50 km in length) between the CTW network and Forbes and Parkes.	$25 million (includes Parkes branch of $3 million)	$270,00 annualised total OM&D costs	14,118	This pipeline connection will be a sub-section of the Lake Rowlands to Forbes Pipeline and should branch to connect into the existing pipeline transfer from the Lachlan River offtake to Parkes. The connection should be used to supplement the supply to Parkes when supply from the Lachlan River and Parkes or Forbes bores are not sufficient to cater for the demand at Parkes. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	This component could be designed and constructed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.
Upper Lachlan	Lack of information to determine	Although this system was not modelled in detail due to the lack of information, it is expected to be secure and so no options for security improvement were developed as part of the study.	NA	NA	NA	Further investigation studies might be undertaken to fulfil data gaps and confirm the security of this system.	Completion of an independent data gathering study could be commenced immediately.
Weddin	Continued service from the CTW Scheme	Business as usual.	See Central Tablelands Water				
Wellington	Burrendong Dam to Wellington Pipeline	This pipeline connection (375 mm diameter, 28 km in length) from Burrendong Dam to Wellington replaces the current transmission via Macquarie River to prevent evaporation losses from occurring.	$16 million	$900,000 annualised total OM&D costs	6,304	Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	Development of a sharing plan could be commenced immediately.
Young	Lack of information to determine	Not modelled as the Murrumbidgee system and the Goldenfields County Council supply was outside of project scope, however desktop assessment shows supply relatively secure.	NA	NA	NA	The potential Young to Bendick Murrell Pipeline should be operated in both directions to allow for the CTW and Murrumbidgee systems to supplement supply where and when required. Implementation of this option would require completion of feasibility, concept and detailed design and construction processes. However, since the security of the Murrumbidgee system was not modelled in this study, further investigation studies might be undertaken to fulfil data gaps and confirm the security of this system.	Completion of an independent data gathering and security assessment study could be commenced immediately.
Central Tablelands Water	Lake Rowlands Augmentation	This storage augmentation option has been previously investigated by CTW and should involve the construction of a new dam wall approximately 2.5km away from the existing Lake Rowlands dam. The augmentation should increase the capacity of Lake Rowlands to 26,310ML and should be able to supplement regional supplies to improve security for Cowra, Forbes, Orange, Parkes and Young.	$150 million	$2.2 million annualised total OM&D costs	10,322	Implementation of this option would require completion of feasibility, concept and detailed design and construction processes. Timeframes for approvals and stakeholder engagement for dam construction are lengthy as are construction and first-filling processes.	Approvals, stakeholder engagement, environmental assessment and concept and detailed design processes for this element should be commenced immediately.
	Lake Rowlands to Millthorpe Pipeline (Trunk Mains D and F Duplication) and Cadia Hill Link	This pipeline (500 mm diameter, 36 km in length) will be a duplicate capacity of the existing trunk mains D and F. The duplicate capacity should be used to transfer water from Lake Rowlands to Millthorpe, for supply to Orange, and should be sized accordingly.	$37 million	$575,000 annualised total OM&D costs		Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	This component could be designed and constructed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.
	Lake Rowlands to Gooloogong Pipeline (Trunk Mains P and C Duplication)	This pipeline (375 mm diameter, 75 km in length) will be a duplicate capacity of the existing trunk mains P and C. The duplicate capacity should be used to transfer water from Lake Rowlands to Gooloogong, for supply to Forbes and Parkes, and should be sized accordingly.	$40 million	$525,000 annualised total OM&D costs		Implementation of this option would require completion of feasibility, concept and detailed design and construction processes.	This component could be designed and constructed in parallel with the concept and detailed design stages for Lake Rowlands Dam Augmentation.

5.2 MANAGING RISK AND OPPORTUNITY IN IMPLEMENTING THE STRATEGY

Table 5-2 identifies and recommends management actions for a number of the implementation risks and opportunities associated with the preferred strategy.

Table 5-2: Strategy Implementation Risk Management

RISK/OPPORTUNITY	SOURCE OF RISK/OPPORTUNITY	DESCRIPTION	MANAGEMENT ACTION	TIMING
Opportunity	Mining Related Demand	There is the potential to integrate town water supply infrastructure with the needs of mining related interests.	Limited data has been available to assess the likely demand of the mining sector. However, the scale of this demand could be such that it impacts on the size of augmentation of Lake Rowlands or the need to put in place additional pipeline that may have shared benefit between towns and miners. This opportunity needs further assessment and engagement with mining interests. Importantly however, the town water grid system proposed in the regional strategy is predominantly treated water and mining demands would not require treated water. Similarly, the pipelines have been sized to deal with the supplementary needs of towns, not the constant demands of mining interests. It should be noted however, that modelling has indicated that there is a risk of supply failure in Wyangala and that access to this storage is dependent on the purchase of additional allocation by the mining interests. This may impact on irrigation activities.	Immediate.
Opportunity	Potential to Recoup Investment	There is an opportunity for Councils that have invested in water security to recoup this investment from a wider rate paying basis through sharing of water resources.	Analysis of an appropriate tariff structure for water sharing arrangements could be undertaken.	Immediate.
Opportunity	Potential to Further Integrate Town Water Supplies to Improve Regional Security.	The scope of this study did not include modelling of the Murrumbidgee system and Goldenfields County Council. There is an opportunity to undertake this assessment in the light of this study to consider the viability of a wider water management area going forward.	Assessment of the security of the Murrumbidgee system could be undertaken.	Immediate.
Opportunity	Clarence Colliery Transfer System	There is a potential for the mine dewatering process at the nearby Clarence Colliery to provide additional supplementary water supply to Lithgow via an existing transfer system. The current transfer system has a capacity of up to 6ML/day and there is potential for this transfer volume to be increased. It is important to note however, this opportunity exists only in so far as the mine is operating.	Lithgow City Council and the Fish River Water Supply Authority could liaise regarding the upgrade of the transfer system from Clarence Colliery to potentially supplement the supply to Lithgow as well as other future studies.	Immediate
Opportunity	Alternative Water Supply Sources for Delta Electricity	There are some limited opportunities for alternative water supply, such as treated effluent and mine dewatering, to be sourced to supplement process water use at Delta Electricity and reduce its reliance on the Fish River Supply. However, the demands of DE are very large (70 ML/d – some of which must be potable quality) and these opportunities may have limited ability to relieve pressure on the FRWS and therefore allow for more water resource to be available for Lithgow and Oberon.	Users of the Fish River Water Supply could liaise to investigate the potential to supply process water from alternative source(s) to Delta Electricity.	Immediate
Opportunity	Linking the Central Tablelands Water and Murrumbidgee systems.	There is a potential for the Young to Bendick Murrell Pipeline to be incorporated into the preferred strategy to connect the CTW and the Murrumbidgee water networks. This connection will be operated in both directions to allow for transfer between the systems and further secure water for the region.	Assessment of the security of the Murrumbidgee system could be undertaken.	Immediate
Risk	Emergency Drought Circumstances and Lead Times associated with the Regional Strategy	Key elements of preferred strategy will take a number of years to be operational. In the interim, towns may reach a drought crisis situation.	Approvals and stakeholder engagement process are critical elements in planning timeframes for infrastructure delivery. This will be particularly the case for the augmentation of Lake Rowlands, but also for all other recommended elements of the strategy. As a result, the on-going maintenance of existing emergency bores for Wellington, Yeoval, Blayney, Bangaroo, Gooloogong, and Crookwell. In addition, contingent on the development of an emergency situation, the following actions should be considered: • The emergency development of the groundwater resources of Forbes, Wellington, Condobolin and Lake Cargelligo • Although some potential exists to utilise groundwater as an emergency source, the construction of the pipeline connection between Orange and the Macquarie River provides a greater level of security. However, no assessment of the yield of this connection has been made at this time and it should be noted that there is anecdotal information suggesting the Macquarie River in this location has ceased to flow at times.	Immediate commencement of approvals and stakeholder engagement processes and concept and detailed design (potentially within a delivery program setup). As emergency situation arises bearing in mind the relative level of completion of the regional-wide strategy at that time.
Risk	Political Risk	Concern exists within sections of the study area community around the impacts of sharing water through the connection of town water supplies across the region.	A community engagement process could be put in place to establish the nature of concerns in particular communities and to engage these communities in a process that addresses these concerns.	Immediate.
Risk	Climate Change	Climate change, and the need for adaptive management approaches, is not generally well understood by the community.	A community education and advice program around climate change could be put in place to raise capacity and to engage the community in water savings and water management in response to climate change.	Immediate.
Risk		The management of water and energy resources are inter-related. Water supplies are being impacted by global generation of carbon dioxide and other greenhouse gases.	A complementary energy and emissions management strategy for the preferred strategy, integrated with the operations of the Centroc water utility business, should be prepared and implemented	Immediate.

RISK/OPPORTUNITY	SOURCE OF RISK/OPPORTUNITY	DESCRIPTION	MANAGEMENT ACTION	TIMING
Risk		Climate change is expected to result in decreased water availability and increased water demands. As such, connection between the Upper Macquarie River Catchment and the Upper Lachlan Catchment may be required to ensure regional water supply security.	Preparation of contingency plans to make connection between the two systems.	Following the two actions above related to climate change.

Ensuring the Best Use of Water

At a State and Commonwealth level, the development and expansion of water markets and trading across and between catchments and states has been encouraged to improve the management of water. This has involved developing:

- Clear rules for trading;
- Water accounting arrangements;
- Pricing based on the recovery of full cost;
- Mechanisms for the provision of environmental flows; and
- Mechanisms for returning allocation to sustainable levels.

Water trading allows the available water resource to move to the highest value uses. Full cost recovery pricing ensures that clear price signals are sent to all water users to make sure they are efficient.

Over the past 10 years, water sharing plans have been developed by the States to improve the use of water. These plans set an access regime for bulk water sources. For those waterways within the Murray Darling Basin, these plans are now being reconsidered in the light of the overall Basin Plan and the need to address over-allocation issues across the Basin.

The right to access and use water, and to construct water management works, is granted by the State Government as a licence or approval. A water access licence defines a limited property right to access a share of the bulk water available in a particular water source.

To implement this strategy, Local Water Utilities and other water users such as the mining sector will need to obtain relevant licences and approvals for water access and use.

To be compliant with NSW government best-practice management guidelines for water utilities, which are designed to ensure the efficient and effective management of urban water services, full-cost recovery tariffs will need to be put in place to recoup the costs associated with the provision of this strategy.

Best-practice management emphases the importance on usage based pricing. This pricing sends clear messages to customers who can choose to consume less in order to save money on their water bills. Best-practice water supply pricing requires that the usage charge recover those costs that vary with demand in the long-term through a usage charge. These costs should include licence and extraction fees from external regulatory agencies as well as treatment and transfer costs. In NSW, it is a requirement that residential water usage charges be set to recover at least 75% of residential revenue to encourage efficient use of environmental and financial resources.

From the 2007-08 NSW Water Utility Performance Summary the Centroc group of utilities had a mean average water revenue per connection of $574 compared with all of the NSW utilities of $535. If the Centroc average were increased by the 25% expected increases in water revenues required to fund the strategy, it would imply water revenues per connection of $717, a number well within the range for NSW utilities from $1,250 to $273.

It would not be appropriate to place too much weight on this comparison as it is not related to any performance benchmarks or the structure of charges. Similarly, the 25% is a scheme-wide average. Actual bills would need to capture user-pays principles which ensure those benefiting from the services pay for the service improvement. Detailed financial modelling and assessment would be required to determine the typical residential bills to be paid by customer.

The costs per kL represented in this report are not usage charges to customers, but rather, the costs associated with the capital investment and operation of each individual infrastructure option or scheme.

5.3 MANAGEMENT ARRANGEMENTS

The definition of appropriate management and institutional arrangements for the long-term sustainable delivery of water supply to the Centroc region will be an important aspect to the successful implementation of this strategy.

5.3.1 ORGANISATIONAL STRUCTURE

The Centroc policy position supports the independence of members and trades on the benefits of cooperation. The effectiveness of that cooperation is highlighted by the ability of the regional organisation to participate in, and govern the delivery of, this study.

However, State and Federal policy regarding management arrangements advocates reform of the involvement of local government in the provision of water supply and sewerage services to varying degrees to achieve greater effectiveness and efficiency. More advice regarding State and Federal Policy can be found in Appendix E.

A summary of the organisational structures currently in operation in Australia is set out in Table 5-3. In general, corporation models, be they local or state owned, predominate. Similarly, with the exception of Tasmania and NSW, the role of local government in the provision of these services has diminished in recent years.

Table 5-3: Summary of Water Utility Structure in Australia (NSW Government, 2008)

JURISDICTION	STRUCTURE
Victoria	13 non-metropolitan urban water authorities (state-owned corporations) with responsibilities including water and sewerage services within statutory districts. Each of the 13 serves approximately 1 million people. Area of operation generally catchment related. Skills-based boards and payment of dividends to the Victorian Government. Performance improvements believed to be derived from economies of scale and commercial management framework.
Tasmania	In January 2009, three new local government owned regional corporations formed to provide water and sewerage services. In addition, a fourth council-owned regional water corporation was formed for the purpose of providing services that exhibit economies of scale; or support the management of business risk; or deliver consistency in the provision of water and sewerage services resulting in a regulatory, planning or consumer benefit. Each council owns an equal number of shares in the regional corporations with rights to differ only for the payment of dividends. Owners are not to dispose of shares, significant assets or the corporations' main undertakings. This ensures that all councils maintain an owner's voice and privatisation cannot occur. All owner returns – dividends, tax equivalent payments and guarantee fees – are to flow back to councils.
Queensland	Restructured in 2007. State statutory authorities created for bulk water supply, major transport infrastructure and manufactured water. This included transfer of local government assets (for which compensation was paid) to the new authorities. The retail component of water and sewerage services which are provided by 17 local councils and two water boards, are to be consolidated into no more than ten council-owned retail businesses by 1 July 2010. All water and sewerage reticulation, service pipes and meters will be owned and operated by a single council-owned distribution business by 1 July 2010.
South Australia	Urban water supply is managed in most areas by the South Australian Water Corporation (SA Water).

JURISDICTION	STRUCTURE
Western Australia	The Water Corporation (WA) is by far the State's largest water service provider, supplying services to almost two million Western Australians. Other industry participants include the Bunbury and Busselton water boards. Sewerage services to the 200,000 people who live in Western Australian country towns are provided by councils.

Table 5-4 sets out some of the issues that have been raised by stakeholders for consideration in the development of appropriate management arrangements considering the strengths, weaknesses, opportunities and risks to local government developing management arrangements for water supply in Central NSW.

Table 5-4: Strengths, Weaknesses, Opportunities and Risks

STRENGTHS	WEAKNESSES
• Local government is established and experienced in the management of water supply in Central NSW • Regional co-operation and governance arrangements established in Central NSW • Technical staff sharing information in local government is established in Central NSW • Mentoring from larger to smaller Councils established in Central NSW • Centroc is a leader in regional understanding on water security including climate change • Community resilience	• Asset investment backlog and its resourcing • State and Federal policy positions around local government capacity to deliver water supply services efficiently and effectively • Lack of local government control over its destiny in relation to water management • Uncertainty around climate change • Fear in the community around water security
OPPORTUNITIES	**RISKS**
• Measurable outcomes from regional co-operation averts loss of local control over water supply management • Potentially greater access to funding as a regional entity delivering a project of national significance • Local determination of management arrangements responding to State and Federal policy positions • Local determination of management structures demonstrating Local Government capacity to deliver effective and efficient services giving consideration to skills and representation	• Location of Centroc members in Murray Darling Basin gives greater exposure to Federal Legislation around water supply management • NSW is perceived Federally as lagging on water supply management • Forced amalgamation of water supply management • Removal of water supply management to other levels of government • Community perceptions and fear around water security bring on the changes more rapidly • Councils have organisational impacts as a result of removal of water supply management • Suggested new management arrangement proving unsatisfactory to stakeholders

The following are considerations for management as a result of the outcomes of this study:

- Where policy options can be managed by either a regional or local approach, a regional approach offers a better fit with the direction of the State government as well as potentially offering economies of scale.
- Regarding infrastructure options, the interconnection of supplies, and the need to deliver a significant program of capital works effectively and efficiently, may be a relevant consideration in developing future water management structures.

Table 5-5 summarises the options for organisational structure which have been contemplated in NSW. These generally capture the organisational arrangements which could be considered for implementation in the Centroc region. Importantly however, the inquiry supported only the following options: binding alliance; council-owned regional water corporation; and current arrangements for certain existing general purpose councils and county councils. However, the inquiry noted that the county council model should only be considered for future aggregations if it is the preferred model of all constituent councils and that it can be demonstrated that the impacts on councils' viability, economies of scope, employment and local communities can be adequately managed.

Table 5-5: Summary of Options for Organisational Structure (NSW Government, 2008)

OPTION		DESCRIPTION
1	Mandatory (or Binding) alliance	"Mandatory alliance" refers to an arrangement between participating councils to establish a body that has responsibility for certain functions such as strategic planning. The extent of the body's functions, autonomy and powers are matters for participating councils to determine. The responsibilities of both the new body and the participating councils could be specified in a performance agreement. Participating local councils would generally continue to own their water supply and sewerage assets and would continue to be responsible for maintaining and operating these assets. The councils would also be responsible for customer interface including billing and complaints handling. The alliance is made a binding alliance by legislation that compels certain councils to be members of a specified alliance.
2	County Council (Service Provision Only)	County councils are established by proclamation under the Local Government Act 1993. In the case of a "service provision only" county council, the proclamation would transfer a function, in this case water supply and sewerage services, from the councils specified in the proclamation to the county council. Councils specified in the proclamation are not permitted to duplicate any function assigned to the county council. Under this model the provision of water supply and sewerage services is the responsibility of the county council. Operation and maintenance of water supply and sewerage assets services would also be the responsibility of the county council. However, the ownership of assets remains with the individual local councils. The individual councils are represented on the county council's board of management.
3	County Council (Asset Ownership)	Under this model the proclamation establishing the county council would transfer both the function and the related assets from nominated councils to the county councils.
4	Council-Owned Regional Water Corporation	The corporation would own water supply and sewerage assets and provide water supply and sewerage services. It would be managed by a board of directors appointed by the shareholders. The shareholders are local councils.
5	State-Owned Regional Water Corporation	This is similar to Model 4. However, the state would own the water supply and sewerage assets and would provide the water supply and sewerage services. The state would be the shareholder. Local councils would have no role in providing water supply and sewerage services in the corporation's area of operations.
6	Regional Council Aligned to Catchment or Sub-Catchment	This model involves the amalgamation of councils with boundaries for the resulting new regional council approximating water catchment or sub-catchment boundaries. All water supply and sewerage assets of the former councils would be transferred to the regional council. The regional council would be responsible for the delivery of all water supply and sewerage services.
7	Single Regional NSW-Wide Corporation	A single state-owned corporation would provide water supply and sewerage services outside the areas serviced by Sydney Water, Hunter Water, Gosford City Council and Wyong Shire Council. All water supply and sewerage assets in the single regional corporation's area of operations would be owned by the corporation

OPTION		DESCRIPTION
8	Disaggregated Model – Bulk Supply, Distribution and Retail	This model involves separating the water supply and sewerage function into three distinct new functions: Bulk, Treatment and distribution, Reticulation and retail. Local government is only involved in the reticulation and retail component.
9	Status Quo	Retain the current approach to water supply and sewerage service delivery.

It is recommended that the State be provided advice regarding the recommendations of this report for consideration in their current determination of the way forward for water utilities management in Central NSW.

5.3.2 FUNDING OPPORTUNITIES

A key aspect of the implementation of the recommendations of this study is the identification of funding sources. Whilst the utilities involved have a responsibility to ensure full-cost recovery of service provision, support for the implementation of the strategy may potentially be gained from the funding sources summarised in Table 5-6. A detailed assessment of these sources is not contained here. It is the responsibility of the utilities (and their nominated associations such as Centroc) to identify and pursue funding opportunities.

Table 5-6: Summary of Funding Opportunities

SOURCE	DESCRIPTION
Federal Government	Department of Environment, Water, Heritage and the Arts: Through Water for the Future, the Australian Government is investing in a range of programs over 10 years to address four key priorities; taking action on climate change, using water wisely, securing water supplies and healthy rivers and waterways. Water for the Future continues to release funds for small and regional communities and other reform initiatives in the urban sector which may be applicable for funding the outcomes of this study. Infrastructure Australia: The Infrastructure Australia Act 2008 came into effect on 9 April 2008 paving the way to establish Infrastructure Australia. Infrastructure Australia will develop a strategic blueprint for our nation's future infrastructure needs and - in partnership with the states, territories, local government and the private sector - facilitate its implementation. In the 2008-09 Budget the Government announced the establishment of a Building Australia Fund. Allocations from the Fund will be guided by Infrastructure Australia's national audit and infrastructure priority list.
State Government	Office of Water: this agency administers a series of grant and funding programs including emergency water supply capital works, the Country Towns Water Supply and Sewerage Program (backlog works) and other water related infrastructure funds and demand management and source substitution grant programs.
Private Sector	Private sector involvement in water supply service provision can encompass the full spectrum outsourcing and partnering to alliancing or privatisation, joint ventures and public private partnerships. The contract model and financing solution adopted must complement the projects requirements and therefore requires detailed assessment of project needs and appropriate model.

6. REFERENCES

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APPENDIX A

STAKEHOLDER ENGAGEMENT

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APPENDIX B

DEMAND ANALYSIS AND FORECASTING

APPENDIX C

WATER SECURITY MODELLING

APPENDIX D

EVALUATION OF OPTIONS, SCENARIOS AND STRATEGIES

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APPENDIX E

WATER MANAGEMENT STRUCTURES

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