Not relevant

606 MINISTER FOR WATER SECURITY'S ITEM (Karlene Maywald) - NOTED

Not relevant

606

MINUTES forming **ENCLOSURE** to MWSCS07/068

LOCKED

TO: PREMIER FOR CABINET TO NOTE

RE: DESALINATION WORKING GROUP REPORT

1. PROPOSAL

1.1. That Cabinet note the report of the Desalination Working Group.

1.2. That Cabinet note that further submission(s) will be made to Cabinet, regarding in particular :

- Endorsement of the Desalination Working Group's recommendations;
- Commencement of the site acquisition processes;
- Approval of preparations for a pilot plant study;
- Appropriate procurement arrangements for the projects.

2. BACKGROUND

2.1. The Desalination Working Group was established in March 2007. The working group is chaired by Mr Ian Kowalick, South Australia's independent Murray-Darling Basin Commissioner, and includes senior representatives of the Department of Treasury and Finance, Department of Transport, Energy and Infrastructure and SA Water.

2.2. The working group's terms of reference are:
To investigate and advise the Minister for Water Security on the potential for seawater desalination as a water resource for metropolitan Adelaide including:

- How desalination would fit with the Water Proofing Adelaide strategy for an integrated and diversified water supply system;
- The feasible options and optimal technology for a seawater desalination plant;
- Options for sizing and location, and integration with the existing metropolitan Adelaide water supply system;
- The estimated capital and operating costs of desalination as a resource for metropolitan Adelaide, including funding options and implications;
- Appropriate arrangements for constructing and operating a desalination plant;
- Environmental implications of constructing and operating a desalination plant, including in the context of climate change.

2.3. Based on early advice from the Desalination Working Group, the 2007/08 State Budget included an allocation of $3 million for environment baseline studies in the Gulf St Vincent as a necessary precursor to approving and designing a desalination plant.

2.4. The Desalination Working Group provided an interim report in August 2007, foreshadowing that it would be recommending a multi-faceted water security strategy which included desalination and increased storage in the Mt Lofty Ranges. These recommendations build on the existing Water Proofing Adelaide strategy which continues to have relevance to demand management and recycling in particular.

2.5. On 11 September 2007, the Premier advised Parliament that the Government preference is to consider both desalination and an expansion of Mt Bold reservoir.

3. DISCUSSION

3.1. The Desalination Working Group's report notes that Adelaide's current water supply is relatively secure, except in extreme drought years. Until recently, it was entirely reasonable to conclude that Adelaide had a reliable water supply in absolute terms and relative to other Australian capital cities, based upon supply from the Mt Lofty catchments and pumping from the River Murray.

3.2. However the Working Group's view is that, with the experience of the last six years, it is now clear that long-term water security strategies need to be updated to provide additional sources of water. It is not necessary to engage in the greenhouse debate – these changes are clearly demonstrated by recent rainfall and temperature trends.

3.3. The Desalination Working Group (DWG) concludes that Adelaide is faced with developing strategies to deal with four water security challenges:

- Increases in average demand for water due to growth and changed climatic conditions;
- Managing increased variability of in-flows brought about by climate change;
- Reduced inflows due to environmental impacts and environmental flow releases;
- Balancing security across parts of the distribution system.

3.4. Each of these challenges and recommended solutions is briefly outlined in the following sections.

Increases average in demand

3.5. The existing Water Proofing Adelaide strategy comprises demand reduction and re-use initiatives that target 47 GL savings in potable water. These savings almost completely balance the expected increases in average demand and hence do not result in any greater reliance on the River Murray. The DWG therefore recommends that the Water Proofing Adelaide strategy should continue to be supported.

3.6. The substitution of non-potable water for potable water for agricultural and public open space irrigation (e.g. local storm water schemes and waste water recycling) will continue to be an important contributor to the Water Proofing Adelaide strategy <u>but they are not viable as a direct source of potable water</u>. Indeed the use of recycled water for potable re-use is both more expensive than alternatives and involves risks that are unacceptable.

3.7. There is a case for reconsidering opportunities to use Adelaide's underlying aquifers as a source of water. However, the long-term viability of this source will take time to prove and does not alter the recommendations of the report. The short-term mining of this water as a source of water during the current drought is a matter for the Water Security Task Force.

Managing variability of in-flows

3.8. The impact of climate change is difficult to forecast. Studies underway by the CSIRO and Bureau of Meteorology will provide longer term climate change predictions over the coming year. In the meantime, it can be assumed that there will be a reduction in rainfall, accompanied by a reduction in inflows. The biggest concern for Adelaide is the likelihood of increased variability.

3.9. The natural intakes in the Mt Lofty Ranges still represent the lowest cost water available. The solution for managing increased variability is to have a supply of water that can be made available for those years when in-flows in the Mt Lofty Ranges are below average and when restrictions are placed on River Murray use.

3.10. An increase in Mt Lofty Ranges storage capacity of 200 GL – such as by expanding the capacity of Mt Bold reservoir – is recommended by the DWG as providing a buffer against rainfall variability by storing water in normal years for use during dry years.

Reduced inflows

3.11. Inflows into Mt Lofty catchments and the Murray Darling basin have reduced over the last seven years and are likely to continue to remain at reduced levels, and with increased variability, as a consequence of long-term climatic impacts.

3.12. By 2025, in-flows in the Mt Lofty Ranges are expected to reduce on average by 30 GL and River Murray licences will be reduced by 15 GL, creating a 45 GL reduction in water availability. When combined with 5 GL of demand increases that are not met by Water Proofing Adelaide savings, there is a need for 50 GL of additional water for Adelaide.

3.13. The DWG recommends that the need for additional water be met by a 50 GL desalination plant. A desalination plant is climate independent, does not increase Adelaide's reliance on the River Murray and achieves a further level of diversification.

Balancing security across the distribution system

3.14. Some water security measures increase the reliability of one part of Adelaide's water distribution system to a greater extent than the other. For example, an additional 200 GL of storage at Mt Bold does not benefit the northern part of the system to the same extent as the southern part of the system. Similarly a desalination plant in the south, at Pt Stanvac for example, improves the supply to the southern part of the distribution system, but sufficient water cannot be transferred to the northern part of the system.

3.15. The DWG therefore recommends that interconnection pipe work be built to balance reliability across the system. The pipeline would also allow for greater operational flexibility and has contingency planning benefits by increasing the ability of the system to cope with serious water quality problems and/or treatment plant outages.

Summary of recommended strategy

3.16. In summary, the DWG has recommended that:

- The Water Proofing Adelaide strategy continue to be supported as the means to address increases in Adelaide's average demand for water, noting in particular the pursuit of recycled water and stormwater for non-potable uses;
- Mt Lofty Ranges storage capacity be increased by 200 GL to store water in normal years for use during dry years as a buffer against rainfall variability. The expansion of Mt Bold reservoir would achieve this goal;
- A 50 GL desalination plant be constructed to address reductions in inflows in the Mt Lofty Ranges and River Murray, noting that information available to the Working Group indicates Pt Stanvac is the preferred site for a plant;
- Interconnection pipe work be built to balance reliability across the north and south of Adelaide's water distribution system.

3.17. Implicit in the Working Group's recommendations is the view that Adelaide's use of River Murray water is not a major impost on the viability of the Murray-Darling basin. The whole state of South Australia is responsible for only 6% of extractions from the river and Adelaide is responsible for only 1% extractions. Continued reliance on the river therefore remains a valid policy choice. The question about the extent to which Adelaide's water supply can rely on water pumped from the River Murray during periods of drought is addressed via the Working Group's recommendations, which add flexibility to Adelaide's water supply in the form of increased storage and desalination.

3.18. It is also important to note that the Desalination Working Group's recommendations form a multi-faceted approach for dealing with the challenges facing Adelaide's long-term water security, as set out in the following table:

	Up to 2025	**Beyond 2025**
Increases in demand	Water Proofing Adelaide demand reduction and re-use initiatives Completion date:~ 2025	To be considered in conjunction with reduced in-flows
Managing variability	200 GL increased storage (Mt Bold or equivalent) $1,110 million Completion date:~ 2017	Strategic reserve in River Murray upstream storages
Reduced in-flows	50 GL desalination plant $1,097 million Completion Date:~ 2012	50 GL desalination upgrade or purchase of River Murray licences†
Balancing security across the distribution system	North-south interconnection pipe work $304 million Completion date:~ 2014	(Included in first stage works)

(†Beyond 2025 the purchase of additional River Murray allocations may be an option in lieu of further desalination but this would depend on suitable arrangements to guarantee the reliability of the additional water. This could be through changes to the Murray-Darling Basin Agreement or a greater strategic reserve held in upstream storages.)

3.19. The outcomes of the recommended strategy would be that:

- By 2012 the initial 50 GL desalination plant and interconnection pipelines provide increased protection against in-flow variability, but will not prevent water restrictions and the need for special water sharing agreements in extreme drought. (The other states are unlikely to agree to alternative water sharing arrangements unless Adelaide is on major water restrictions.)

- By 2017, when the increase in Mt Bold storage becomes available, the strategy would allow Adelaide to survive a repeat of the current drought with no worse than level 3 restrictions.

Desalination

3.20. Desalination is not a water supply option to be chosen lightly. The plants are energy intensive and lock water supply into high-energy usage that is likely to be subject to ongoing increases in real prices. The energy intensity, of itself, means desalination is not "green" and needs to be implemented with great care to avoid environmental damage.

3.21. There is currently a level of support for desalination as a water supply solution that risks unthinking decision making that could lead to a bad long-term outcome. The Working Group has been careful to ensure that its recommendation that a desalination plant be constructed is based upon a real need and that there are no easy alternatives.

3.22. Desalination is the only climate independent solution and therefore diversifies Adelaide's water supply. Desalination caps Adelaide's average extraction from the River Murray at the current level (about 40% of average annual supply). Future upgrading of desalination capacity is related to the future management of the Murray-Darling basin.

3.23. All plants being constructed or proposed in Australia use reverse osmosis as the desalination process. The Desalination Working Group (through SA Water) let a consultancy to assess the different technologies available for large-scale desalination. The consultants concluded that reverse osmosis is the most energy and cost efficient technology currently available.

3.24. Sites considered for a desalination plant stretched along the Adelaide metropolitan coast and a south coast location near Waitpinga. A site assessment study concluded that, while seawater was generally deeper at sites to the south of Pt Stanvac (ie around Myponga), there were concerns over potential influence of the Myponga eddy in this region which could severely limit the movement and dispersion of brine. The cost of constructing infrastructure in southern areas to transfer water back to Adelaide was also much more significant than locations around Pt Stanvac to Pelican Point.

3.25. A multi-criteria analysis of twelve plant sites was conducted with three nominal locations chosen for further assessment and cost estimation by United Water. They concluded that the Pt Stanvac site was the preferred location for a seawater desalination plant in Adelaide, based on proximity to existing infrastructure, ease of integration into the water supply system and the depth of seawater off the Pt Stanvac coast.

Next steps

Increased storage capacity

3.26. Further investigations are already underway into the concept of increasing storage at Mt Bold reservoir. The environmental implications of such an expansion are likely to be significant and base line environmental studies are underway. A detailed review is also underway into other possible reservoir sites throughout the Mt Lofty Ranges. An increase in total storage may be able to be spread across multiple sites.

3.27. This work will continue, with further recommendations to be made to Cabinet on Mt Bold and/or other expansion sites.

Desalination

3.28. Before detailed design for a desalination plant can commence, it is necessary to complete a number of initial stages to obtain critical information needed for the plant design process. These include environmental baseline studies, source water quality characteristic investigation, brine dispersion modelling, identification of plant location and a pilot plant study on pre-treatment processes.

3.29. Environmental baseline and source water studies are already underway. As noted above, the 2007/08 State Budget included an allocation of $3 million for these studies.

3.30. With respect to location, the report of the Desalination Working Group has recommended Port Stanvac as the optimal location of a desalination plant for Adelaide. While Pelican Point is the second possible site, it has a number of significant disadvantages would be a much more costly option. While a number of other sites along the coast were initially investigated for comparison purpose, it was concluded by the DWG that Pt Stanvac and Pelican Point are the most realistic sites.

3.31. As noted, a pilot plant study is also an essential input into the final design of a desalination plant. The pilot plant study will:

- Confirm the feasibility of pre-treatment processes based on seawater sampling, as well as test the processes under varying seawater quality;
- Evaluate filtered and treated seawater with respect to the quality requirements of reserve osmosis membranes;
- Establish design parameters for filter rates, flocculation requirements etc;
- Develop operations protocols and knowledge for commissioning of a plant and its ongoing operation.

3.32. A pilot plant study will require the identification of a suitable site reasonably close to the intended location in order to test the characteristics of the seawater that will be desalinated by the plant. EPA and other approvals will also be required.

3.33. A further submission(s) will be made to Cabinet seeking approval to commence land acquisition processes and prepare for a pilot plant study.

3.34. Further advice will also be provided to Cabinet on appropriate procurement arrangements, following investigations by the Department of Treasury and Finance and SA Water, including any implications for the outsourcing contract with United Water.

4. RECOMMENDATIONS

4.1 That Cabinet note the report of the Desalination Working Group.

4.2 That Cabinet note that further submission(s) will be made to Cabinet, regarding in particular :

- Endorsement of the Desalination Working Group's recommendations;
- Commencement of the site acquisition processes;
- Approval of preparations for a pilot plant study;
- Appropriate procurement arrangements for the projects.

K Maywald

Karlene Maywald
MINISTER FOR WATER SECURITY

12 October 2007

RECEIVED 12 OCT 2007 CABINET OFFICE

In Cabinet

15 OCT 2007

NOTED

PREMIER

Confidential: Subject to Cabinet Consideration

Report

of the

Desalination Working Group

for Cabinet Consideration

30 September 2007

Index - Desalination Working Group Report

Executive Summary

The Desalination Working Group was established in March 2007 to consider the following terms of reference:

To research and report to the Minister for Water Security on:

- How desalination fits with the Water Proofing Adelaide strategy for an integrated and diversified water supply system;
- Feasible options and optimal technology for seawater desalination;
- Options for sizing and location, and integration with the existing metropolitan Adelaide water supply system;
- The estimated capital and operating costs of desalination as a resource for metropolitan Adelaide, including funding options and implications;
- Environmental implications of constructing and operating a desalination plant, including in the context of climate change;
- Appropriate arrangements for constructing and operating a desalination plant.

In order to respond to these terms of reference the Working Group has had to consider the many components of the Water Proofing Adelaide strategy and, in particular, the medium to long-term options for use of water from the River Murray.

This report summarises and is supported by a large number of studies carried out by consultants and SA Water staff on behalf of the Desalination Working Group to enable consideration of the many factors that impact upon inflows into Adelaide's water supply, the future demand for water, and the engineering, site location and environmental issues that arise from desalination plants.

Two important conclusions underlie the recommendations of the Desalination Working Group, *viz*:

- Until recently it was reasonable to conclude that Adelaide had a reliable water supply in absolute terms and relative to other Australian capital cities, based upon supply from the Mt Lofty catchments and pumping from the River Murray;
- The Water Proofing Adelaide strategy was a good strategy to provide for growth in demand.

The Working Group found that Adelaide's current water supply is relatively secure, except in extreme drought years such as those presently being experienced. Until recently, it was entirely reasonable to conclude that Adelaide had a reliable water supply in absolute terms and relative to other Australian capital cities, based upon supply from the Mt Lofty catchments and pumping from the River Murray.

However, with the experience of the last six years, it is now clear that long-term water security strategies need to be updated to provide additional sources of water. For the purposes of this report it is not necessary to engage in the greenhouse debate – these changes are clearly demonstrated by recent rainfall and temperature trends.

In considering long-term water security, a warning is necessary about comparisons with other places. Adelaide's water supply has a very different configuration to most other Australian cities and comparisons can be very misleading.

The Working Group concludes that Adelaide is faced with developing strategies to deal with four water security challenges:

1. Increases in average demand for water due to growth and changed climatic conditions;
2. Managing increased variability of in-flows brought about by climate change;
3. Reduced inflows due to environmental impacts and environmental flow releases;
4. Balancing security across parts of the distribution system.

Increases average in demand

The existing Water Proofing Adelaide strategy comprises demand reduction and re-use initiatives that target 47 GL savings in potable water. These savings almost completely balance the expected increases in average demand and hence do not result in any greater reliance on the River Murray. It is therefore recommended that the Water Proofing Adelaide strategy should continue to be supported.

The substitution of non-potable water for potable water for agricultural and public open space irrigation (e.g. local storm water schemes and waste water recycling) will continue to be an important contributor to the Water Proofing Adelaide strategy but they are not viable as a direct source of potable water. Indeed the use of recycled water for potable re-use is both more expensive than alternatives and involves risks that are unacceptable.

There is a case for reconsidering opportunities to use Adelaide's underlying aquifers as a source of water. However, the long-term viability of this source will take time to prove and does not alter the recommendations of the report. The short-term mining of this water as a source of water during the current drought is a matter for the Water Security Task Force.

Managing variability of in-flows

The impact of climate change is difficult to forecast. Studies underway by the CSIRO and Bureau of Meteorology will provide climate change predictions over the coming year. In the meantime, it can be assumed that there will be a reduction in rainfall, accompanied by a reduction in inflows. The biggest concern for Adelaide is the likelihood of increased variability.

The natural intakes in the Mt Lofty Ranges still represent the lowest cost water available. The solution for managing increased variability is to have a supply of water that can be made available for those years when in-flows in the Mt Lofty Ranges are below average and when restrictions are placed on River Murray use.

An increase in Mt Lofty Ranges storage capacity of 200 GL – such as by expanding the capacity of Mt Bold reservoir – is recommended as providing a buffer against rainfall variability by storing water in normal years for use during dry years.

Reduced inflows

Inflows into Mt Lofty catchments and the Murray Darling basin have reduced over the last seven years and are likely to continue to remain at reduced levels, and with increased variability, as a consequence of long-term climatic impacts.

By 2025, in-flows in the Mt Lofty Ranges are expected to reduce on average by 30 GL and River Murray licences will be reduced by 15 GL, creating a 45 GL reduction in water availability. When combined with 5 GL of demand increases that are not met by Water Proofing Adelaide savings, there is a need for 50 GL of additional water for Adelaide.

The Working Group recommends that the need for additional water be met by a 50 GL desalination plant. A desalination plant is climate independent, does not increase Adelaide's reliance on the River Murray and achieves a further level of diversification.

Balancing security across the distribution system

Some water security measures increase the reliability of one part of Adelaide's water distribution system to a greater extent than the other. For example, an additional 200 GL of storage at Mt Bold does not benefit the northern part of the system to the same extent as the southern part of the system. Similarly a desalination plant at Pt Stanvac improves the supply to the southern part of the distribution system, but sufficient water cannot be transferred to the northern part of the system.

The Working Group therefore recommends that interconnection pipe work be built to balance reliability across the system. The pipeline would also allow for greater operational flexibility and has contingency planning benefits by increasing the ability of the system to cope with serious water quality problems and/or treatment plant outages.

Summary of the Recommendations

In summary, the DWG has recommended that:

- The Water Proofing Adelaide strategy continue to be supported as the means to address increases in Adelaide's average demand for water, noting in particular the pursuit of recycled water and stormwater for non-potable uses;

- Mt Lofty Ranges storage capacity be increased by 200 GL to store water in normal years for use during dry years as a buffer against rainfall variability. The expansion of Mt Bold reservoir would achieve this goal;

- A 50 GL desalination plant be constructed to address reductions in inflows in the Mt Lofty Ranges and River Murray, noting that available information indicates Pt Stanvac is the preferred site for a plant;

- Interconnection pipe work be built to balance reliability across the north and south of Adelaide's water distribution system.

Together, these recommendations form a comprehensive, multi-faceted approach to providing Adelaide with long-term water security, as set out in the following table:

	Up to 2025	**Beyond 2025**
Increases in demand	Water Proofing Adelaide demand reduction and re-use initiatives Completion date:~ 2025	To be considered in conjunction with reduced in-flows
Managing variability	200 GL increased storage (Mt Bold or equivalent) $1,110 million Completion date:~ 2017	Strategic reserve in River Murray upstream storages
Reduced in-flows	50 GL desalination plant $1,097 million Completion Date:~ 2012	50 GL desalination upgrade or purchase of River Murray licences†
Balancing security across the distribution system	North-south interconnection pipe work $304 million Completion date:~ 2014	(Included in first stage works)

(†Beyond 2025 the purchase of additional River Murray allocations may be an option in lieu of further desalination but this would depend on suitable arrangements to guarantee the reliability of the additional water. This could be through changes to the Murray-Darling Basin Agreement or a greater strategic reserve held in upstream storages.)

The role of the River Murray

Implicit in these recommendations is the view that Adelaide's use of River Murray water is not a major impost on the viability of the Murray-Darling basin. The whole state of South Australia is responsible for only 6% of extractions from the river and Adelaide is responsible for only 1% extractions. Continued reliance on the river therefore remains a valid policy choice. The question about the extent to which Adelaide's water supply can rely on water pumped from the River Murray during periods of drought is addressed via the Working Group's recommendations, which add flexibility to Adelaide's water supply in the form of increased storage and desalination.

What do these recommendations deliver?

By 2012 the initial 50 GL desalination plant provides increased protection against in-flow variability, but will not prevent water restrictions and the need for special water sharing agreements in extreme drought. (The other states are unlikely to agree to alternative water sharing arrangements unless Adelaide is on major water restrictions.)

By 2017, when the increase in Mt Bold storage becomes available, the strategy would allow Adelaide to survive a repeat of the current drought.

Is a desalination plant necessary?

Desalination is not a water supply option to be chosen lightly. The plants are energy intensive and lock water supply into high-energy usage that is likely to be subject to ongoing increases in real prices. The water is expensive. The energy intensity, of itself, means desalination is not "green" and needs to be implemented with great care to avoid environmental damage.

There is currently a level of support for desalination as a water supply solution that risks unthinking decision making that could lead to a bad long-term outcome. The Working Group has been careful to ensure that its recommendation that a desalination plant be constructed is based upon a real need and that there are no easy alternatives.

Desalination is the only climate independent solution and therefore diversifies Adelaide's water supply. Desalination caps Adelaide's average extraction from the River Murray at the current level (about 40% of average annual supply). Future upgrading of desalination capacity is related to the future management of the Murray-Darling Basin.

Location of a desalination plant

A range of issues must be considered when determining the feasibility and location of a seawater desalination plant. Sites considered stretched along the Adelaide coast of Gulf St Vincent and a South Coast location near Waitpinga.

A site assessment study concluded that while seawater was generally deeper at sites to the south of Pt Stanvac (ie around Myponga) there were concerns over the potential influence of the Myponga eddy in this region which could severely limit the movement and dispersion of brine. The cost of constructing infrastructure in southern areas to transfer water back to Adelaide was also much more significant than locations around Pt Stanvac to Pelican Point.

Seawater depth significantly decreases from Pt Stanvac north along the Gulf and is associated with poor marine dispersion characteristics. This has substantial ramifications for the length of seawater intake and brine outfalls for areas north of Pt Stanvac.

A multi-criteria analysis (MCA) of twelve plant sites was conducted with three nominal locations chosen for further assessment and cost estimation by United Water. It was concluded that the Pt Stanvac site was the preferred location based on proximity to existing infrastructure, ease of integration into the water supply system and the depth of seawater off the Pt Stanvac coast.

Stormwater and re-use of wastewater

The substitution of non-potable water for potable water for agricultural and green space use (e.g. local storm water schemes and waste water recycling) should continue to be an important contributor to the Water Proofing Adelaide strategy but they are *not viable as a direct source of potable water.* Indeed the use of recycled water i.e.

indirect potable re-use is both more expensive than alternatives and involves risks that are unacceptable.

The stormwater non-potable reuse schemes being implemented by local government (most notably over many years in Salisbury) are an excellent model for this source to make a contribution to water management.

There is a case for the government to consider opportunities to use Adelaide's underlying aquifers as a source of water. However, the long-term viability of this source will take time to prove and does not alter the recommendations of this report. The short-term mining of this water as a source of water during the current drought is a matter for the Water Security Task Force to consider.

Seawater desalination technology

All major plants being constructed or proposed in Australia use reverse osmosis as the desalination process. The Desalination Working Group (through SA Water) let a consultancy to assess the different technologies available for large-scale desalination. The consultants concluded that reverse osmosis is the most energy and cost efficient technology currently available.

A seawater desalination plant for Adelaide should use reverse osmosis as the preferred technology.

Emerging technology

This report is based on the best current technology and knowledge of desalination. It is possible that new water technologies will emerge and will need to be evaluated from time to time.

1 Introduction

The Desalination Working Group was established in March 2007 to consider the following terms of reference.

To research and report to the Minister for Water Security on:

- How desalination fits with the Water Proofing Adelaide strategy for an integrated and diversified water supply system;
- Feasible options and optimal technology for seawater desalination;
- Options for sizing and location, and integration with the existing metropolitan Adelaide water supply system;
- The estimated capital and operating costs of desalination as a resource for metropolitan Adelaide, including funding options and implications;
- Environmental implications of constructing and operating a desalination plant, including consideration in the context of climate change;
- Appropriate arrangements for constructing and operating a desalination plant.

In order to respond to these terms of reference the Working Group has considered many alternative sources of water supply (previously canvassed in the Waterproofing Adelaide Strategy) and in particular the medium to long-term options for use of water from the River Murray.

The report does not address the immediate difficulties with water supply in South Australia and the options canvassed in this report do not offer short-term solutions. Rather, these matters are being dealt with through other mechanisms that require cooperation between the Federal, South Australian, Victorian and NSW governments.

There are two policy matters that underlie this report, viz:

1. *Has the current protracted drought exposed fundamental flaws in the management of allocations from the Murray-Darling Basin System and thus at what rate can the River Murray sustainably provide water to South Australia?*
2. *Are the current extreme drought conditions a manifestation of the longer-term variation due to climate cycles and/or the permanent effect of climate change on catchment inflows?*

This report has had to make observations and assumptions on these matters to provide recommendations on the terms of reference.

There has been much comment about the role that desalination can play in future water supply and that requires a warning about comparisons with other places. The water supply physiography of Perth, Sydney, Melbourne and Brisbane are very different to Adelaide so economic and environmental comparisons are capable of being very misleading. Similarly the economic and environmental factors that apply overseas in places such as Singapore or the United Arab Emirates do not map easily into the South Australian situation.

1.1 The Role of the River Murray

There has been public comment about the need for Adelaide's water supply to become independent, or less dependent, on water supplied by the River Murray. The increased costs of such a change could have serious long-term economic consequences for Adelaide and the wider South Australian economy. The unintended consequences of such a policy for the environment of the River Murray may be perverse because some of the advocates of that position are motivated by self-interest rather than regard for the River Murray in South Australia.

There are perceptions in the eastern states that Adelaide's use of River Murray water is the consumption of their water. If one regards the Murray-Darling Basin as a natural system, then the following chart shows that, compared to natural conditions, the upstream states have taken 94% of the water diverted at the expense of the River Murray in South Australia by reducing outflows to the sea from 54% to 21% of total flows and reducing water for wetlands by 34%.

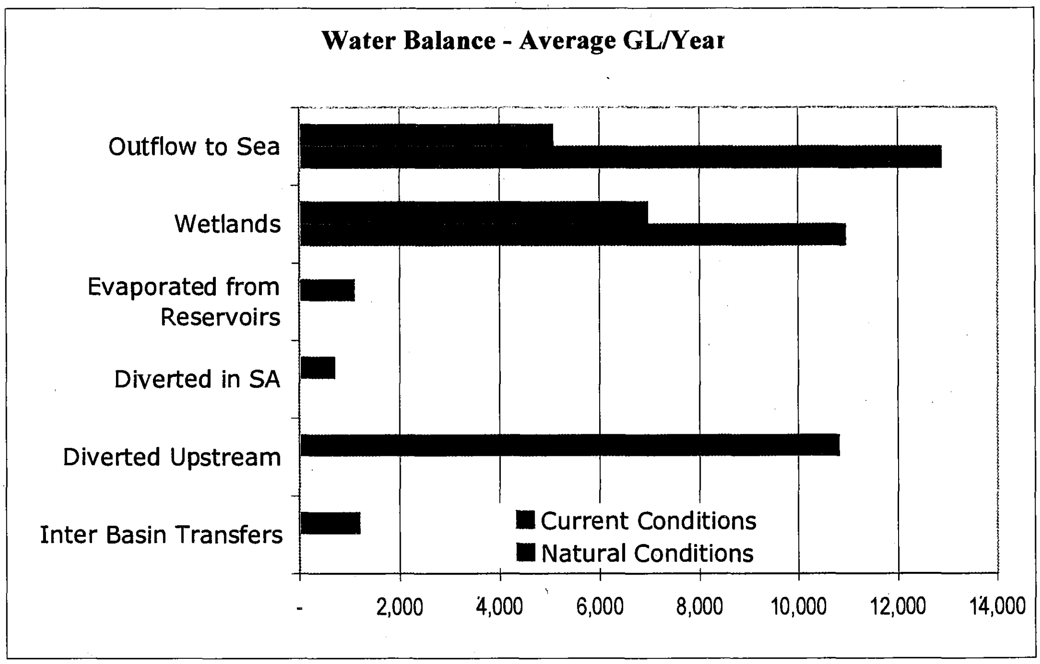

Chart 1: River Murray water balance (2005/06)[1]

The environmental problems of the River Murray and the lakes are mostly a consequence of excess diversions of water upstream. Adelaide's use of River Murray water is of no significance to the problems of the River Murray.

On average 40% of Adelaide's water supply is met by diversions from the River Murray, with 60% being met by the Mt Lofty Ranges catchments. In periods of drought in the Mt Lofty ranges, up to 90% of demand can be met from the River Murray and in wet years only 10% needs to be supplied from the Murray.

Inflows from the Mt Lofty Ranges are subject to significant existing variability and this is discussed later. This existing variability is managed by extracting water from the River Murray.

[1] Murray-Darling Basin Commission

Chart 2 shows the proportional usage of water by each of the states.

On average, Adelaide and all South Australian users of River Murray water represent only 6% of diversions in the system, with Adelaide's use being only 1% of basin-wide diversions.

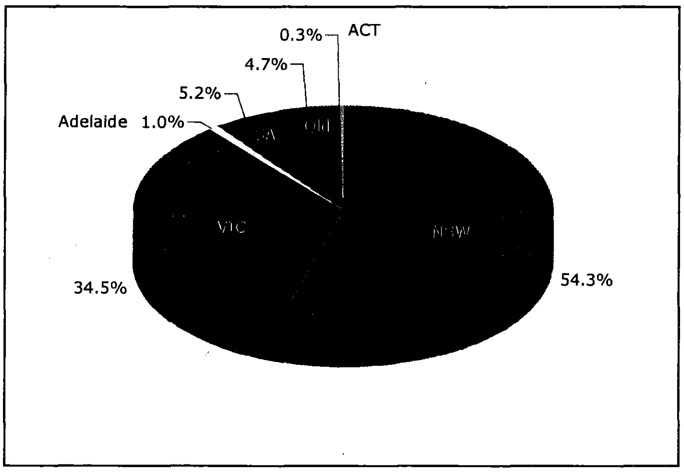

Chart 2: Share of surface water diversions from the Murray-Darling Basin, 2006

Clearly, whether or not the Murray-Darling Basin system, which is 14% of the nation's land area, can sustain ongoing diversions is mostly a function of future usage in NSW and Victoria. In particular, the high proportion of usage of diversions for agricultural use, for which NSW is mostly responsible, could be reduced by improving delivery efficiency of irrigation schemes and improving efficiency of on-farm use. It has been estimated that only approximately 42% of water diverted in the Murray and Murrumbidgee regions is beneficially used for transpiration by productive crops[2].

Among the key tenets of the recent discussions about reform of the management of the Basin are better allocation of water and further development of an efficient market for water so that the market determines the optimal price and allocation of water. A key element of the recent federal legislation is to develop a basin management plan that will lead to sustainable diversions from the basin.

Given that water has been over allocated (especially in NSW), it is inevitable that a free market for water will lead to higher long run real prices with the following consequences:

- At the margin, some rural production activities may become uneconomic
- It will encourage the more efficient use of water
- It will be more attractive for less profitable users to sell their water allocations.

Whilst much of the agricultural production in the basin has been profitable and has the capacity to adapt to higher real prices of water, it is also true that there are many activities that provide marginal returns and landowners are locked into these activities

[2] Meyer, W (2005). *The Irrigation Industry in the Murray and Murrumidgee Basins.* CRC for Irrigation Futures Technical Report No. 03/05, CSIRO.

because they have had no exit strategy available to them. A market for water can help structural adjustment by providing an exit, but it may not be sufficient to deliver the desired policy outcome without additional intervention by governments.

Climate change is likely to be a very significant factor driving reduced inflows, causing the price of water to increase. Other climate change effects such as an increase in average temperatures, will impact on rural production, causing structural adjustment needs in sectors of the rural economy to increase.

It is clear that Adelaide's use of Murray-Darling water is not a major impost on the viability of the Basin, nor inappropriate given Victoria's proposals for usage of Goulburn water to supply Victorian cities. The use of Murray-Darling water is likely to require purchases on the market at higher real prices. Following the principles of efficient resource allocation (where water is used for its highest value use), Adelaide's continued or even increased River Murray extraction would be justified.

The fundamental question that then remains is:

> *To what extent should Adelaide's water supply rely upon water pumped from the River Murray?*

This is a basic policy issue as well as an economic and engineering matter, but it is not a matter about which there is any moral high ground in the long-term in reserving water for irrigation purposes.

2 Security of the Current Supply

Until recently, Adelaide's water supply was viewed as being one of the most secure in Australia, with Adelaide having two separate water sources; the Mount Lofty Ranges and the River Murray.

Water from the River Murray is supplied from two main pipelines, the Mannum-Adelaide pipeline and the Murray Bridge-Onkaparinga pipeline. Adelaide's water supply is also supplemented by the Swan Reach-Paskeville pipeline. Chart 3 is a schematic representation of the metropolitan Adelaide water supply system.

The security of Adelaide's water supply is largely a function of climatic variability. The Mount Lofty Ranges experiences significant variability in reservoir inflows. Between 10 and 90% of Adelaide's annual water requirements can be sourced from the Mount Lofty Ranges, with an average of 60%. This variability is currently managed by pumping water from the River Murray.

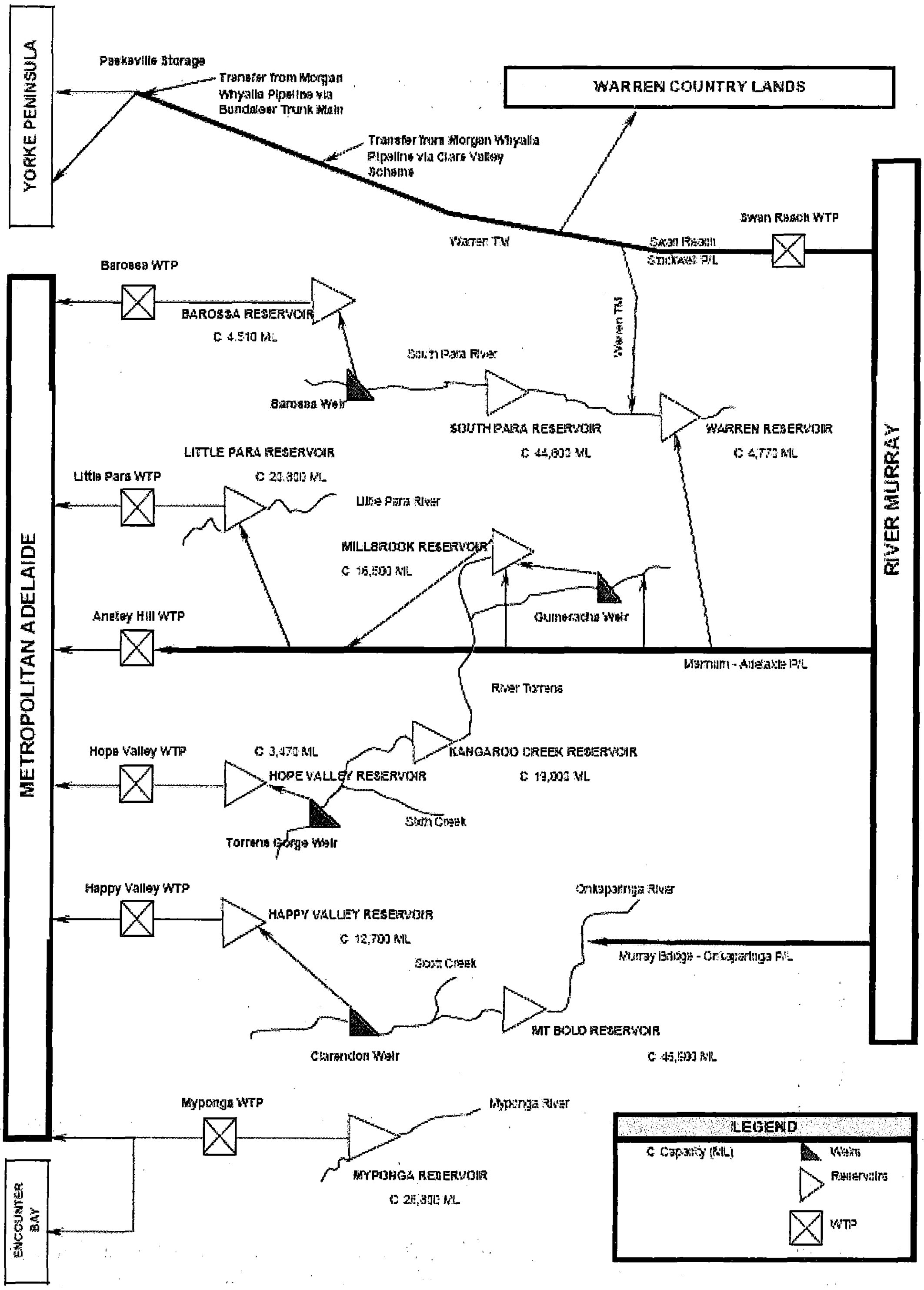

Chart 3: Metropolitan Adelaide Water Supply System Headworks

While other major cities such as Melbourne and Sydney have local storages equivalent to three to four years supply at normal demands, Adelaide has less than 12 months supply in storage. This is exacerbating current problems. Adelaide's usable storage capacity (155 GL) is less than the annual metropolitan Adelaide demand (around 200 GL).

The current situation in the Murray-Darling Basin has shown that water supply from the River Murray may not be as secure as previously anticipated. In fact, over the next 25 to 50 years, climate change may result in both reduced flows and greater variability of flows to reservoirs in the Mount Lofty Ranges, as well the Murray-Darling Basin.

The Desalination Working Group has investigated the overall reliability of the existing metropolitan Adelaide water supply system (MAWSS). This work was undertaken by Tonkin Consulting and is referred to as the MAWSS Security Investigation[3].

The outcome of the MAWSS Security Investigation is a quantification of the risk of shortfall in supply, and identification of possible methods to reduce this risk by implementing a range of options for provision of an alternative supply source such as seawater desalination.

The MAWSS has a licence to extract 650 GL from the River Murray over five years. This is referred to as the rolling-average licence. The rolling average licence includes water supplied by the Swan Reach-Paskeville pipeline, although the pipeline supplies areas defined to be outside the MAWSS. This pipeline also supplies Barossa Infrastructure Limited (BIL) with 5 GL of water per year under a commercial transportation agreement. (They have their own licence). It is estimated that around 10 GL is supplied to regions outside the Adelaide supply area (not including BIL).

In this report the reliability of a water supply system is generally defined in terms of the frequency, severity and duration of water restrictions experienced. On this basis, the MAWSS Security Investigation sought to investigate water supply reliability under different scenarios. The MAWSS Security Investigation comprised two stages:

1. Assessment of reliability under current MAWSS configuration;
   - Based on historical records in the Mt Lofty Ranges (including some stochastically generated data) from 1891 to 2000 and not considering the last seven years of records
   - Based on the worst seven year records in both the Mt Lofty Ranges (1993 to 1999) and the Murray-Darling Basin (2001 to 2007)

2. Assessment of reliability under possible future operating conditions, including:
   - demand growth;
   - implementation of water conservation initiatives (in-line with the Water Proofing Adelaide strategy);
   - reduction of inflows due to climate change;
   - potential operating changes to the Murray-Darling Basin.

[3] Tonkin Consulting (2007). *Metropolitan Adelaide Water Supply Security Investigation. Stage 1 – Current Demands*. Tonkin Consulting for SA Water Corporation

Stage 1 of the MAWSS Security Investigation showed that, based on inflow records prior to the year 2000[4], should SA Water be able to utilise its rolling average licence[5] together with an additional 'first-use licence' of 16 GL, the reliability of Adelaide's water supply was comparable to targets set for other major cities, as shown in Table 1. This shows that Adelaide compares well in terms of the frequency of needing restrictions but has a significant problem at the extreme case where 1 in 320 years it may face the situation where there will be insufficient water to cover critical urban needs. In an extreme drought, level 5 water restrictions may not be able to limit demand to the volume available and there are no other options to provide additional water supply. This is where Adelaide's water supply system is exposed.

This highlights the fact that the previous operating paradigm of the MAWSS was in the past sound and that, based on historical records prior to the year 2000, Adelaide's water supply system was considered to be very reliable. The extent of the current problems in the Murray-Darling Basin could not have been foreseen 10-20 years ago.

It should be noted that the targets shown in Table 1 have not taken into account the operation of desalination plants and other water security improvement options, and assume no significant reduction in rainfall due to climate change. For example, both Sydney and the ACT now aim to never require restrictions greater than level 3. It should also be noted that Adelaide's probability is based on modelling results and is not a definitive level of service objective.

Table 1: Level of service criteria for different capital cities[6]

Location	Probability of Exceedance (POE)		
	L3 restrictions	***L5 restrictions***	***Run out of water***
Sydney	<1:10 yrs	<1:10 yrs	<1:100,000 yrs
Melbourne	<1:20 yrs	Never	Not defined
ACT	<1:10 yrs	<1:50 yrs	<1:1,000 yrs
Perth	Permanent (Sprinklers only 2 days per week)	<1:200 yrs	Not defined
Adelaide	1:100 yrs	1:230 yrs	1:320 yrs

Without the use of the 16 GL 'first-use licence', the risk of supply shortfall increases substantially due to constraints on the use of the 5-year rolling average licence of 650 GL. The constraints on use of the 650 GL rolling average licence affects how this usage has been modelled in part due to the current policy for sharing water restrictions between irrigators and urban users. The absence of a well defined policy for determining restrictions on SA Water's licences increases the risk associated with

[4] i.e. prior to the recent drought and possibly the impact of climate change.

[5] SA Water has a River Murray licence to use 650 GL over five years. This is referred to as the rolling average licence.

[6] Adapted from KBR (2007). *Levels of Service Discussion Paper (draft). South East Queensland Water Supply Strategy.* Kellogg Brown & Root for Department of Natural Resources, Qld.

relying on River Murray extractions to provide a secure water source for Adelaide in years where there are flows below entitlement.

Without the first-use licence, the requirement for level 3 restrictions increases from around 1 in 100 years to 1 in 20 years. Level 5 restrictions would be required in around 1 in 40 years compared to 1 in 230 years as shown in Table 2.

Table 2: Probability of restrictions under different licensing scenarios

Restriction level Required	Probability of Exceedance (POE)	
	650 GL Rolling Licence only	650 GL Rolling Licence + 16 GL First Use Licence
Level 1	1 : 15 yrs	1 : 60 yrs
Level 2	1 : 17 yrs	1 : 70 yrs
Level 3	1 : 20 yrs	1 : 100 yrs
Level 4	1 : 30 yrs	1 : 170 yrs
Level 5	1: 40 yrs	1 : 230 yrs

Of the scenarios investigated in the MAWSS Security Investigation, the scenario that models the likely future business as usual (BAU) operating scenario (ie the do nothing option that ignores recent experience and climate change) is where the MAWSS uses the rolling average licence plus the first use licence.

2.1 Paradigm Shift

While the previous operating paradigm (prior to year 2000) was sufficient to provide Adelaide with a secure water supply, the last few years of inflows in the Murray-Darling system has shown that a paradigm shift is required to adapt to current conditions. The likely increase in the frequency of water restrictions (and the circumstances where the system runs out of water) is representative of the future operating paradigm. Climate change is expected to exacerbate these problems, refer section 3.7.

To model recent climatic conditions a theoretical worst case scenario has been developed assuming the lowest seven-year inflow period recorded in the Mount Lofty Ranges (1993-1999) was assumed to coincide with the lowest seven years of River Murray inflows (2001-2007). This scenario was used to assess the reliability of the MAWSS under extreme (but possible) conditions. In the seventh year of analysis the River Murray availability was assumed to be zero gigalitres so that the current drought conditions could be assessed.

This 'hypothetical' seven year scenario (which is consistent with recent experience in the River Murray) shows that, in order to manage the climatic variability being experienced, a large desalination plant of around 100 GL/a or additional storage of around 200 GL in the Mt Lofty Ranges would be required. This assessment does not include the effects of climate change. However, based on recent experience, it is known that this extreme case may be representative of possible conditions that South

Australia may experience in the short-term regardless of the longer-term effects of climate change.

In order to provide Adelaide with a secure water supply system a paradigm shift is needed in the way that water resources are managed in the long-term.

2.2 Water Proofing Adelaide

Water Proofing Adelaide (WPA) is an integrated water resources management framework based on three main pillars:

1. Management of existing resources
2. Responsible water use
3. Additional water sources

The WPA strategy identifies 63 different initiatives that could be undertaken to achieve the outcomes of the three main pillars. Some of these initiatives are legislative, regulatory and administrative in nature but are important to create the governance framework within which the identified outcomes could be achieved.

The set of potential WPA outcomes include matters that are beyond the issue of creating new sources or savings of potable water. There is an important element of WPA relating to improvements in environmental flows, the protection of catchments in the Mount Lofty Ranges and water quality issues.

WPA is a competent water resources strategy and many of the strategies are consistent with best practice water resources management. However, it did not anticipate the extent of the current problems in the Murray-Darling Basin. In fact, the WPA strategy was developed on the fundamental basis that the River Murray would always be able to provide water security for Adelaide. WPA is still relevant but the basis on which the strategy was developed needs to be reviewed with respect to water security and the current problems in the Murray.

WPA seeks to reduce demand by improving efficiency of use and substitution of alternative water sources for potable supplies. A total of 47 GL of potable water savings are targeted when compared to the projected business as usual (BAU) 2025 demand.

The 2025 target demand incorporates 34.5 GL of water efficiency savings and 12.5 GL of additional water supplies (stormwater, rainwater, water sensitive urban design and recycled water), when compared to the business as usual (BAU) 2025 demand.

It should be recognised that as outdoor water efficiency is improved through WPA, water savings are applied to meet future growth, the impact of climate change and environmental flows. This results in a reduced ability to respond to a drought scenario if water restrictions are implemented. Section 2.3 discusses this issue in further detail.

SA Water has developed a climate corrected demand tool that can be used to assess the progress against the broad WPA demand reduction targets. Chart 4 shows that average savings of 30 GL have been achieved to date. This is equivalent to around

14% of the peak MAWSS demand in 2000/2001 and includes permanent water conservation measures that commenced in 2002/03.

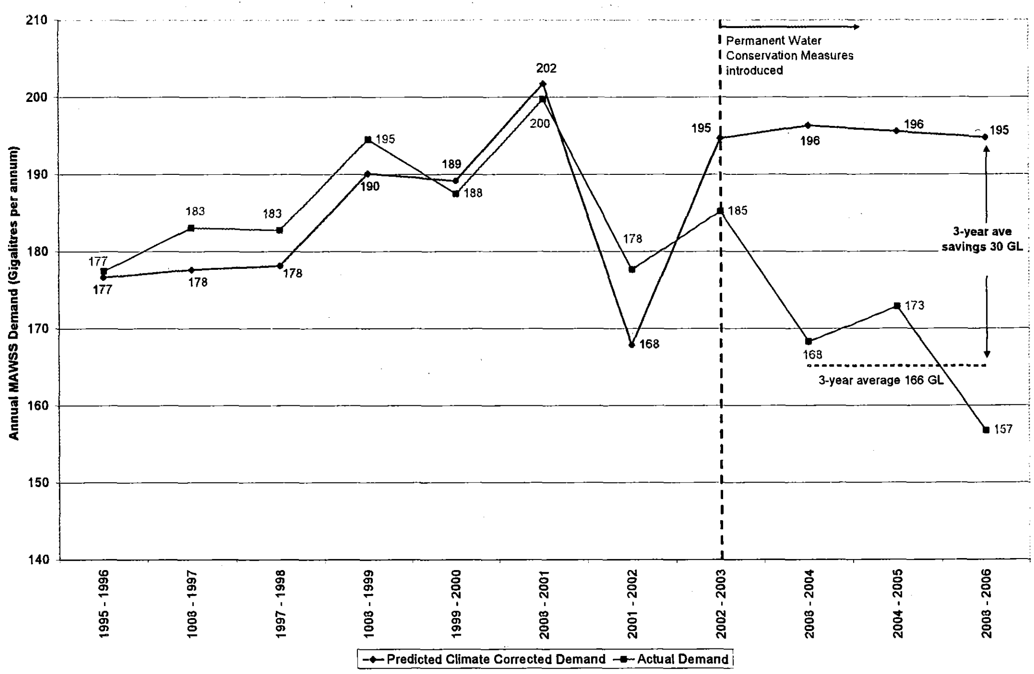

Chart 4: Water Proofing Adelaide savings compared to climate-corrected demand model

The WPA demand reduction target for per capita urban potable water consumption is 17% from 175 kL/a to 146 kL/a. Other states around Australia have lower per capita demand targets than the WPA target. There are significant differences between Australian cities and Melbourne and Sydney have the most aggressive targets. However, their proportion of outdoor residential water use is much lower than Adelaide's due to smaller garden sizes. Adelaide is also significantly drier than other Australian cities. The closest climatic comparison to Adelaide is Perth, although Perth has a high percentage of backyard bores which provide a significant amount of water for garden irrigation. Table 3 details per capita consumption targets.

Table 3: Per capita demand targets for different Australian cities and basic climate data

Capital City	Net Evaporation (mm)*	No. Days > 30 °C	Mean no. summer rain days	Target Consumption (kL/capita/a)	Target Date
Sydney	700	22	36	107	2020
Melbourne	600	30	26	108	2020
Canberra	1100	31	N/A	131	2023
Brisbane	350	50	38	146	2010
Perth	900	59	N/A	155	2012
Adelaide	**950**	**54**	**14**	**146**	**2025**

* Difference between annual evaporation and annual rainfall

Adelaide's three year average per capita total urban potable water demand (all sectors) was 142 kL/a per capita (not including 2006/07 which experienced restrictions). While this shows that significant gains have been made in the short term, future demand growth, climate change and capping of the water resources in the Mount Lofty Ranges are expected to have a significant adverse impact. Future impacts are discussed further in Section 3.

2.3 Demand Hardening

The WPA strategies targeting outdoor water efficiency impact on the effectiveness of water restrictions if drought conditions are experienced. WPA seeks to use savings due to outdoor efficiency to meet a proportion of growth in demand over the 25 year period. In WPA, approximately 25 GL of the target potable water savings is related to outdoor water use in the residential and non-residential sector. This means that if water restrictions are implemented in the future, there will be a reduced ability to save water because efficiency savings have already been applied to meet baseline demand growth. This effect is referred to as 'demand hardening'.

California Urban Water Agencies[7] provide the following definition for demand hardening:

> *"The diminished ability or willingness of a customer to reduce demand during a supply shortage as the result of having implemented long-term conservation measures"*

Expanding on this definition, demand hardening also refers to the ability of a customer to achieve further water efficiency gains after the easy 'low-hanging fruit' solutions have been implemented, ie the implementation of water conservation measures make future reductions more difficult.

Table 4 below shows the effect that demand hardening is expected to have on the effectiveness of water restrictions. As water efficiency is improved due to WPA, restrictions become less effective as a drought response measure. The table shows that on average water restrictions are expected to be 5% less effective in 2025 compared to before 2003, which was when permanent water conservation measures were introduced. Table 4 expresses the effectiveness of restrictions as percent reduction of unrestricted demand for each year.

Table 4: Effectiveness of water restrictions over time

	Pre-2003	Post-2003	2025
Restriction level	Saving (%)	Saving (%)	Saving (%)
PCM	3.5%	-	-
Level 1	6%	3%	1%
Level 2	11%	8%	6%
Level 3	18%	15%	13%
Level 4	22%	19%	17%
Level 5	27%	24%	22%

[7] Tabors Caramanis and Associates (1994). *Long-Term Water Conservation & Shortage Management Practices: Planning that Includes Demand Hardening.* California Urban Water Agencies, June 1994.

2.4 Environmental Flows in the Mount Lofty Ranges

In 2006, SA Water agreed to participate in environmental flow trials in the Mount Lofty Ranges. These trials have currently been suspended due to ongoing drought conditions. However, it is likely that once a water allocation plan (WAP) has been developed for the Mount Lofty Ranges, SA Water will be required to make environmental flow releases.

The agreed trial environmental releases totalled 16 GL per annum across the Mount Lofty Ranges. Approximately 4 GL of this volume is required in the River Torrens between Gumeracha weir and Kangaroo Creek reservoir. This volume can be recaptured in Kangaroo Creek reservoir so that the net environmental flow trial agreement volume is around 12 GL per annum. However, it should be recognised that the volumes agreed to in the environmental flow trials may increase after the WAP process has been finalised.

As discussed in Section 2, SA Water would require an additional 16 GL of 'first-use' River Murray licences so that supply was not constrained by the limitations of the rolling-average licence. Under that assessment, the provision of environmental flows was provided, in-line with the agreed trial volume. The additional 16 GL of River Murray licences were calculated based on existing system conditions and did not consider any inflow reduction in the Mount Lofty Ranges due to climate change.

SA Water has a first use licence of 15 GL. In order to provide the full environmental flow amount an additional 1 GL may be required in the short-term. In the longer-term an additional volume of water may be necessary due to the effects of climate change and the possibility that a greater level of environmental flows may be required.

DWLBC has indicated to SA Water that average reservoir spilling is considered as part of overall environmental flow requirements. Therefore, it is likely that SA Water's total environmental water provision will be the volumes agreed to in the environmental flow trial plus the reservoir spill volume. This has important implications under climate change conditions where the overall water resource decreases. An alternative view is that the overall environmental water requirement should decrease in proportion to the reduction in inflows due to climate change. However, the higher volume has been assumed for this report.

2.5 The Problems of the Murray-Darling Basin and Future Outlook

Dartmouth Dam was built in the 1970's to improve the reliability of the Murray-Darling Basin system. It supplements releases from Hume Dam and increases supplies to the River Murray system which is particularly important in dry seasons.

The Murray-Darling Basin Agreement, however, is primarily focused on meeting the current year's demand for water, rather than taking a multi-year outlook. Clause 100 of the Agreement specifies that a minimum reserve of no more than 835 GL must be retained each year, a very small amount compared to the long term average diversions which currently exceed 4000 GL per year. As a result, the volume of water retained in Murray-Darling Basin Commission (MDBC) storages is generally governed by the level of demand rather than any pro-active reserve strategy and there is no adaptive management of reserves during extended dry periods.

This is demonstrated by comparing the River Murray inflows of the last seven years in Chart 5 to diversions from the system over the same period, as shown in Chart 6.

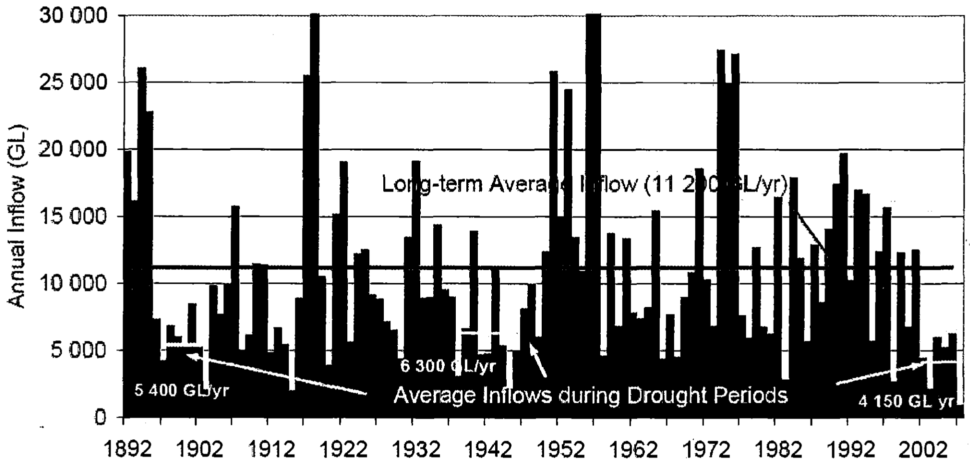

Chart 5: Total River Murray system inflows[8]

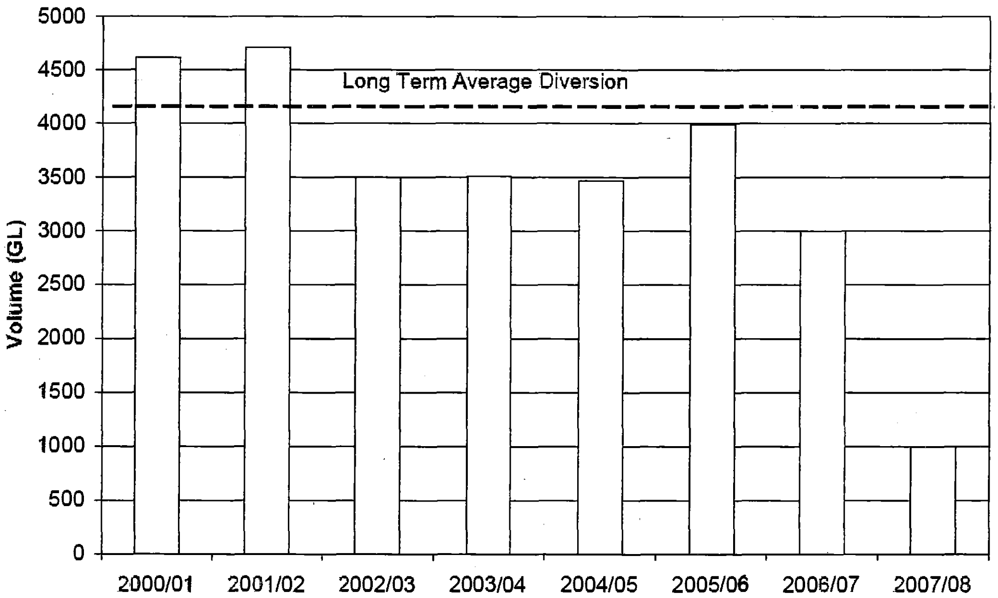

Chart 6: Total River Murray System Diversions[8]

The chart shows the net result of the current management paradigm - diversions were not reduced sufficiently during a period of drought to offset inflows less than 50% of the long-term average and the driest period on record is ending with little or no water in storage in the Murray-Darling Basin. The inherent weakness of the management framework that has been in place for many years has been exposed by the drought. The MDBC was not able to act to anticipate what could happen if there was a record-breaking drought, i.e. the Murray-Darling Basin Agreement has not enabled contingency planning for improbable, but possible, events.

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[8] Murray-Darling Basin Commission

It is vital to ensure that any new arrangements will be better able to manage diversions and to ensure that there is adequate warning of the need to reduce diversions to deal with drought conditions.

It has taken six years of drought to deplete the MDBC storages to the extent that special arrangements need to be made just to supply the very small volumes required to meet critical human needs. Recovery of the storage could take a similar period.

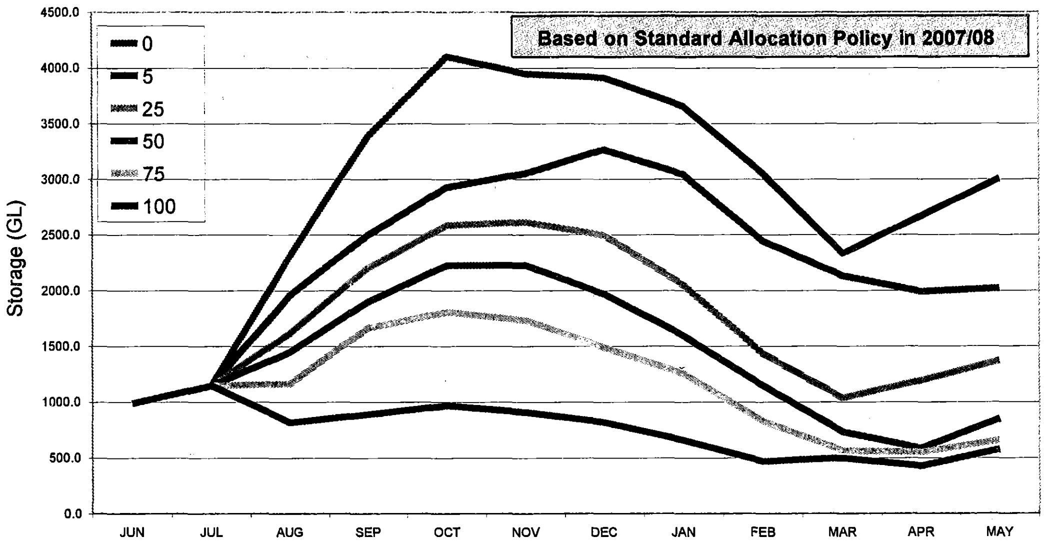

Chart 7: Distribution of total storage (excluding Menindee), end of July dry tercile years[9]

Chart 7 shows expected changes in total MDBC storage levels for different inflow conditions for 2007/08, based on the standard water allocation policy. For average conditions (50% probability of exceedance) or worse the volume of water in storage at the end of the year will be less than at the start of the year. Even with very good conditions (5% probability of exceedance) the storages would only recover to around 2000 GL compared to the average level of more than 4500 GL at the end of the year.

Chart 7 is based on normal water sharing arrangements, and the outcome could change if special arrangements are made to specifically reserve water to recover the MDBC storages to normal levels. At this stage it appears that the only water that will be held back in a strategic reserve will be the minimum amount required to ensure losses can be met in the following year. This is likely to be around 1000 GL, or the same volume that was in storage at the start of 2007/08.

It is evident that a series of average to good years will not lead to recovery. It will take "drought breaking" conditions in the MDB catchments before any real improvement is seen. This could well take a number of years. During this period, the availability of water for Adelaide will be heavily dependent on intakes in the Mt Lofty Ranges, and on-going restrictions can be expected.

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[9] From the Murray-Darling Basin Commission

3 Future Risks to Water Security

A range of risks to the metropolitan Adelaide water supply system (MAWSS) have been identified. These risks include:

- Effects of climate change in the Mount Lofty Ranges
- Effects of climate change in the Murray-Darling Basin
- Provision of environmental flows in the Mount Lofty Ranges
- Provision of environmental water requirements in the Murray-Darling Basin under the Living Murray Initiative
- Demand increases due to climate change (ie increased temperature and decreased rainfall)
- Demand hardening

These risks need to be evaluated in the context of potential future system operating conditions.

3.1 The Need for Supply Insurance – Do Nothing is not an Option

Reliability of a public water supply is expressed in many ways. How often any restrictions are needed, how often restrictions beyond a certain level are needed and how long restrictions last are just a few of the measures used.

A critical aspect of any urban water supply is to have a contingency plan that guarantees that the system can never "run out of water" even in the most extreme drought. Critical urban needs should always be maintained. It is in this area that the reliability of Adelaide's water supply has been found wanting in the current drought. If water from the River Murray is not available or is severely restricted at the same time that there are low inflows in the Mt Lofty Ranges, Adelaide's water supply system is unable to meet demands even if all external watering is banned.

In the current year Adelaide is relying on the agreement of New South Wales and Victoria to vary the conditions of the Murray-Darling Basin Agreement to give priority to critical human needs ahead of the normal water sharing rules and trading market conditions. Even with this goodwill, South Australia may need to build a temporary weir near Wellington simply to enable continued operation of the major pumping stations. The temporary weir is necessary just to access what little water there is in the river.

While better management of the River Murray might ensure that the MDBC storage levels never reach the critical levels they have in recent times, South Australia is not able to guarantee this. Even with improved management of the river, climate change will increase the variability of inflows in the Murray-Darling Basin storages and reduce the reliability of water flowing across the South Australian border.

While the River Murray will continue to make an important contribution to Adelaide's water supply, it is essential that South Australia reduce its reliance on this source at least to the extent that it can manage during extreme drought when there may be no water available from the river.

3.2 Climate Change

As noted earlier, on average Adelaide's water supply comes from catchments in the Mt Lofty Ranges (60%) and the Murray-Darling Basin river system (40%). However, in periods of drought in the Mt Lofty Ranges up to 90% of demand is met from the River Murray and in wet years only 10% needs to be supplied by the River Murray.

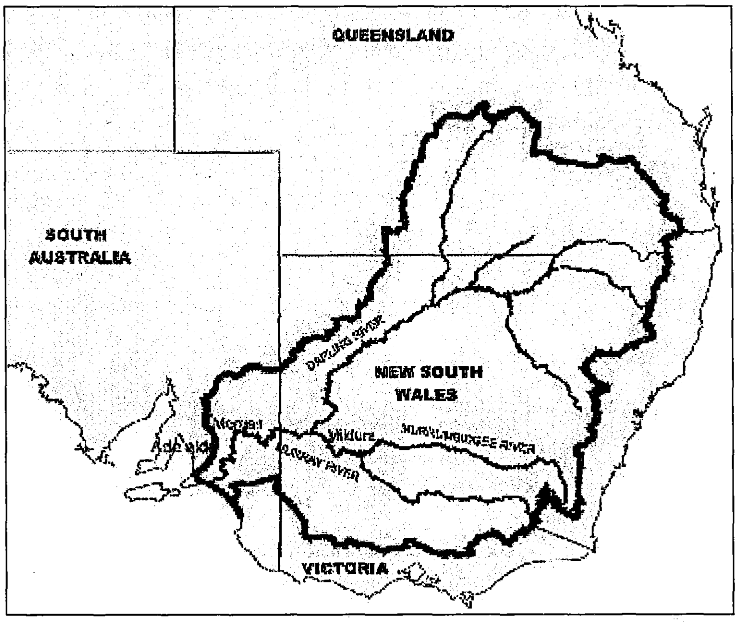

Chart 8: The Murray-Darling Basin

Thus any reduction in rainfall, or increase in the variability of rainfall, due to climate change in both the Murray-Darling Basin and South Eastern Australia regions (shown in the Chart 9) will have an impact on the reliability of Adelaide's water supply.

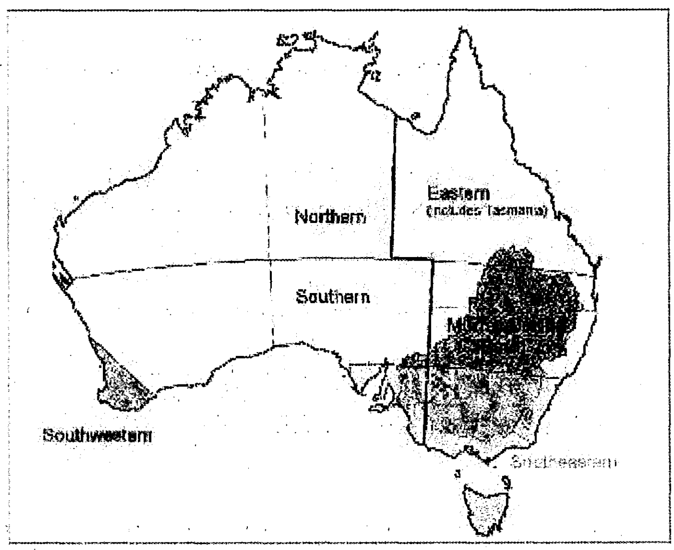

Chart 9: Bureau of Meteorology Climate Regions

The Intergovernmental Panel on Climate Change (IPCC) has advised in their Fourth Assessment report[10] that there has been a global increase of temperature of approximately 0.75 degrees Celsius, and that there is an "unequivocal" scientific link between this temperature increase and increased greenhouse gas emissions from human behaviour. In Australia, a similar temperature increase over this period is also reflected in Bureau of Meteorology records particularly since 1950.

Chart 10 and Chart 11 demonstrate that over the period 1910 to 2000 there has been a ~1.0 °C increase in mean temperatures in both the South East Australia and the Murray-Darling Basin regions

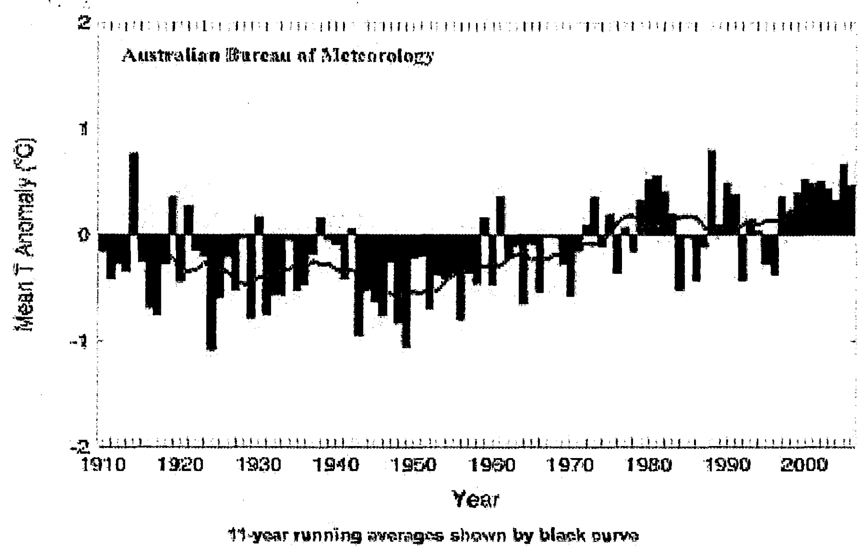

Chart 10: South-eastern Australia annual mean temperature anomaly (base 1961-90)

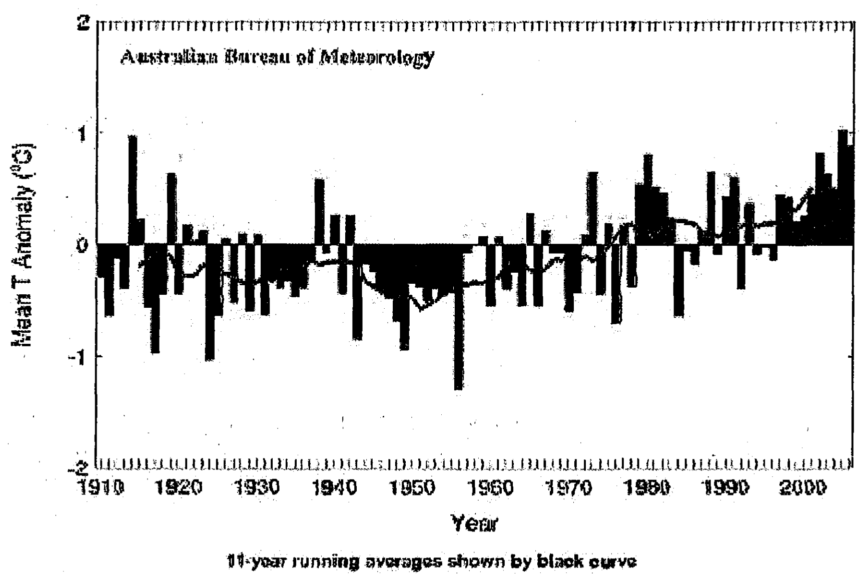

Chart 11: Murray-Darling Basin annual mean temperature anomaly (base 1961-90)

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[10] Solomon et al. (2007). *Climate Change 2007. The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Accessed from: http://ipcc-wg1.ucar.edu/wg1/wg1-report.html

From 1920 – 2005 the maximum temperature has increased +0.06°C per decade and the minimum temperature has increased +0.12°C per decade. Increasing average temperatures *regardless of any other climate change impact* will drive higher evaporation rates, reducing the amount of water that is retained on land and in surface and groundwater systems.

The effect of increasing mean temperatures and increasing temperature variability is shown in Chart 12, as produced by IPCC. The distribution of temperature often resembles a normal distribution.

Chart 12(a) shows that increasing the mean temperature generally results in more hot weather occurring. It has the effect of increasing the extreme hot weather too, but because of the nature of the normal distribution this also results in less cold weather.

Chart 12(b) shows the effect of increasing temperature variability but maintaining a constant average temperature. In this case, more extreme cold and hot weather events are likely to occur.

Finally, Chart 12(c) shows the effect of increasing mean temperature and increasing variability. This results in not only consistently more hot weather, but also more extreme hot weather events and generally less cold weather. Given the likely relationship between temperature and catchment runoff, this serves to illustrate the effect that changing temperatures may have on Australian water resources. Sections 3.3 and 3.4 explain the possible climate effects on the water resources in the Murray-Darling Basin and the Mt Lofty Ranges.

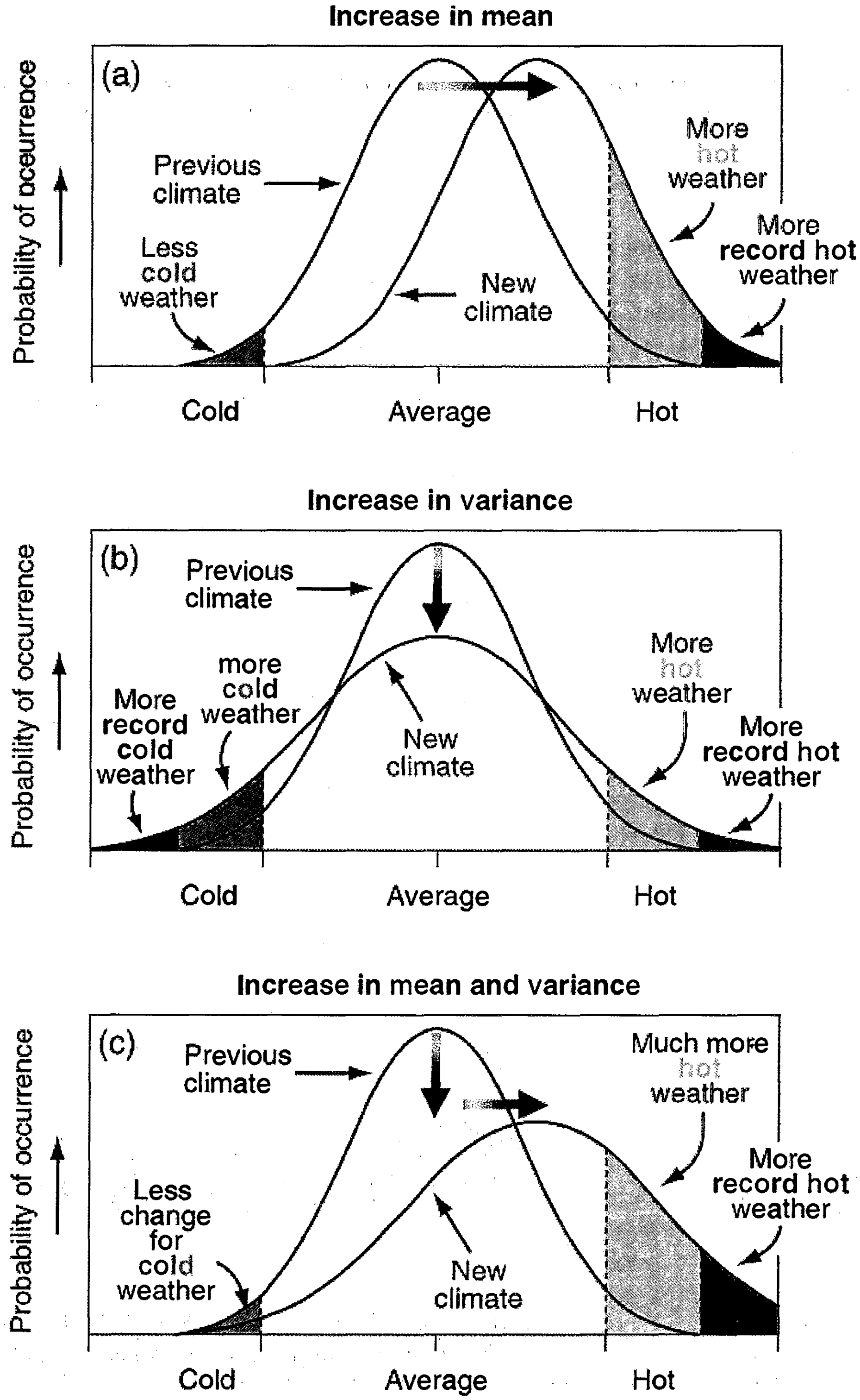

Chart 12: Schematic showing the effect on extreme temperatures when (a) the mean temperature increases, (b) the variance increases, and (c) when both the mean and variance increase for a normal distribution of temperature.[11]

[11] Houghton, J. et al. (2001). *Climate Change 2001: The Scientific Basis.* Intergovernmental Panel on Climate Change. Accessed from http://www.grida.no/climate/ipcc_tar/wg1/088.htm

3.3 Climatic Impacts in the Murray-Darling Basin and SE Australia

Murray-Darling Basin climate records show that there are long-term cycles of rainfall in South Eastern Australia and the catchment area of the River Murray that is most important to South Australia during a drought. Chart 13, which shows rainfall anomaly in SE Australia, against a 1961-1990 base, demonstrates that average rainfall in the period from 1946 to 1990 was greater than for the period 1900 to 1946. Since 1990 there has been a pattern of reduced rainfall similar to conditions in the first half of last century.

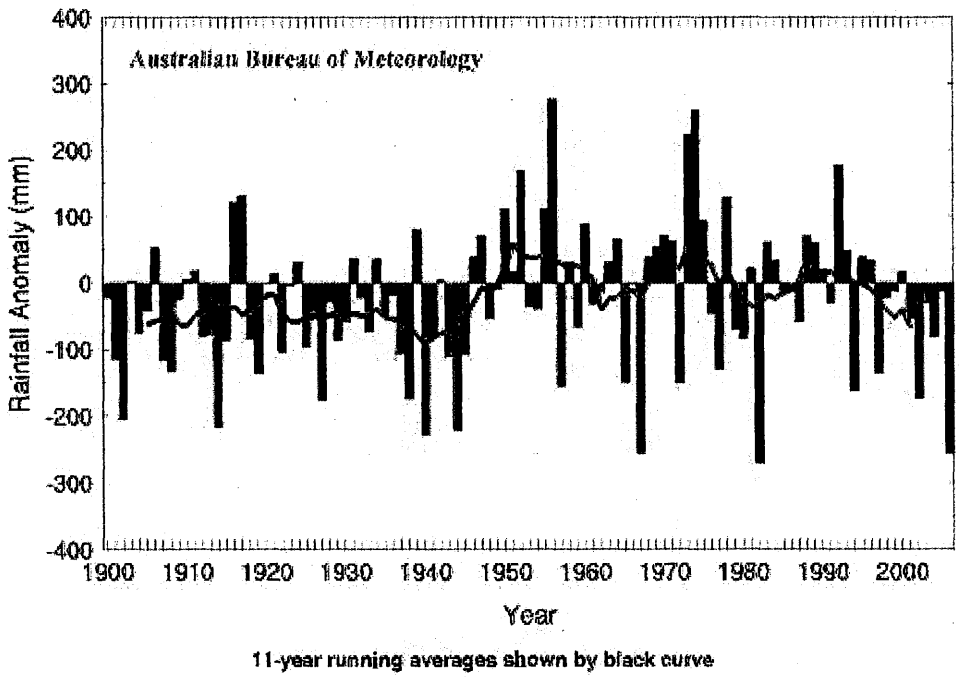

Chart 13: South-eastern Australia annual rainfall anomaly (base 1961-90)

This long-term natural variation in weather patterns would occur even if there were no risk of long-term climate change caused by human activities. However, future climate change impacts due to greenhouse effects may be in addition to these cyclical climatic effects and that may increase the frequency of droughts and the variability of climate.

It is important to note that the period of greatest economic development, built upon diversion of Murray-Darling Basin water, occurred during a period when it may be that rainfall was atypically higher than the long run average.

If the rainfall returns to the pattern that applied in 1900 to 1946, the impact of the changed weather pattern on rainfall in the River Murray catchment would be a ~15% reduction.

Based upon the historical data, it would be prudent for the long term planning of water usage to assume at least a ~15% reduction in rainfall, which on average could result in a much greater than 15% reduction in inflows. The extent to which the full range of greenhouse induced climate change will further reduce these inflows is a matter now being studied as part of the Commonwealth Government's proposals for future management of the Murray-Darling Basin.

Chart 14 shows the very similar pattern that applies to the Murray-Darling Basin.

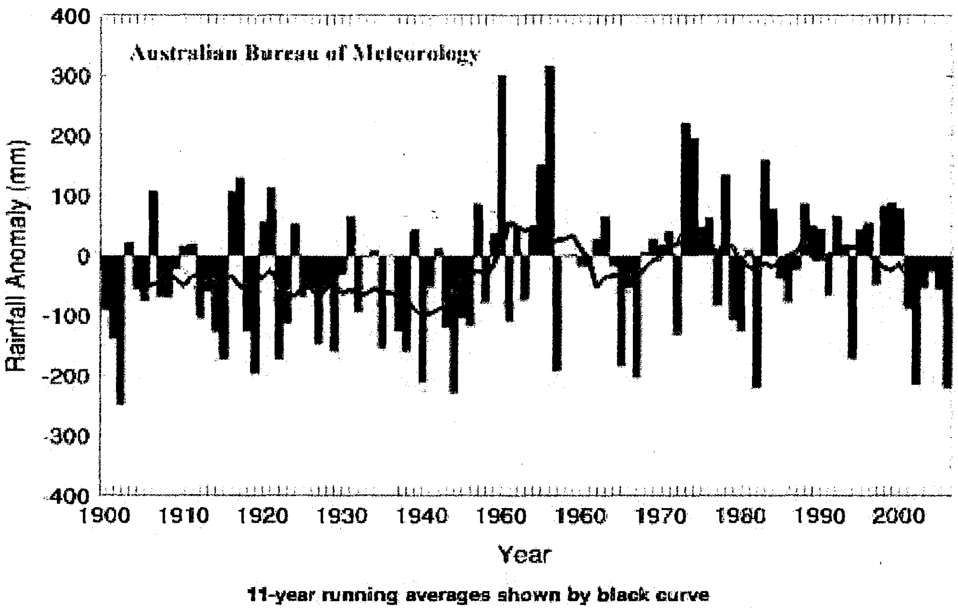

Chart 14: Murray-Darling Basin annual rainfall anomaly (base 1961-90)

The Murray-Darling Basin Commission with the CSIRO is investigating the impacts of climate change on the water resources of the Murray-Darling Basin. This work is not expected to be complete until late-2008.

The MDBC has provided SA Water and DWLBC with preliminary advice on expected flows across the South Australian border under climate change scenarios. However, this data (like the Mount Lofty Ranges data) does not include the effects of increased climate variability. A preliminary assessment has shown that there are likely to be total, basin-wide, inflow reductions of around 10% and possibly up to 40% in the worst case scenario (or between 1,100 to 4,400 GL/a). The MDBC has indicated that a similar percentage reduction in flows across the South Australian border is likely.

In a business as usual (BAU) scenario (where Adelaide continues to rely solely on the Murray-Darling Basin to manage variability), it is likely that SA Water's overall share of Murray-Darling Basin resources will need to increase in the future, even if SA Water's volumetric requirements stays the same. This reasoning assumes that if there is a reduction in available water resources and the Living Murray Initiative is implemented, then there is likely to be significantly less water available for consumptive use across the basin.

The Living Murray First Step agreement was to return 500 GL per annum to the Murray by June 2009. Under WPA, the South Australian Government has targeted that the full Living Murray volume of 1,500 GL be returned to the River by 2018.

The annual average inflow reductions due to climate change and the Living Murray First Step are likely to total 1,600 GL initially. This represents a reduction of 15% to available surface water resources.

The MDBC has presented a list of risks to water resource availability in the Murray-Darling Basin. If all likely risks to water resources in the Murray-Darling Basin over the next 20 years are included, then it is likely that overall there will be a flow reduction of between 23 – 31% of existing diversions. The range is given to show the effect of the Living Murray First Step to full implementation.

Table 5 has been adapted from a presentation given by Bob Douglas (MDBC) at the Heads of Water Agencies Meeting on 10 August 2007.

Table 5: Risks to water resources in the Murray-Darling Basin

Risk Factor	Likely Estimate by 2030 (GL/a)
Climate Change	1,100
Increased Farm Dam Construction	250
Tree Re-growth due to Bushfires	850
Environmental Flows	500 – 1,500
Increased Groundwater Extraction	250
Land Use Change	50
Total	**3,000 – 4,000**
Existing Surface Water Diversions	11,500
Existing Groundwater Diversions	1,500
Total Diversions	13,000
Percent Reduction of Total Diversions	**23 – 31%**

Based on the table above and if assuming no additional sources of water are provided for Adelaide, SA Water's share of Murray-Darling Basin diversions would increase from its current 1% to around 2% of total surface water diversions. Under drought conditions, SA Water's share of available resources would potentially be more than 2% of total diversions even if urban demands were subject to water restrictions. This recognizes that critical urban supplies would need to be maintained in a severe drought event even if there was no irrigation allocation.

3.4 Climatic Impacts in the Mt Lofty Ranges

Chart 15 shows the inflow anomaly for Mt Lofty Ranges catchment.

There is no conclusive evidence to suggest that climate change has started to have an impact on stream flows in the Mount Lofty Ranges. The Mount Lofty Ranges has always been subject to significant climate variability, with between 10% and 90% of Adelaide's water being supplied from local catchments. Although, over the last 10 to 20 years of records inflows have been considerably lower than average. The climatic variability is shown in Chart 15.

However, inflows will be reduced in both the Mt Lofty Ranges and the Murray-Darling Basin by climate related factors such as increased temperatures increasing evaporation and by land use changes such as the numbers of on farm dams and the area used for forestry etc.

Climate change projections are inherently speculative because they have to assume future scenarios for modelling the future impact of greenhouse gas concentrations in the atmosphere as well as scenarios of human behaviour. Future climate scenarios and water availability projections are therefore being developed by the CSIRO and the Department for Water Land and Biodiversity Conservation, based on downscaling Inter Governmental Panel on Climate Change (IPCC) global climate models to focus on specific catchments and regions such as the Murray-Darling Basin and Mount Lofty Ranges.

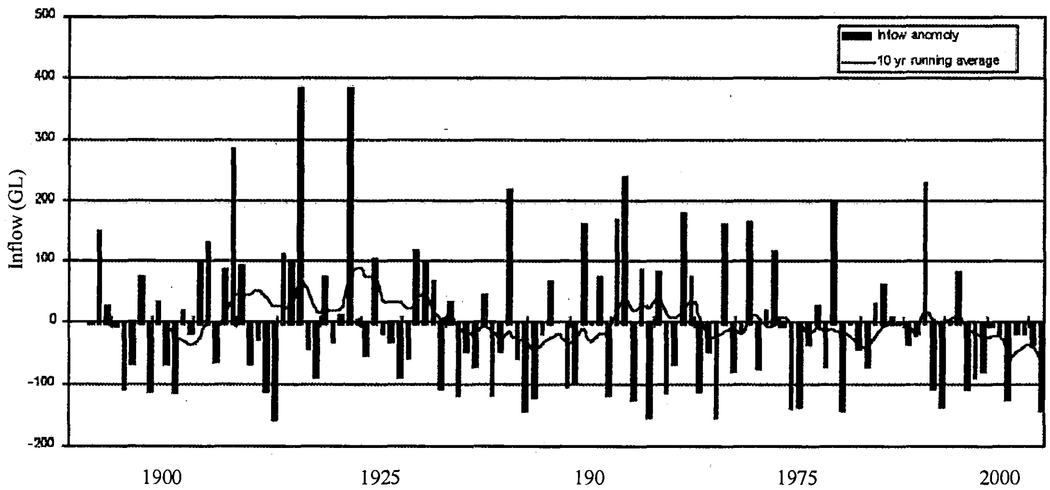

Chart 15: Anomaly of inflows to Mt Lofty Ranges catchments

Work on identifying the implications of climate change is on-going. The CSIRO have provided the Department of Water, Land and Biodiversity Conservation (DWLBC) with data for rainfall stations across the Mount Lofty Ranges[12] and DWLBC will perform detailed modelling of likely climate change effects on stream flows in the Mount Lofty Ranges. This work will be complete early 2008. Climate change data is currently based on the Intergovernmental Panel on Climate Change (IPCC) scenarios A2 and B2. There is also recognition that additional modelling should be performed for the A1F1 scenario.

Preliminary results from DWLBC have indicated that climate change in the Mt Lofty Ranges under Scenario A2 is likely to reduce inflows to Adelaide's reservoirs by up to 30% by 2050 (relative to 1990 inflows). This equates to a reduction of around 17% by 2025.

The A2 scenario is representative of a greenhouse intensive, human behaviour scenario, representing continued high rates of greenhouse gas emissions, continuously increasing populations and a focus on regional economic development rather than

[12] Charles et al. (2006). *Stochastically Downscaled Precipitation Projections for the Mount Lofty Ranges and Upper South East Region of South Australia. Draft Final Report.* CSIRO Land and Water for DWLBC.

technological change and global environmental concerns. The B2 scenario, in contrast, has slower emissions growth as governments and industry move towards environmental and social sustainability.

The inflow reductions for IPCC Scenarios A2 and B2 are both very similar for the 2025 and 2050 cases (28% for B2 compared to 30% for A2). The main reason postulated for this is that significant climate change effects are expected after 2050, when the IPCC scenarios are expected to significantly diverge.

In real terms this will mean a reduction in water availability of around 30 GL from the MLR in 2025 and a reduction of 44 GL by 2040, taking into consideration the provision of environmental flows, maintenance of reservoir spill volumes and reservoir (evaporation) losses.

Significantly, an increase in climate variability has not yet been taken into account. This is likely to exacerbate the existing variability of inflows in the Mount Lofty Ranges. The Mount Lofty Ranges already has significant variability, with between 10% - 90% of Adelaide's water supply being sourced from the Mount Lofty Ranges, with an average of 60%. In future, the range of variability may not change. However, the frequency of extreme dry events is likely to increase.

As previously noted, the Department of Water, Land and Biodiversity Conservation will be providing updated climate change information in early 2008, including the effect of climate change on climate variability. Any increase in climate variability could be significant in the context of water availability in a catchment already subject to significant existing inflow variability. This is likely to have an effect on the severity and frequency of drought events.

3.5 Climate Variability

Irrespective of possible climate change impacts, Australia already has rainfall variability higher than many other countries as shown in Chart 16.

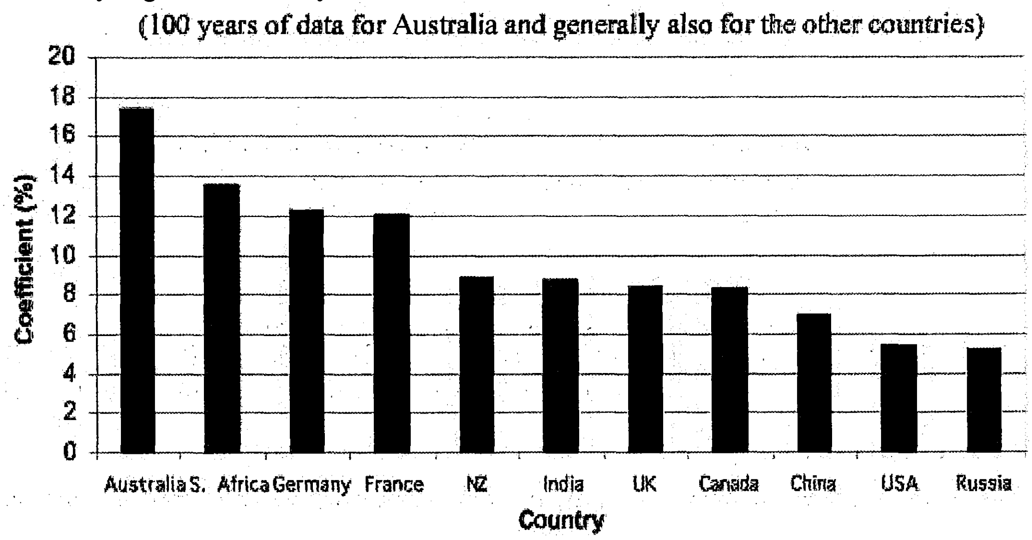

Chart 16: Variability of annual rainfall (source: MDBC)

This is consistent with Table 6 that tabulates the ratio of the maximum and minimum flows for major rivers in several countries. The Mt Lofty Ranges has a maximum to minimum flow ratio of approximately 30.

Table 6: Ratio between maximum and minimum river flows for some of the world's major rivers (source: MDBC)

COUNTRY	RIVER	RATIO BETWEEN THE MAXIMUM and the MINIMUM ANNUAL FLOWS
BRAZIL	AMAZON	1.3
SWITZERLAND	RHINE	1.9
CHINA	YANGTZE	2.0
SUDAN	WHITE NILE	2.4
USA	POTOMAC	3.9
SOUTH AFRICA	ORANGE	16.9
AUSTRALIA	MURRAY	15.5
AUSTRALIA	HUNTER	54.3
AUSTRALIA	DARLING	4705.2

Increasing variability in rainfall, combined with reduced average inflows due to climate change, will require increases in storage capacity to reliably supply a decreased amount of water from both the Mt Lofty catchments and the Murray-Darling Basin.

Adelaide has relied upon diversions from the River Murray to manage variability in rainfall in the Mt Lofty Ranges. With climate change it is clear that Adelaide will need to look to other supplies as an "insurance supply" to deal with drought conditions and variability.

However, the predicted climate changes do not of themselves mean that Adelaide should completely abandon diversions from the River Murray as a source of water.

In summary, Australia is a relatively dry country with a high natural variability in its rainfall regime and the climate in Australia is changing – i.e. increased temperatures, more variable rainfall, lower mean rainfall and extremes of rainfall and temperature.

The current prolonged drought has placed the water supply from the River Murray under extreme stress and this illustrates the likely future impact of climate change upon the Murray-Darling Basin system. However, the inherent deficiencies of the Murray-Darling Basin Agreement as a management model (rather than the management responsibilities of the MDBC itself) have in part exacerbated the problems because the MDBC is not able to take a five-year view of basin management.

3.6 Climatic Impacts on Demand

SA Water has developed a climate corrected demand model for the MAWSS. The model relates demand from 1980 to 2003 to monthly rainfall, evaporation and number of days where the maximum temperature exceeds 30°C. This model can be used to assess progress on demand reduction initiatives.

This model has also been used to investigate the influence that climate change may have on demand. Climate change scenarios for the Mt Lofty Ranges are expected to result in increased average temperatures, decreased rainfall and increased evaporation.

Three climate change scenarios have been investigated to determine the influence on demand[13,14]. The data used for assessment of influence were the expected seasonal variation in temperature and rainfall and annual variation in evaporation for 2030 and 2050 conditions.

The modelled influence of climate change on 2025 demands was an annual increase of between 1.3% and 5%, with an average of 2.5% compared to the business as usual demand. The largest increase in demand occurred in Spring. In the 2050 scenario the increase in demand was between 2 and 11%, with an average of 6.2% of the business as usual demand. The largest increase again occurred in Spring.

3.7 Climate Impacts on Water Security

In Stage 2 of the MAWSS Security Investigation[15], Tonkin modelled the impacts of climate change on average inflow reductions in the Mt Lofty Ranges and the Murray-Darling Basin (MDB), as well as modelling a range of population growth scenarios. An 'envelope' of probability curves was developed for 2025 and 2050 conditions based on high and low climate change scenarios and high and low population growth (demand) scenarios.

Chart 17 shows four representative scenarios that were analysed:

1. Series 1 represents high growth, high climate change in the MDB and IPCC Scenario A2 in the Mt Lofty Ranges
2. Series 2 represents high growth, low climate change in the MDB and IPCC Scenario A2 in the Mt Lofty Ranges
3. Series 3 represent high growth and low climate change in the Murray-Darling Basin and IPCC Scenario B2
4. Series 4 represents low growth, low climate change in the MDB and IPCC Scenario B2

The MDBC had provided DWLBC and SA Water with three inflow reduction scenarios representing likely inflow reductions at 2030, 2050 and 2070. In stage 2

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[13] Suppiah, et al (2006). *Climate change under enhanced greenhouse conditions in South Australia.* CSIRO

[14] McInnes et al (2003). *Climate change in South Australia.* CSIRO

[15] Tonkin Consulting (2007). *Metropolitan Adelaide Water Supply Security Investigation. Stage 2 – Future Demands.* Prepared by Tonkin Consulting for SA Water, September 2007.

Security Investigations, Tonkin assumed that the high inflow reduction for 2025 was equivalent to the likely 2050 inflow reduction. This means that Series 1 in Chart 17 is very conservative and is representative of an accelerated impact of climate change.

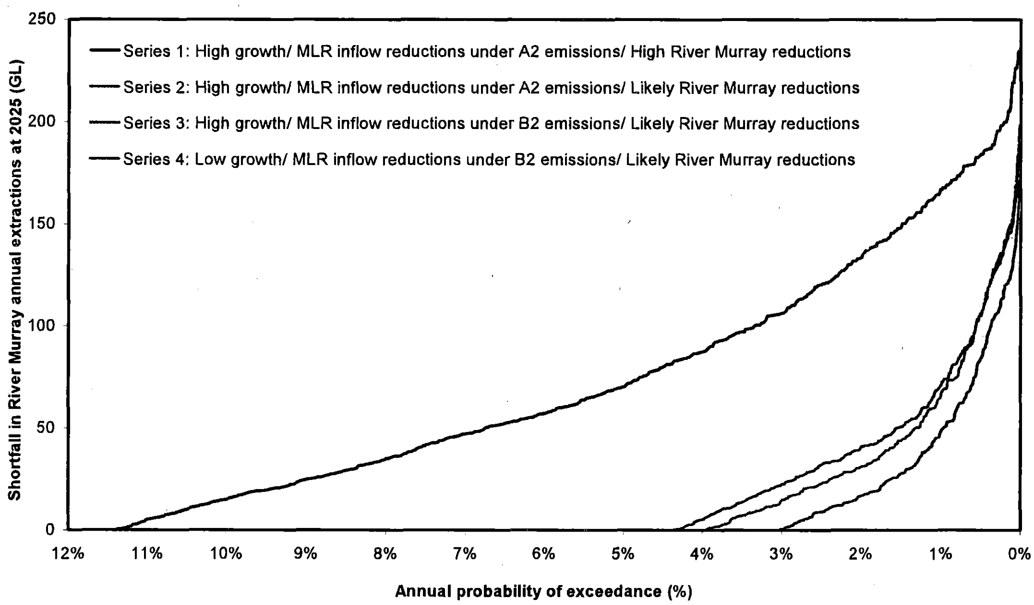

Chart 17: Probability of Exceedance (POE) for water supply shortfalls (expressed as shortfall in River Murray extractions) in different climatic and demand scenarios at 2025

Series 1 shows that inflow reductions in the MDB are potentially the single largest influence on water security in Adelaide. Series 1 is an extreme case to consider for 2025. However, it serves to illustrate Adelaide's dependence on the River Murray.

Comparing Series 3 and Series 4 shows that the impact of system growth is not a major influence in water security calculations. The low population scenario (in-line with Planning SA population scenario 5) is based on 1,342,000 people by 2025 in the Greater Adelaide area, whereas the high population scenario (in-line with Planning SA population scenario 14) is based on a population of 1,472,000. These targets are in-line with the South Australian Strategic Plan target of two million people in South Australia by 2050.

By 2050 the frequency of shortfalls increases as shown in Chart 18.

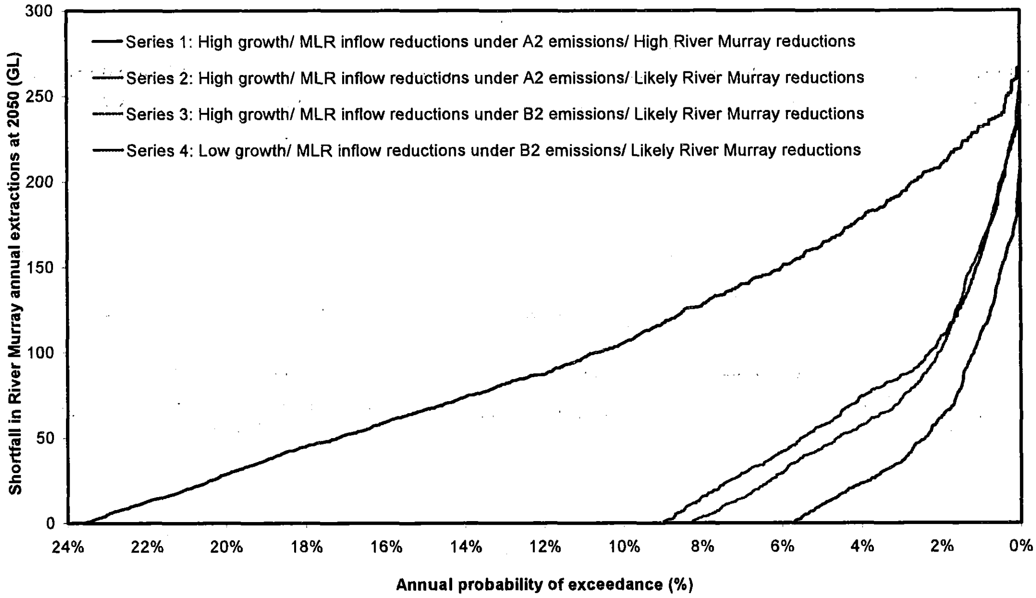

Chart 18: Probability of Exceedance (POE) for water supply shortfalls (expressed as shortfall in River Murray extractions) in different climatic and demand scenarios at 2050

Series 2 and 3 are the most likely water security scenarios for 2025 and show that supply shortfalls would occur at around 1 in 25 years compared to the previous assumption of around 1 in 60 years (based on historical records using the rolling average and a 16 GL 'first-use' licence). By 2050, shortfalls in supply would be expected at a frequency of around 1 in 10 years as shown in Chart 18.

Table 7 shows the impacts of climate change and growth on the security of the MAWSS, if Adelaide relied solely on the traditional water resources of the Mt Lofty Ranges and the River Murray. It should be noted that the 2025 and 2050 scenarios in Table 7 are not based on the 650 GL rolling average licence, but rather are based on a licence sufficient to meet the peak historical demand in the absence of water shortages on the River Murray. There will be a need to increase the "first use" licence over time to match this criteria.

Table 7: Probability of restrictions for different scenarios

Restriction Level Required	Probability of Exceedance (POE)		
	650 GL Rolling Licence + 16 GL First Use Licence	Chart 17, Series 2, 2025	Chart 18, Series 2, 2050
Level 1	1 : 60 yrs	1 : 23 yrs	*
Level 2	1 : 70 yrs	1 : 25 yrs	1 : 10 yrs
Level 3	1 : 100 yrs	1 : 30 yrs	1 : 13 yrs
Level 4	1 : 170 yrs	1 : 40 yrs	1 : 14 yrs
Level 5	1 : 230 yrs	1 : 45 yrs	1 : 15 yrs

*** - Level 1 restrictions cease to have a calculated impact and are not included in this analysis**

Climate variability will exacerbate the situation. The effect that increased variability has on water security will be modelled when information is available from DWLBC and the MDBC.

3.8 System Water Balance

Given the range of possible effects on water resources in the future, an overview water balance has been developed to assist in explaining how water resources may need to be managed. The water balance has been developed based on average inflow reductions, consistent with IPCC Scenario B2 and a growth scenario consistent with South Australia's Strategic Plan target of two million people in South Australia by 2050.

Environmental flows are assumed to be maintained constant regardless of climate change. However, reservoirs spills in the Mt Lofty Ranges are assumed to reduce in proportion to the climate change reduction.

Table **8** provides a water balance to 2025 and the period around 2040 showing the effect of climate change and environmental flows on the MAWSS. The margin for error in climate change and demand projections for the period after 2025 increases and as such an approximate range is given. All climate change and demand data has been interpolated from 2050 to provide data for the 2040 scenario.

The water balance shows that under the B2 change scenario an additional 50 GL of water will be required by 2025. Due to the ongoing climate change effects, it is estimated that by 2040 an additional 102 GL will be required. A seawater desalination plant is one method that would provide a climate independent water source suitable for the average climate change effects discussed.

Future climate variability is not considered in this water balance, only supply/demand influences. If a seawater desalination plant is proposed to manage climate variability as well as the average supply shortfalls expected, then the plant would need to be sized considerably larger than 50 GL in 2025 and around 100 GL in around 2040.

Table 8: MAWSS water balance under IPCC Scenario B2

Item	Existing	2025	2040
MLR inflows (GL)	180	150	136
MLR eflows (GL)	13	13	13
MLR spill (GL)	40	40	40
Evaporation (GL)	17	18	18
Availability (GL)	110	79	65
Peak/BAU demand (GL)*	213	258	282
Demand increase due to climate change (GL)	-	6	13
Non-MLR water required (GL)	103	185	230
MDB licence reduction (GL)	-	15	25
Expected Murray pumping (GL) *	103	88	78
WPA savings (GL)	-	47	50
Total additional water required (GL)	**-**	**50**	**102**

* based on 2000/2001 MAWSS demand

3.9 Level of Service

The level of service refers to the frequency, duration and severity of water restrictions imposed on a community. Table 1 shows the target level of service for some capital cities.

Recent evidence in Adelaide suggests that in drought conditions most consumers are willing to accept level 3 restrictions but there is significant concern in moving to tougher restrictions. Interstate water authorities have recently announced that they will target level 3 as their maximum restriction level (or severity criteria). For example, Sydney Water aims to achieve this target by constructing a 250 ML/d seawater desalination plant, with the ability to upgrade to 500 ML/d. It is important to note that Sydney Water had specified a trigger level for proceeding with the construction of their desalination plant based on reservoir levels dropping below 30% of capacity. Sydney Water also has other trigger levels for contingency purposes such as accessing 'dead storage' in reservoirs and accessing groundwater from nearby aquifers.

There is currently no formal level of service target for Adelaide's water supply. For the purpose of developing proposed improvements, it has been assumed that the service target will be that level 3 restrictions should not be experienced more than 1 in 100 years.

The maximum level of water restrictions that Adelaide should face, and what the cost will be to consumers, is a public policy judgement for the Government and is outside the scope of this report.

4 Water Security Options

Climatic impacts are expected to result in reductions of reservoir inflows and increased variability. Water security can be improved by increasing storage capacity to allow better management of climate variability, providing additional water sources to make up for the expected inflow reductions or a combination of these options.

There are sixteen strategies relating to the provision of additional water supplies and fostering innovation in the Water Proofing Adelaide strategy. There are also measures for greater water efficiency that will not be discussed here; rather this discussion will focus on potential sources of additional supply and methods to better manage climate variability.

Options for additional water supply to Adelaide that have most often been canvassed publicly include:

- Purchase of additional water licences
- Additional Mt Lofty Ranges storage filled by increased pumping from the River Murray during period of good flows
- Desalination plants
- Treatment of wastewater for reuse;
- The capture, storage and reuse of stormwater
- Increased use of aquifers

The reuse of treated wastewater and stormwater and the increased use of aquifers were assessed in detail during development of the Water Proofing Adelaide strategy. In addition to the Government's, opposition to potable reuse, the common factors that determine their cost structure and competitiveness include:

- Capital cost of treatment plants
- Operating costs including the variability of these costs
- The availability and cost of energy (i.e. electricity)
- Environmental management costs
- The flexibility of supply i.e. does the supply need to be base load or can it be regarded as peaking supply in periods of high demand?
- The location of any plant and the cost of dealing with site constraints
- The cost of linking the plant to existing water infrastructure given that the existing infrastructure is designed to accept water from Mt Lofty catchments or the River Murray
- Variability of source water quality and quantity

In addition to these common factors there are issues specific to each option.

4.1 Storage options

4.1.1 Upstream Storage of Additional Water

Special arrangements to hold a strategic reserve of water in upstream storages may be a cost effective way of improving Adelaide's water security.

Additional temporary water leases could be purchased on the open market, and special arrangements could be made with the other states for holding this water in upstream storages. South Australia currently does not have arrangements for holding "carry-over" water except during periods of low water availability when Special Accounting applies.

This option would also have the added benefit of improving the security of country water supplies.

The potential draw-backs of such a proposal are:

- The potential difficulty reaching agreement with NSW and/or Victoria over holding a strategic reserve in the upstream storages, which is a fundamental requirement to improve reliability in drought periods;
- There are no guarantees that even if there were agreements in place to store the strategic reserve for Adelaide, these might be set aside in periods of drought if the choice came between providing this water to support gardens and lawns in Adelaide compared to allowing permanent agricultural plantings die;
- Unless the upstream storages have significant "spare" capacity that is not filled very regularly, the strategic reserve might spill on a regular basis (the South Australian water is likely to be the first water to spill under such an arrangement). In the future the other states may also see benefits in holding their own strategic reserves, which would reduce the effectiveness of this strategy for South Australia;
- The strategic reserve may have to be large enough to contribute to dilution flows for delivery of usable water to Mannum or Murray Bridge.
- The costs for utilising space in the upstream storages could be substantial, including replacement of water lost through spill.

Holding a strategic reserve of water in upstream storages is likely to be a viable and cost effective strategy if the goal is only to provide assurance against running out of water. That is, the strategy would involve accepting that the water was only available if Adelaide were on full restrictions to outside watering. This option is risky at best and probably not viable if the aim is to provide Adelaide with a level of reliability that goes beyond acceptance of total outside watering bans.

4.1.2 Increased Mt Lofty Ranges Storage

As noted above, with an efficient market for water it is possible that water, in addition to existing Murray-Darling Basin entitlements, could be bought on market to put into storage in the Mt Lofty Ranges without putting additional stress on the Basin. This option has already been made public as a proposal to increase the storage capacity of the Mt Bold reservoir. Under this proposal, the existing pumping infrastructure could be used to put additional water into storage in periods when there is adequate flow in the River Murray. Storage dams are costly (in this case the current estimate is around

$1.1 billion) and it is likely to take about seven years to design and construct (including obtaining environmental approvals) and up to three years to fill. It should be noted that the current Mt Bold estimate of $1.1 billion may change as more detailed investigation works progress.

There are many technical and geotechnical issues that will need to be resolved before a commitment could be made to a site. Any additional storage in the Mt Lofty Ranges will also raise environmental conservation issues. The advantages of this option include that existing major pipeline infrastructure (including pump stations) can be used.

More importantly, this option has significant benefits for managing climate variability and improving the reliability of Adelaide's water supply. It also has benefits for the management of the Murray-Darling Basin system. At present, the major storages for water are upstream in the catchments (Dartmouth and Hume), or shallow water dams (Lake Victoria) that have very high evaporation rates. In addition, there are significant river channel and evaporation losses within the system.

Benefits for the Murray

In order to meet Adelaide's River Murray demand, the system losses need to be met to ensure sufficient quantity of water. During drought conditions with low river flows the quality of this water is seriously degraded by saline inflows and additional dilution flow would need to be released to ensure acceptable water quality. Storage of water in the Mt Lofty catchments during periods of flows surplus to both diversions and the environmental needs of the river, for later use during drought conditions, would place less stress on the river system.

Chart 19 and Chart 20 show the modelled difference in River Murray extractions during a 7-year worst case scenario. These charts show that in years where the river is stressed and less than entitlement flow is available, a larger Mt Bold can be used to supply Adelaide's demand and less water needs to be pumped from the Murray. Years 6 and 7 are extreme drought cases where little to no water is available from the River Murray.

This option can provide benefits to the sustainable management of the River Murray as well as increased water security for Adelaide.

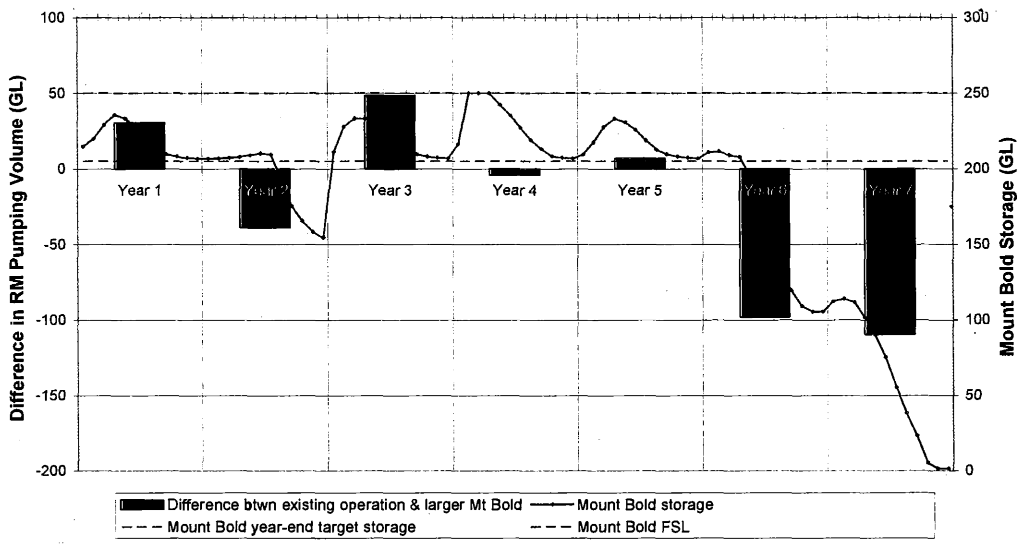

Chart 19: Larger Mt Bold reservoir and difference in River Murray pumping

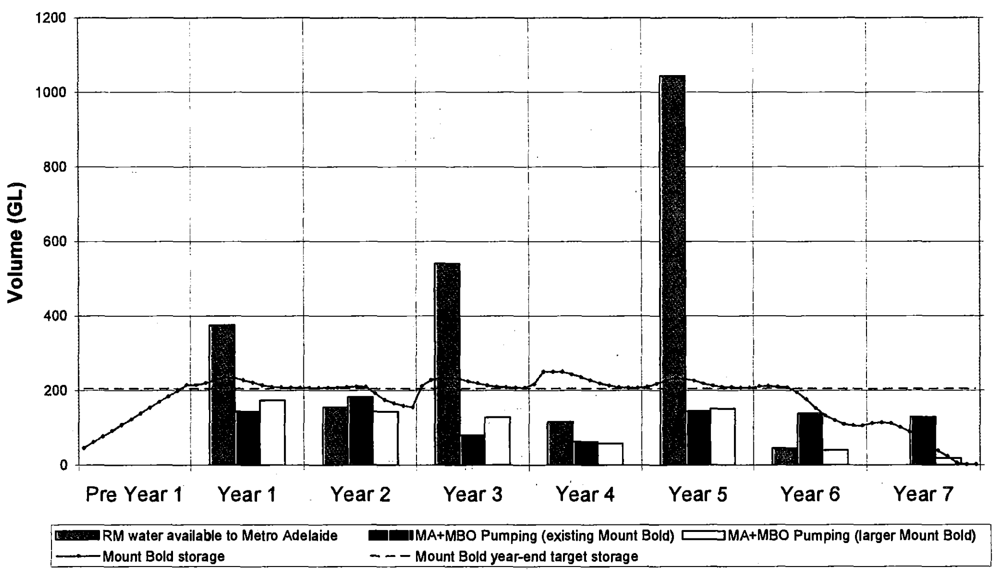

Chart 20: Larger Mt Bold and River Murray availability

Reservoir Operation

There would be little opportunity to harvest additional water from the Mount Lofty Ranges. The State Government has issued a notice of intent to prescribe the water resources of the Western Mount Lofty Ranges. As a result, in the near future it is likely that SA Water will be required to provide increased environmental flows in the Onkaparinga and Torrens Rivers (during non-drought years). Based on preliminary estimates of likely environmental flow requirements, it has been estimated that in an average year only an additional 6 GL of harvestable yield would be available from the Onkaparinga River catchment. However, additional storage in the Mount Lofty Ranges could serve as balancing storage for River Murray extractions. The additional storage could be filled from the River Murray when sufficient water is available to be extracted.

In years where South Australia's entitlement flow can be met and in wet years in the Mount Lofty Ranges, water could be extracted and pumped to storage in the Mount Lofty Ranges for use during dry years, when less than entitlement was available. Temporary entitlements could be purchased on the market to fill the storage if/when required. This would effectively 'bank' the water for use when required. Apart from the one-off fill of the reservoir, under average conditions no additional water would be extracted from the River Murray.

<u>Concept</u>

The full supply level storage capacity of Adelaide's reservoirs is currently 198 GL (although the usable volume is only around 155 GL). This is less than one year of unrestricted demand. Most interstate cities tend to have approximately three years of storage. With this in mind, Adelaide appears to have a relatively low storage capacity compared to annual demand. In the past, this has not been a major concern, because the River Murray has effectively provided the storage capacity that SA Water requires to provide security of supply. However, this does become a problem if there are very low Murray inflows.

To meet the theoretical worst case scenario (under current demands), the MAWSS Security Investigation highlighted an additional 200 to 250 GL of storage would be required.

The Mount Bold capacity increase option is discussed in detail in the Mount Bold Reservoir Capacity Expansion Scoping Study report[16]. This report highlights that it was deemed feasible to raise the capacity of the Mount Bold reservoir to provide a total storage of around 240 GL at the site, or an additional 194 GL above the existing storage. The scoping study report also identified a number of significant environmental issues particularly relating to the clearance of native vegetation, these issues are discussed in more detail in Section 6.

In the Mount Bold Scoping Study a brief review of the site geology was carried out to assess whether there are any geotechnical/geological issues that would raise concerns about the feasibility of the project. From the brief review it was concluded that there are no engineering issues that would prohibit construction and that the most appropriate form of dam at each location can only be determined after extensive investigations. However, at this stage, the form of dam selected was the concrete faced rock fill dam (similar to Kangaroo Creek and Little Para dams). This choice was influenced by the dam sites being in close proximity to the Willunga fault zone, a potential location for significant earthquake activity. Concrete faced rock fill dams generally perform well under earthquake shaking. Additionally with this type of dam separate spillways are required and the cost estimate of works required would be appropriately conservative. A concept plan of the reservoir civil works is shown in Chart 21.

[16] SA Water (2007). *Mount Bold Reservoir Capacity Expansion. Scoping Study. An option to improve the security of the MAWSS.* SA Water.

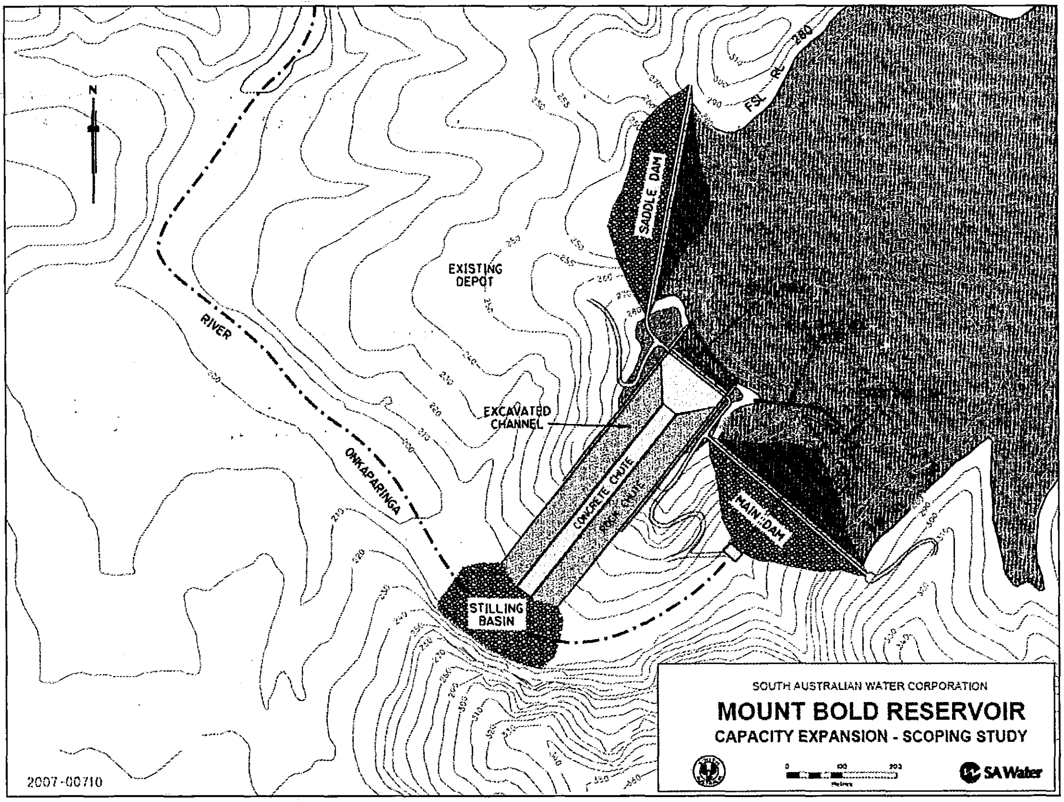

Chart 21: Mount Bold reservoir expansion concept plan for civil works

Geotechnical investigations are continuing to confirm the most appropriate dam design type. In addition, further work is being completed to determine the optimum height of the dam wall. Increasing the dam wall height above the currently assumed height will enable the storage of more water, but will also result in a considerable increase in the water spread and will result in a significant amount of land acquisition and greater environmental impacts. By the same token a lower height will reduce capacity (and the water security benefit), but also reduce the environmental impact.

The environmental issues regarding the Mount Bold expansion are covered in detail in Section 6. These environmental issues, which include the high quality of remnant native vegetation and the presence of species of conservation significance, together with outcomes of environmental investigation will also need to inform the feasibility assessments and the dam design.

The advantages of an upgraded Mount Bold reservoir over other Mt Lofty Ranges storage sites are:

- A substantial storage volume is obtained without the waterspread extending beyond the boundary of the existing reservoir reserve
- The storage is an enlargement of an existing reservoir that is already supplied directly from the MBO Pipeline (i.e. no additional works required to deliver River Murray water to the reservoir)
- The Murray Bridge – Onkaparinga pipeline has substantial pumping capacity.
- Within the reservoir reserve the topography of the Onkaparinga valley is deep and narrow which limits the additional waterspread area and hence

low evaporation losses and costs for clearing of vegetation required for the larger waterspread;
- Apart from the works required to retain the increased storage, no new works are required downstream to incorporate the larger storage into the existing Onkaparinga system.

The disadvantages of this site include:
- Sensitive environmental area
- Significant revegetation may be required

The increase in storage will require upgrades to water distribution infrastructure so that large volumes of water can be transferred within the water distribution system. In a severe drought event when the River Murray is not available, water would need to be transferred from the Happy Valley water treatment plant (WTP) system north towards the Hope Valley WTP, Anstey Hill WTP and Barossa WTP systems. These works will also provide benefits under normal operating conditions. Refer Section 4.3 for further discussion.

<u>Cost Estimate</u>
The cost estimate for the Mt Bold upgrade is approximately $1.1 billion. In addition, a $304 million inter-connector pipeline is required within the MAWSS enabling treated water to be transported between water treatment zones. This infrastructure is common between the desalination and Mt Bold options and is discussed further in Section 4.3.

There are components of the Mt Bold expansion cost estimate that may be subject to significant variability. One of the major risks to the project is the cost of revegetation. Specific issues are further discussed in Section 6. As shown in Table 9 the cost of land acquisition, clearance and revegetation is a significant percentage of the total cost.

The revegetation estimate is based on the requirement to provide a significant environmental benefit (SEB) under the *Native Vegetation Act* as a result of removing native vegetation. Around 470 Ha of native vegetation will require clearing to enable the upgrade. It is likely that an SEB will have to be provided in-line with legislative requirements. The cost of land acquisition for revegetation is one of the most significant cost elements of this project and may be subject to significant variability.

The SEB can be achieved in a number of ways including revegetation, providing for the management of other native vegetation, or the restoration of native vegetation in the region. Alternatively, an application can be made to the Native Vegetation Council to make a payment in the Native Vegetation Fund. The amount would need to commensurate the value of acquiring and revegetation the land.

Table 9: Mt Bold capacity increase cost estimate

Item	Cost (2007/08 dollars)
Engineering works	$530 m
Land acquisition, clearance and revegetation	$420 m
Miscellaneous	$160 m
CAPEX	**$1,110** m
OPEX	**$4 m**

Alternative sites

During the Mt Bold Scoping Study an assessment of different storage sites was undertaken. The Mt Bold option was selected for more detailed analysis because of the relative ease that it could be implemented. However, there are a range of environmental impacts associated with increasing storage at the site. These are discussed in more detail in Section 6.

A more detailed review of other possible reservoir sites throughout the Mt Lofty Ranges is being conducted. Most of the suitable storages sites are already in use. However, total storage can be increased across multiple sites in the Mt Lofty Ranges. Mt Bold was chosen as a site for the purposes of estimating cost and determining the water security benefits. These benefits will be transferable if a different storage location is found.

During the MAWSS Security Investigation, an additional storage of around 200 GL was found to have significant water security benefits to Adelaide's water supply. As discussed, this can be achieved in one location, but it could also be spread between the northern and southern parts of Adelaide's bulk water system. As shown in Chart 3, the MAWSS has two major pipeline systems (Mannum-Adelaide and Murray Bridge-Onkaparinga) that supplement supply from Adelaide's two major river systems (Torrens and Onkaparinga).

If 200 GL of storage is spread over the river systems then there may be benefits associated with less downstream connecting infrastructure and lower environmental footprint. For example, an increase of 100 GL at Mt Bold and an additional 100 GL of storage somewhere in the Torrens/Mannum-Adelaide system could achieve the same security benefit as a 200 GL increase at Mt Bold and a large interconnection pipeline between Happy Valley WTP and Hope Valley WTP. This option would also allow less native vegetation clearance. See section 6 for further discussion.

If a two storage solution is progressed then the interconnection pipeline between Hope Valley and Happy Valley WTPs would not be required. However, this pipeline delivers an additional operations benefit for contingency planning purposes because it allows the transfer of large quantities of treated water between Adelaide's major WTPs.

4.2 Additional Sources of Water

4.2.1 Purchase of additional water licences

Purchasing additional water licences would increase SA Water's share of the total water available and could potentially ensure that even when all users are subject to restrictions the allocation to SA Water would still be adequate most of the time.

The delivery of 50GL per annum of water to Adelaide via purchase of permanent water licences is a complex issue. Factors that need to be taken into account include:

- Permanent water licences may be subject to water restrictions such that only a percentage of the water nominally available under the licence is actually available in a particular year;
- The water available under the licence would presumably be purchased from an upstream holder. Flows in excess of the 50GL are needed to actually deliver the water to Adelaide to cover river losses (such as evaporation along the length of the river). In good years these flows would occur as a matter of course but in extreme years the flows may not be feasible;
- The purchase of large amounts of permanent water from, say, NSW irrigators may meet resistance.

Assessing the reliability of additional permanent water is difficult. Purchasing an extra 50 GL to off-set the impacts of reduced inflows in the Mt Lofty Ranges increases the average proportion of Adelaide's water supplied from the River Murray from 40% to 60%. This change reduces the need for water restrictions from 1 in 60 years to 1 in 30 years.

A more reliable supply can be achieved by purchasing a greater volume of water than needed on average. For example, if 200 GL is purchased in most years this will provide 50 GL of usable water. At the moment, this allocation would only give 32 GL under the current allocations for the River Murray in South Australia. However, in the worst case scenario there might be no water available from the allocation.

Having regard to the above factors, South Australia could purchase 200GL of permanent water licences. After allowing for some increase above current prices this could cost South Australia, say, $600 million. In a good year this would deliver 200GL of water to Adelaide. This would exceed requirements and it could be used to:

- Top up storages
- Add to environmental flows down the river
- Be sold as temporary water

In a dry year the full 200 GL may not be available due to water restrictions. Further, flows down the Murray may not be sufficient to transport at least 50 GL of water to Adelaide. The possibility remains that in some years this approach may not deliver an extra 50 GL from the river. To achieve the same reliability as a desalination plant, purchasing additional water allocations would need to be combined with an option for additional balancing storage, such as the Mt Bold proposal discussed in this chapter.

The cost of water from a desalination plant amortised over 25 years using a 6 per cent real discount rate is estimated to be around $2 per KL. In comparison, if 200 GL in water licences is purchased at a cost of $600 million and assuming that delivers 50 GL per year to Adelaide with a high degree of certainty, the cost of that 50 GL amortised over 25 years including pumping and treatment costs is around $1 per kL. In practice this overstates the cost, as there would be some offsetting revenue from sale of temporary water leases in years when Adelaide would have excess water.

The issue becomes whether paying $2/kL for water rather than $1/kL is justified by the higher certainty and diversification of supply from a desalination plant. Even assuming that a 200 GL acquisition of permanent water entitlements were feasible, in a drought year when it is really needed, the enforceability of so called 'entitlements' may be in question. This would especially be the case if Adelaide were seeking to use the entitlements for more than critical urban supply ie if it were proposed to avoid outside water restrictions.

4.2.2 Desalination

Investment in desalination plants is seen to be the solution to water supply problems around the world in locations such as California, Spain, Singapore, the Gulf states and in Australia a plant is now operating in Perth. New large-scale desalination plants are being constructed on the Gold Coast in Queensland and Botany Bay in NSW, while plants are also proposed for the Bass Coast in Victoria and a second plant for Perth near Binningup. There are estimated to be around 2,000 desalination plants worldwide with several hundred of these being of the scale proposed for Australia.

Technology

All plants being constructed or proposed in Australia use reverse osmosis as the desalination process. Reverse osmosis is currently considered to be the most energy efficient technology. Many of the plants constructed in the Middle East use thermal processes which use much greater amounts of energy per unit of water produced, but more recent plants have been based on reverse osmosis technology.

The Ashkelon reverse osmosis plant in Israel (330 ML/d capacity) is reported to have a total power consumption of around 4 kWh/kL water produced compared to the Taveelah multi-effect distillation (MED) plant in the United Arab Emirates (240ML/d capacity) which has a total power consumption of 10 kWh/kL if heat and electrical energy is considered[17]. The Taveelah plant is considered to be one of the most energy efficient thermal plants in the world and requires more than double the energy of one of the most efficient RO plants.

Thermal plants are generally coupled with a power station and use the heat energy produced through power generation to make a thermal desalination process more efficient. This process is referred to as cogeneration. However, the most efficient power stations produce low temperature steam at 35 to 40°C which is inadequate for thermal distillation[17]. It is often more cost effective to produce power and water separately using reverse osmosis instead of coupling a thermal plant to a power generation facility.

[17] Voutchkov, N. (2007). Distillation, Ion Exchange and Electrodialysis. *DBOOT Desalination Master Class. Australian Water Association. Adelaide 13 – 14 September 2007.*

If a cheap source of fuel is available, the thermal process can be cost effective especially where power and water are co-generated. Thermal plants are also used when very high quality water is needed. Thermal systems are generally considered to be easier to maintain than reverse osmosis and are often employed in locations were there are low maintenance requirements or a shortage of skilled operators. This is unlikely to be an issue in Adelaide.

GHD were engaged to investigate the feasibility of cogeneration desalination plants for Adelaide[18]. As part of this investigation, a discussion of thermal desalination technologies was included. GHD (and sub-consultants Fichtner) concluded that the most efficient technologies for large-scale desalination are reverse osmosis (RO) and multi-effect distillation with thermal vapour compression (MED-TVC). These technologies are likely to replace many older technologies in the near future. GHD and Fichtner also concluded that RO should continue to be the preferred technology in Australia because of:

- Lower energy requirement than thermal processes and less greenhouse gas emissions
- Less environmental impact as thermal plants discharge warm brine to the receiving environment
- Some thermal plants discharge metals (ie copper) in the brine (concentrate) discharge
- Better seawater conditions in Australia than the Arabian Gulf (where thermal plants are better suited to the poorer seawater quality)

A cogeneration facility also introduces significantly greater complexity to the project. Producing desalinated water from a cogeneration facility relies on fully operating power generation turbines that produce both waste heat and electricity that drives the desalination process. This process is inextricably linked to the energy generation process and therefore producing water is dependent on producing electricity on-site. Introducing power generation into a desalination project significantly raises the risk profile of the project.

Chart 22 shows a process flow sheet for a typical RO plant. This is a basic representation of the preferred desalination technology for Adelaide.

[18] GHD and Fichtner (2007). *Report on Feasibility Assessment of the Use of Cogeneration for Large Scale Desalination Plants for Adelaide (Draft Report).* GHD and Fichtner for SA Water

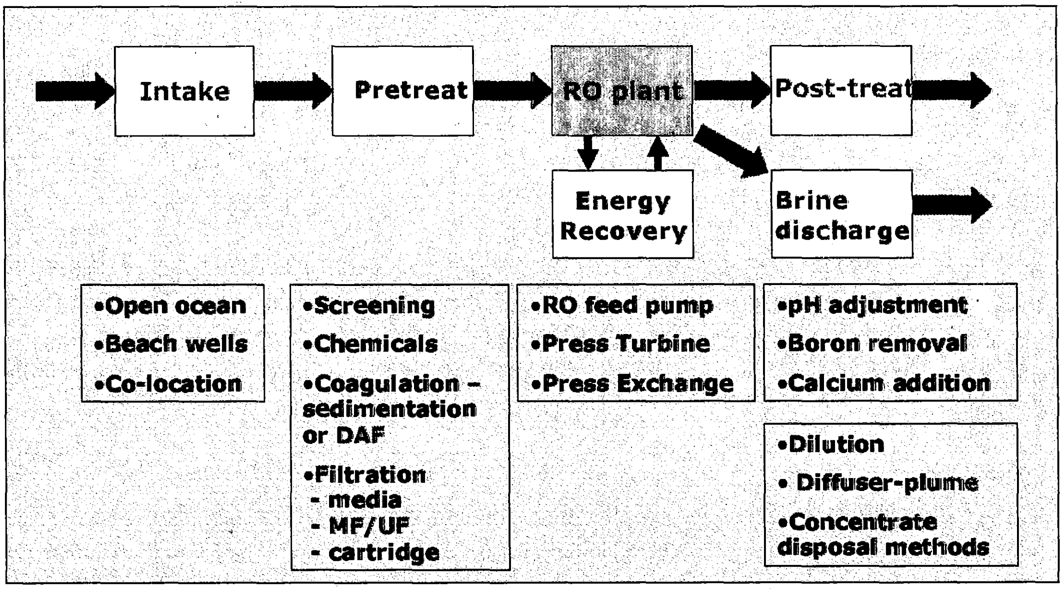

Chart 22: Generic flow sheet for a typical RO plant[19]

Plant Size

In a low probability but high impact drought event, there may be little water available for extraction from both the River Murray and Mt Lofty Ranges. The MAWSS Security Investigation showed that to 'drought-proof' Adelaide by desalination alone, a plant producing around 100 GL per year would be required to ensure supply. This is considered to be a heavy handed response to managing existing climate variability.

A smaller plant of 50 GL per year would deliver water security benefits on its own. However, on its own a 50 GL plant may not provide enough capacity to manage climate variability. In an extreme drought situation, other measures may still be required. If a 50 GL plant was built it would be prudent to construct ancillary infrastructure for an ultimate plant capacity of 100 GL to allow for future expansion. Environmental approvals should also be obtained for the ultimate plant size.

Comparison to the Kwinana, Perth RO plant

A comparison with recently commissioned plant in Perth, which is often used to argue the case for a desalination in Adelaide, provides both a good way of understanding the issues that need to be considered and illustrates the fact that the Perth plant is not a good basis for comparison with Adelaide.

The Perth plant is located on the shores of Cockburn Sound amongst existing heavy industry that has probably in the past degraded the marine environment; it is adjacent to a power station and close to Perth's existing water infrastructure. The marine environment in Cockburn Sound has been researched for many years, it is not an important fishery, and the Sound has access to the Indian Ocean and is subject to movement by coastal currents. The Western Australian Water Corporation carried out two years of environmental assessment studies prior to a commitment to desalination. Whilst the plant is connected to the electricity grid (i.e. it gets its

[19] Fane, T. (2007). Introduction to Reverse Osmosis & Membranes. *DBOOT Desalination Master Class, Australian Water Association, Adelaide, 13 -14 September 2007.*

electrons from the plant next door) the plants CO_2 impact is offset by a wind power facility elsewhere in WA.

The Perth plant is also base load water supply because the decline in Perth's supply from existing sources means that it is desirable to run the desalination plant year round.

In Adelaide by comparison, the Gulf St Vincent is a commercial and recreational fishery and fish breeding ground, the water movements in the Gulf have not been extensively studied and the most recent studies indicate water interchange issues so that brine dispersion will require careful analysis and design to avoid environmental damage[20].

General

Rather than disposing of the desalination plant concentrate (brine), one often cited end-use for the desalination plant waste stream (concentrated brine) is as a feed for a salt processing facility. However, the evaporation basin area required for a 50 GL/a desalination plant is estimated to be approximately 6,400 Ha (assuming a net evaporation rate of 950 mm per year). This is around 8 times larger than the salt pans at Dry Creek. Therefore, a significant area of land would need to be reclaimed for this purpose.

As noted earlier, Adelaide's water supply is relatively secure except in infrequent severe droughts and the continued use of water from the River Murray is an ongoing option. Thus operationally a desalination plant need not be base load supply. However, desalination plants and associated infrastructure have high fixed costs around 50% capital and significant, fixed, unavoidable operating costs so that up to 70% of the costs are incurred whether, or not, the plant is used. In these circumstances it is possible to use a desalination plant for peaking supply as "water security insurance" but the cost per kilolitre for water to consumers is significantly increased. Most desalination plants are operated as base load supply for this reason. Chart 23 provides a graphical breakdown of the range of the components of the water production costs in a desalination plant.

[20] The conditions in the Upper Spencer Gulf are very different in the region where BHP-Billiton have proposed to construct a seawater desalination plant. Developments such as the Port Bonython gas facilities, Whyalla Steelworks and fisheries have required a much greater understanding of marine conditions in Spencer Gulf than gulf St Vincent. Thus Spencer Gulf is better understood to allow environmental impact assessment and design to proceed.

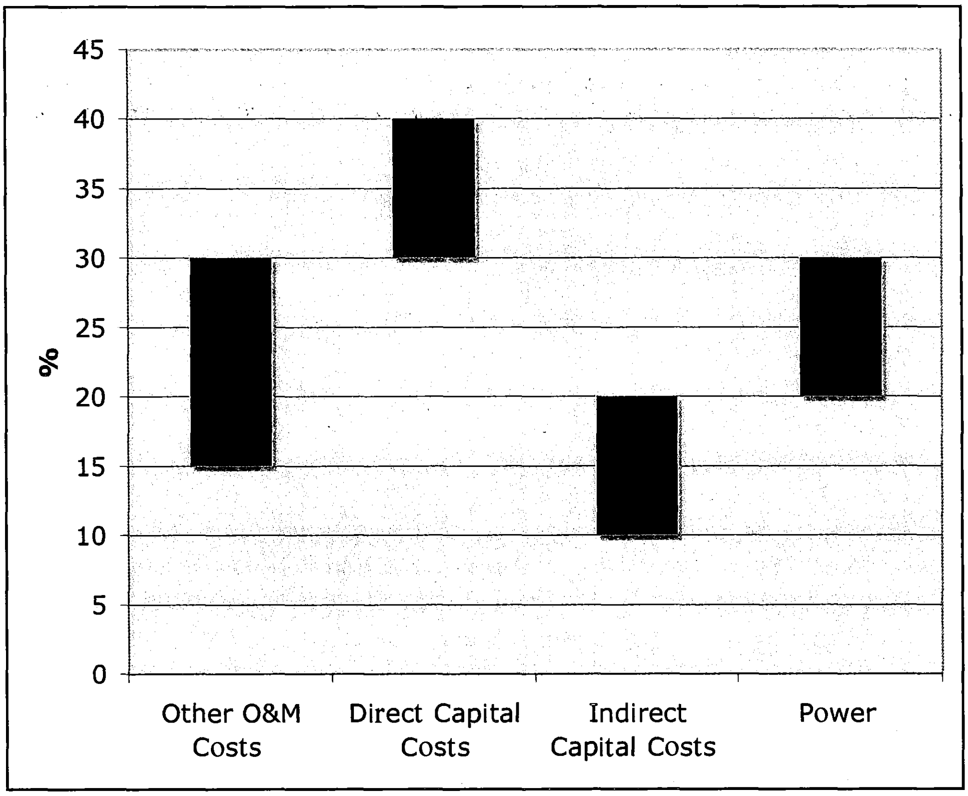

Chart 23: Cost of water production from RO plant[21]

Water Quality

The water quality of desalinated water is generally expected to be better than water from existing sources. This can cause problems with operating the distribution system throughout the year due to changes in the salinity as the percentage supplied from different sources is varied.

There will be times throughout the year where the distribution system in the Happy Valley WTP zone only receives desalinated water and other times when it will be supplied with blended water from the desalination plant and the Happy Valley WTP. Over time customers become conditioned to the water quality they receive and any change in quality may be noticeable and result in complaints.

There is no adverse health affect associated with varying salinity levels.

Location of plant

A multi-criteria analysis (MCA) of twelve possible locations to integrate a desalination plant into the metropolitan Adelaide water supply system was undertaken. The analysis considered a range of sites and the associated issues and feasibility of constructing a desalination plant. Sites considered stretched along the Adelaide coast of Gulf St Vincent and a South Coast location near Victor Harbor[22].

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[21] Adapted from Voutchkov, N. (2007). Estimating desalination plant costs. *DBOOT Desalination Master Class. Australian Water Association, Adelaide, 13 – 14 September 2007.*

[22] SA Water (2007). *Site Selection Investigation.* SA Water for the Desalination Working Group

The sites considered (from north to south) were:

- Port Parham
- Bolivar (on existing SA Water land)
- Torrens Island (close to power station)
- Pelican Point (close to power station)
- Fort Largs (on existing government land)
- West Beach (near the airport)
- Marion (near Marion Quarry)
- Port Stanvac (near refinery)
- Sellicks Beach
- Myponga
- Rapid Bay
- South Coast (near Waitpinga)

The main drivers of this investigation were to assess locations based on potential environmental impact of seawater intake, brine outfall and cost to connect the plant into the water supply system. Criteria addressed a range of issues including:

- Proximity to coastline, site size and elevation
- Current landuse
- Offshore marine environment and dispersion properties
- Environmental issues at plant site
- Site elevation
- Likely availability of power
- Ease of integration with existing water infrastructure

The siting study concluded that while seawater was generally deeper at sites to the south of Pt Stanvac (ie around Myponga) there were concerns over potential influence of the Myponga eddy in this region which could severely limit the movement and dispersion of brine. The cost of constructing infrastructure in southern areas to transfer water back to Adelaide was also much more significant than locations to the north of Pt Stanvac.

Based on preliminary cost estimates in the Siting Study, it was estimated that the ancillary infrastructure (ie everything expect the treatment components) would be around double that required for Pt Stanvac, not including the provision of electricity which is likely to be substantial given the isolated location. Operating costs would also be approximately double because of the distance from the Happy Valley water treatment plant system.

Seawater depth significantly decreases from Pt Stanvac north along the Gulf and is associated with poor marine dispersion characteristics. This has substantial ramifications for length of seawater intake and brine outfalls for areas north of Pelican Point. Many kilometres of outfall and intake may be required in locations to the north of Pelican Point to achieve the required brine dispersion. Based on experience, consultants have recommended that the brine outfall would need to be located in a minimum water depth of 10 metres. This depth is much easier to achieve at Pt Stanvac than the northern sites.

As a result of the MCA of plant sites, three nominal locations were chosen for further assessment:

1. Pt Stanvac (near the Mobil refinery)
2. West Beach (near Adelaide Airport)
3. Pelican Point (near power station)

Subsequent to the siting study, United Water (UW) were engaged to estimate the cost of constructing a seawater desalination plant at three preferred sites[23]. It should be noted that these locations do not represent the exact preferred location of a desalination plant and further work is required to determine precise sites that could be acquired at each nominal location, the feasibility of actually acquiring the site and specific environmental constraints and associated site costs such as remediation. This is of particular importance with regards to the Pt Stanvac site.

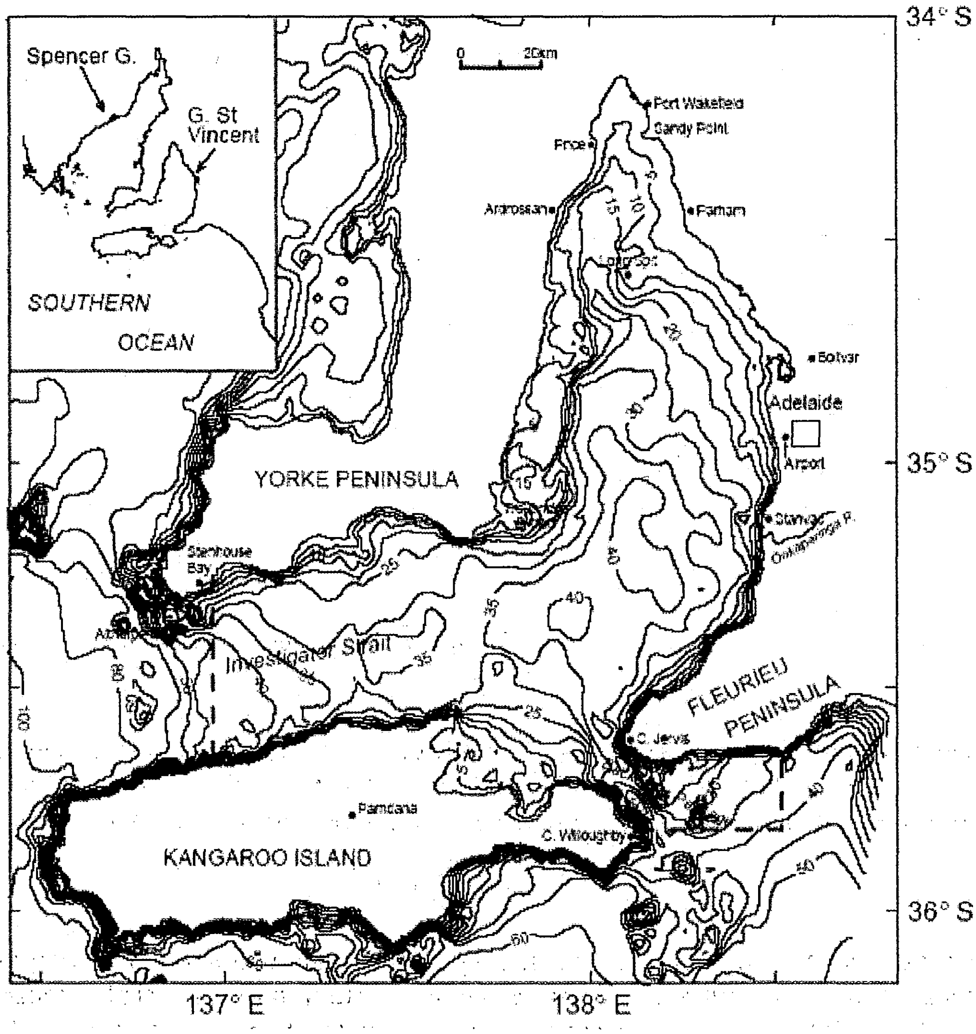

Chart 24: Bathymetry of Gulf St Vincent[24]

[23] UWI (2007). *Desalination Plant for Adelaide Water Supply. Volume I: Scoping Study Report (DRAFT).* United Water International (UWI) for SA Water

[24] de Silva Samarasinghe, J. R etal. (2003). Modeled response of Gulf St Vincent (South Australia) to evaporation, heating and winds. *Continental Shelf Research.* Pergamon, 23, 1285-1313
(Referenced in Pattiaratchi, C et al. (2005). *Physical and oceanographic studies of Adelaide coastal waters using high resolution modelling, in-situ observations and satellite techniques – PPM 2 Sub Task 4 Draft Final Technical*

The plant locations are shown in Chart 25, Chart 27 and Chart 29. There are a range of issues related to each site. The following section summarizes the main findings from the reports.

Pt Stanvac site

The Pt Stanvac site itself is located atop cliffs approximately 50 metres above sea level. Because of the location, the energy consumption of this plant is greater than it would be at other sites. This is because around 340 ML/d of raw seawater must be pumped 50 metres above sea level for processing to produce 152 ML/d of potable water (based on a membrane recovery rate of around 45%). However, because of the height above sea level, less pumping is required to transfer treated water into the water supply system.

The brine disposal outfall is typically required to be in a minimum of 10 metres of seawater to achieve adequate mixing. The area around Pt Stanvac is characterized by relatively deep water, which means the outfall should only be relatively short at around 900 metres, compared to the other sites. However, brine dispersal modeling and environmental characteristic investigations are required to confirm the actual length of outfall required to ensure that there will be no adverse environmental effects in the near-shore zone or nearby reef or sea grass habitats.

The Pt Stanvac site is currently occupied by the Mobil refinery. The area to the north of the refinery is considered to be suitable but there are known indigenous heritage issues related to the area and a cultural heritage study will be required to identify the extent and nature of any issues in more detail.

The location shown in Chart 25 is indicative only.

Report. ACWS Technical Report No. 8 prepared for the Adelaide Coastal Waters Study Steering Committee. Centre for Water Research, University of Western Australia.)

Chart 25: Nominal Pt Stanvac site

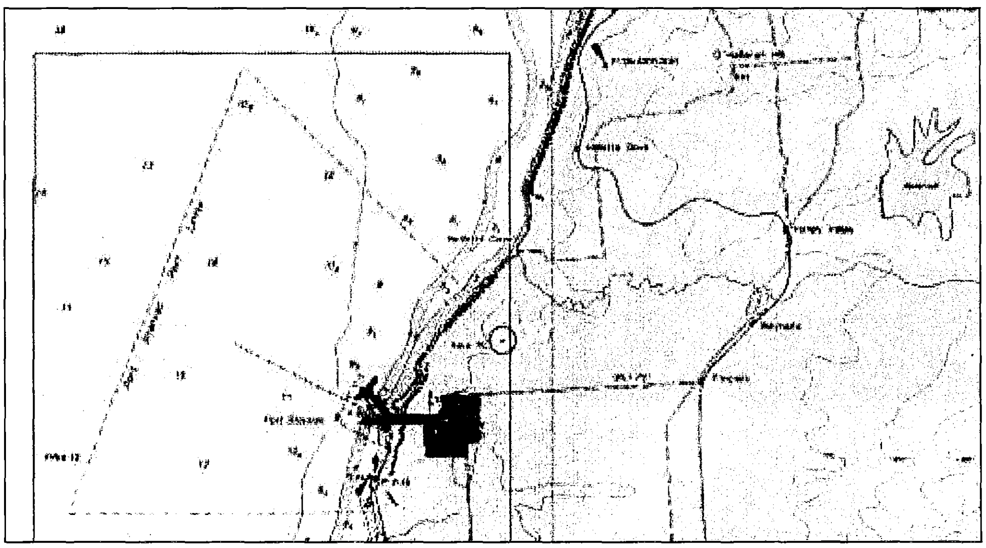

Chart 26: Nominal Pt Stanvac plant intake and outfall

West Adelaide site

The West Beach site is constrained by the proximity of the airport and residential areas. A portion of the nearby golf course would need to be acquired to achieve the 20 Ha area required for the plant. The site shown in Chart 27 is a nominal location only. However, it should be noted that the site is partially located on land owned by the Commonwealth and set aside for a possible second runway for Adelaide Airport. The proximity of this site to sensitive landuse, including residential areas would require significant focus and careful management of environmental issues such as noise and aesthetics.

The seawater intake and outfalls will need to be considerable length at this location to achieve the required seawater depth. In addition to this, given the residential areas on the shoreline, the intake and outfalls will need to be tunneled under the residential areas at substantial cost.

The site is also located near the Barcoo Outlet which may result in the requirement for additional pre-treatment to deal with increased suspended solids and turbidity after storm events.

Given the above, the West Adelaide site has the highest capital cost of the three sites.

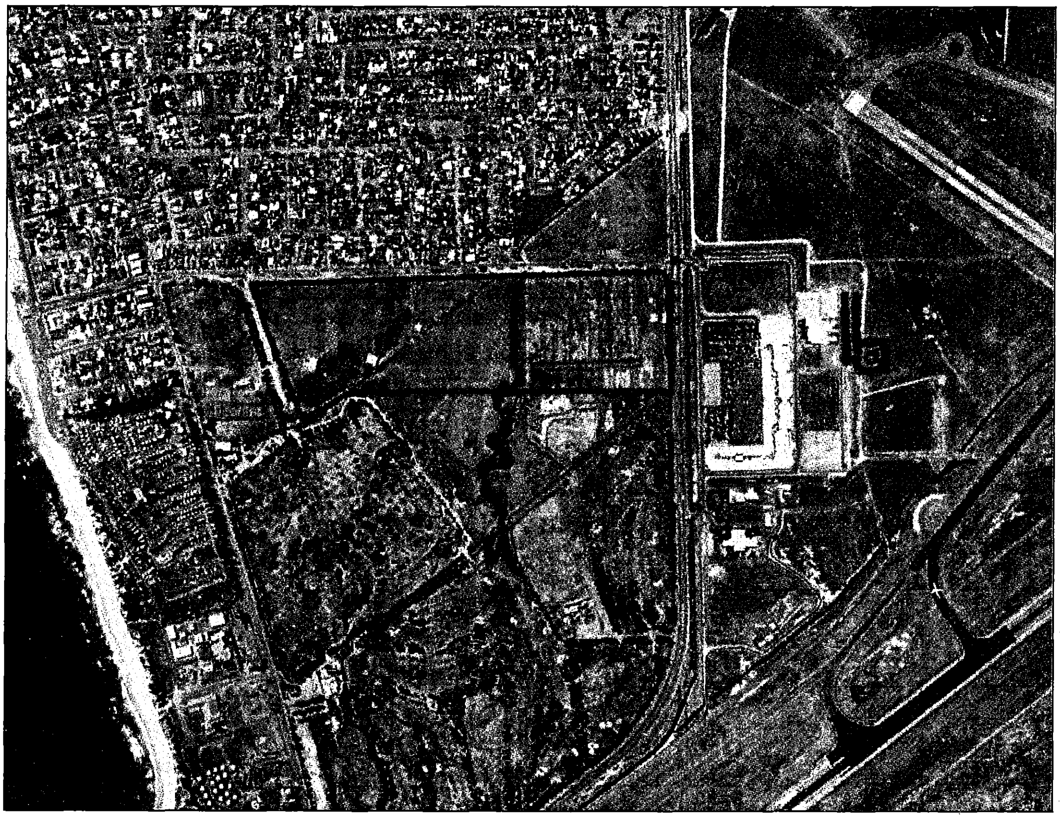

Chart 27: Nominal West Adelaide site

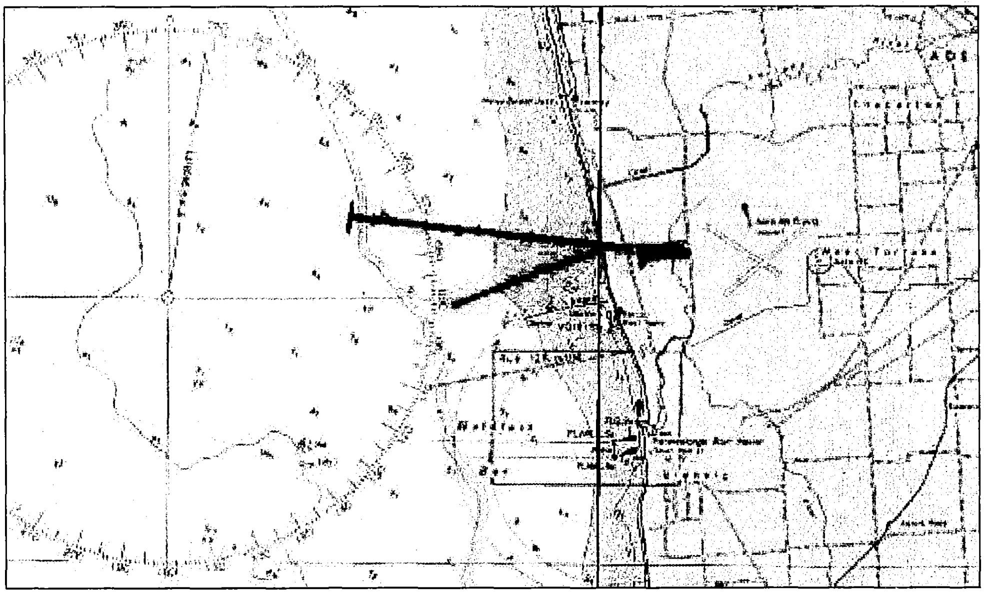

Chart 28: Nominal West Adelaide plant intake and outfall

<u>Pelican Point site</u>

Pelican Point is located near the Pelican Point power station. The seawater intake is located in the Port River estuary, which means that the intake pipeline is relatively short and therefore low cost. However, the water quality in the estuary is variable and a greater level of pre-treatment is required at this site compared to the other two. This results in additional capital and operating cost.

The Pelican Point area is relatively shallow. This has resulted in a significant length of tunneled outfall to achieve the minimum 10 metre water depth.

The distance from Pelican Point to the bulk water distribution system is also significantly greater than the other two sites, which has resulted in additional system integration costs.

The Pelican Point area is reclaimed swamp land and is not engineered fill. All sites are estimated based on having piled foundations. However, there exists an additional construction risk at the Pelican Point site.

There are also known sites of indigenous cultural significance within the area.

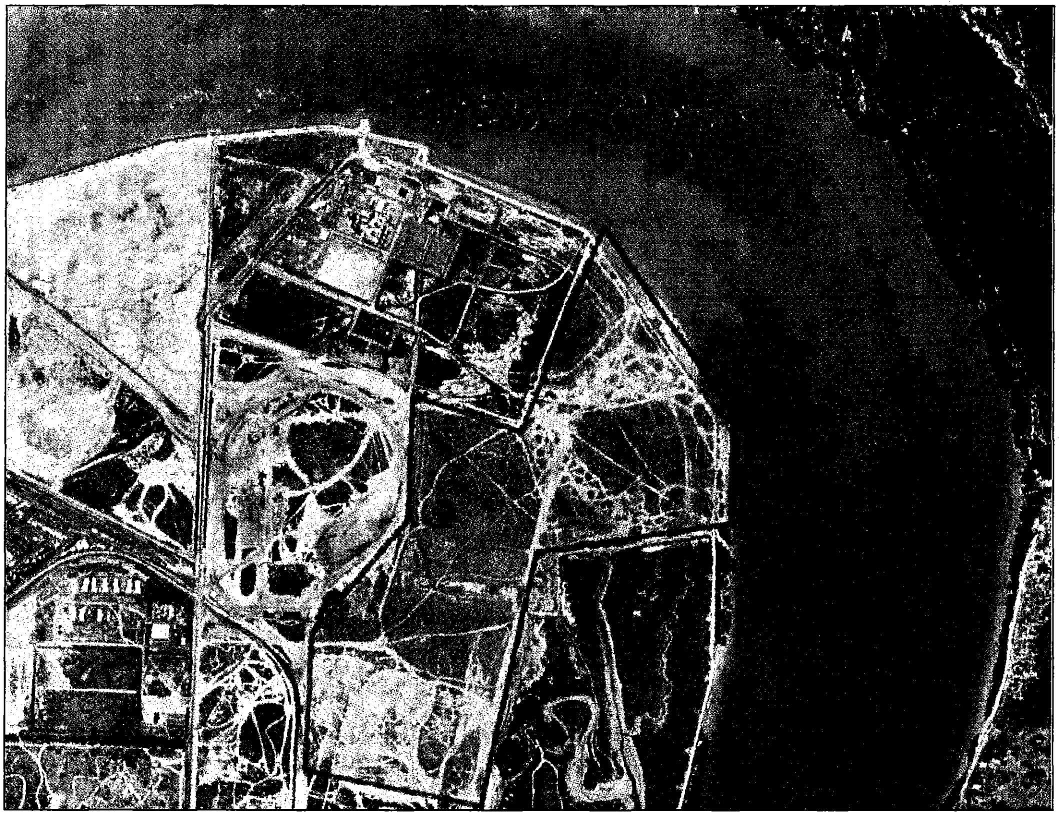

Chart 29: Nominal Pelican Point site

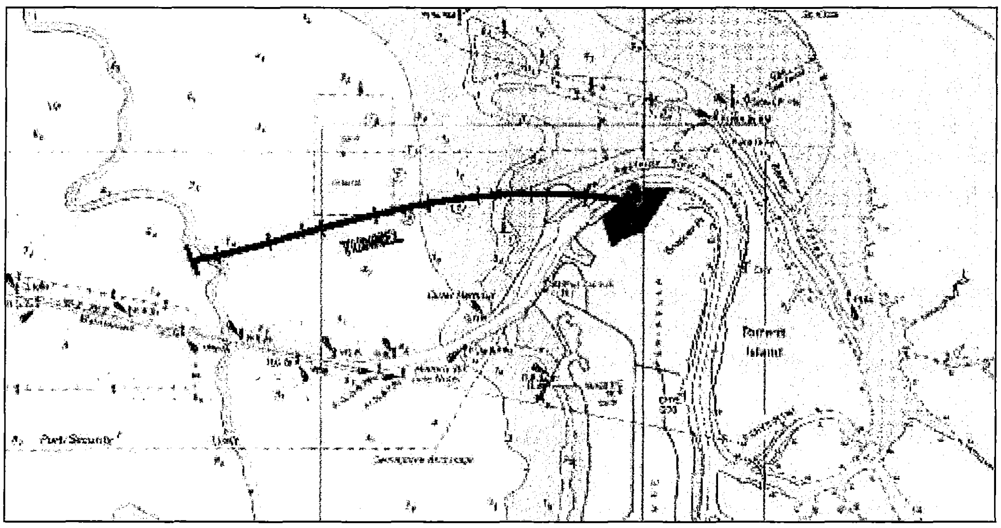

Chart 30: Nominal Pelican Point plant intake and outfall

<u>Preferred location and cost estimates</u>

The preferred location is Port Stanvac, refer to Table 10 for details. This site is the most cost effective, but also represents the best balance between environmental considerations, proximity to the bulk water distribution system and suitable land use. However, more detailed investigations are required to confirm the feasibility of land acquisition from Mobil, site remediation costs and environmental constraints on the brine discharge. Consideration should also be given to allow the procurement process to include the Pelican Point site as an alternative location.

Based on the three sites that were assessed, United Water conducted a multi-criteria analysis based on technical, social and environmental criteria and determined that the preferred site was Pt Stanvac. Out of a possible score of 100, Pt Stanvac rated 80, Pelican Point 73 and West Beach 66.

A 50 GL plant to supplement Adelaide's water supply is likely to cost $1,097 million (comprising $1,007 million for the plant and approximately $90 million for a pipeline from the plant to the bulk water distribution system). It is expected that the net annual operating cost would be around $46 million (including the purchase of green power to offset greenhouse gas emissions and cost savings made from less Murray pumping and conventional treatment).

The cost for a 50 GL desalination plant at Pelican Point is approximately $480 million greater than the cost of a desalination plant at Pt Stanvac. However, there would be some savings with the cost of the north-south system integration works as proposed in Section 4.3. Even with the full integration works considered, the total cost of the Pelican Point option is still around $360 million more than the Pt Stanvac option. Refer Table 10 for cost breakdown.

All scoping study designs for a 50 GL desalination plant have been estimated with respect to ease of upgrade to 100 GL. Several components have been sized for the ultimate capacity, including:

- The pipeline and pump station connecting the Pt Stanvac plant to the water distribution system at Happy Valley
- Land area
- ETSA upgrades
- Most of the intake and outfall (around 90% on a cost basis)
- Drinking water storage

The incremental cost to increase the Pt Stanvac plant to 100 GL plant has been estimated at a cost of around $520 million for the plant plus $304 million for the system integration works. This integration works are discussed in more detail in Section 4.3.

Table 10: Cost of a 50 GL per annum seawater desalination plant at three Adelaide sites

Item	Pt Stanvac (2007/08 dollars)	West Beach (2007/08 dollars)	Pelican Point (2007/08 dollars)
Desalination plant CAPEX	$1,007 m	$1,386 m	$1,334 m
Integration CAPEX	$90 m	$261 m(1)	$242 m(2)
Total CAPEX	**$1,097 m**	**$1,647 m**	**$1,576 m**
Desalination plant OPEX	$38 m	$35 m	$39 m
Integration pipeline OPEX	$4 m	$5 m	$8 m
GreenPower Premium	$12 m	$11 m	$13 m
Savings from major pumping and treatment	-$8 m	-$8 m	-$8 m
Net OPEX	**$46 m**	**$41 m**	**$52 m**

(1) Comprises $187m for the north-south inter-connector pipeline and a further $74m to connect the plant to this pipeline. This option includes some of the works required for system interconnection (see Section 4.3). Therefore, only an additional $117m is required to achieve system interconnection (compared to $304m).
(2) This option includes some of the inter-connection works (see Section 4.3). Therefore, only an additional $187 m is required for system integration (compared to $304 m).

4.2.3 Indirect Potable Re-use of Wastewater (hypothetical)

The Desalination Working Group considered it necessary to undertake some analysis of the potable re-use of wastewater, while also being aware that the South Australian Government's policy clearly precludes it as an option for human consumption. It was the view of the Working Group that some analysis was required to 'benchmark' potable re-use against other options. In particular, the concept of recycling treated wastewater for potable use is frequently cited in the popular media as an option for supplementing the water supply of cities and to reduce the environmental impacts of waste disposal. Potable re-use also was raised as an option at one point by the Commonwealth Government, and could be raised again in the event of discussions about funding water infrastructure or if environmental approvals are required from Commonwealth agencies.

The treatment of wastewater to potable standards to supplement water supplies is a strategy adopted in several places around the world, and is proposed in Queensland and the ACT. In addition to the fact that potable re-use is not SA Government policy, there are a number of factors that militate against this option. For comparison purposes only, this section of the report sets out these factors by considering the issues associated with an hypothetical indirect potable re-use scheme.

The existing wastewater treatment plants were developed in an era when recycling of wastewater for drinking purposes was not a conceivable option. Thus existing plants (such as those at Bolivar and Christies Beach) that are able to deliver water of adequate quality for agricultural use would require substantial upgrading.

Planned indirect potable schemes must include a reverse osmosis stage similar to that employed in desalination plants to ensure water quality. The main advantage over a seawater desalination plant is that the input water has a significantly lower concentration of salts than seawater so the processing costs can be more competitive than a seawater desalination plant. However, it is considered essential that treated wastewater not be delivered directly into the distribution system but is fed into storage for mixing with other water for a holding period of at least six months[25] so that the risk of system failure is significantly mitigated (hence it is often described as indirect potable recycling (IPR).

Managing public perceptions of an IPR scheme would be a significant challenge. The IPR debate that occurred in Toowoomba during 2006 and San Diego in 1999 showed that there are likely to be some elements of the community that are vehemently opposed to IPR. An aggressive 'toilet to tap' campaign was encountered in both Toowoomba and San Diego, which ultimately led to both projects being shelved. Regardless of how well planned any communications strategy may be, there is likely to be widespread opposition to IPR.

General Considerations

About 20% of the existing wastewater stream is diverted for open space or agricultural irrigation from the Aldinga, Christies Beach, Glenelg and Bolivar wastewater treatment plants. Implementation of projects to achieve the re-use targets in Water Proofing Adelaide will see this increase to 45%.

Increasing usage of recycled water using dual reticulation in locations with relatively easy access to the treatment plants may relieve demand on potable water or raw bulk water supplies and have a greater net benefit than recycling to potable standards. More generally, increased use of wastewater in non-potable applications that reduces demand on potable sources is a desirable long-term objective. This can be achieved in the urban sector (ie substitution for open space irrigation). However, if agricultural irrigators using bulk raw water supplies can be encouraged to relocate to the recycled water schemes in the Willunga Basin and Virginia, there may exist an opportunity to substitute large volumes of recycled water for bulk potable water via the agricultural sector. The main benefit for irrigators using recycled water sources is that they can achieve a high level of water security and are not subject to harsh water restrictions.

Risks

One of the main components of cost in an IPR scheme is the transfer of water into balancing storage to achieve the six month environmental buffer. There are advocates of the direct feed of treated water into the distribution system, proposing that treated water directly from the plant would meet health standards. However, that is likely to encounter public resistance and is considered by some scientists to introduce an unacceptable risk of epidemics caused by bacterial infections. An examination of major water quality incidents in developed countries indicates that the largest risk may well be human error rather than the failure of technology.

[25] GHD (2007). *Using Recycled Water for Drinking – An Introduction. Waterlines Occasional Paper No. 2, June 2007*. GHD on behalf of the National Water Commission, Canberra.

There is also some risk associated with the removal of endocrine disrupting compounds (EDCs[26]) in conventional wastewater treatment processes. While, the removal efficiency of EDCs through advanced treatment technologies such as reverse osmosis is greatly improved, some chemicals are known to pass through membranes, albeit at very low concentrations[27]. Most of these chemicals are thought not to have any negative health impacts on humans. However, national and global research capability needs to be increased in this area before it can be unequivocally stated that all EDCs are removed in advanced membrane treatment processes such as reverse osmosis.

A recent report published by the National Water Commission indicated that only one example of direct potable recycling could be found, in one small town in Namibia[28]. The Water Services Association of Australia (WSAA) also concludes that there is a significantly greater level of risk associated with direct potable recycling and that this is at variance to the 'multiple barrier' approach to maintaining drinking water quality because no natural environmental buffer is provided[27].

Treatment of wastewater to a potable quality for use in IPR would produce a concentrated waste stream, which will require further treatment before discharge into Gulf St Vincent. One often quoted benefit of IPR is that the nutrient load to Gulf St Vincent would be reduced, which would have many benefits for sea grass meadows and marine organisms. However, in treating wastewater to potable standards, salt and nutrients are concentrated and removed from product water. A conventional activated sludge plant is required to further treat the water prior to disposal.

Hypothetical IPR Concept for Adelaide

For the purpose of estimating the order of cost for IPR, a hypothetical IPR scheme for Adelaide has been examined. The estimate was based on collecting treated wastewater from the Bolivar activated sludge, Bolivar high salinity and Glenelg wastewater treatment plants and treating to an advanced level using additional pre-treatment, RO membranes and post-treatment of the concentrate (brine).

The target detention time of six months could be achieved by transporting the 50 GL of highly treated water to three of the larger reservoirs, at Little Para, Millbrook and Mt Bold.

To produce 50 GL of potable water, around 65 GL of effluent is required. This is due to the treatment efficiency of brackish RO being approximately 75% overall. The maximum effluent volume available from SA Water's metropolitan wastewater treatment plants is currently around 78 GL. However, by 2031 this volume is expected to fall to 73 GL due to ongoing expansion of existing reuse schemes based at

26 An EDC is a chemical (eg pharmaceuticals) that when taken up by an organism affects the actions of hormones and can disrupt physiological processes.

27 WSAA (2006). *Refilling the Glass. Exploring the issues surrounding water recycling in Australia. WSAA Position Paper No. 02, November 2006.* Water Services Association of Australia

28 GHD (2007). *Using Recycled Water for Drinking – An Introduction. Waterlines Occasional Paper No. 2, June 2007.* GHD on behalf of the National Water Commission, Canberra.

Virginia, Willunga Basin and Glenelg (including the recently announced Glenelg to Adelaide Park Lands scheme).

The hypothetical IPR concept scheme did not include Christies Beach wastewater treatment plant due to the additional length of main required to connect this plant to the scheme. Given that it would not produce significantly greater volumes of available water (largely due to the Willunga Basin reuse scheme), inclusion of this plant was not warranted.

Table 11: Cost for hypothetical IPR scheme for Adelaide

Item	Cost **(2007/08 dollars)**
Treatment CAPEX	$525 m
Integration CAPEX (pipelines, pump stations, etc)	$420 m
Total CAPEX	**$945 m**
Treatment OPEX	$32 m
Integration pipeline OPEX	$14 m
GreenPower premium	$4 m
Savings from River Murray pumping	-$6 m
Net OPEX	**$44 m**

The cost breakdown provided in Table 11 shows that costs are comparative with seawater desalination. This option theoretically makes better use of existing water sources by closing the loop on the urban water cycle. However, it is not a new source of water.

The cost of IPR is comparable to seawater desalination. However, given the risks associated with human error, removal of EDCs and the likely difficulties in managing public perception, the Desalination Working Group confirms that recycled water is best used for non-potable purposes, in-line with Government policy and current practice, and the targets of Water Proofing Adelaide.

4.2.4 Large-scale Stormwater Harvesting

The capture, storage and re-use of stormwater, as a potable water supply is an important source in many places around the world. A good example of stormwater usage is Singapore, where extensive stormwater catchments schemes operate, including the water falling on Changi Airport. It is not a cheap source of water; in Singapore's case it is important for water security reasons rather than cost.

There are good examples of smaller scale stormwater management in the northern suburbs of Adelaide, especially the Salisbury Council area.

There is an almost intuitive appeal in the notion of recycling stormwater that (as a potable water source) is not always justified by the facts. There are inherent difficulties with stormwater as a major source of potable water for Adelaide; the infrequent rainfall, the dispersal of stormwater systems, and the infrastructure cost of collection, treatment and connecting into the distribution system makes stormwater an expensive source of potable water.

Stormwater is often polluted, particularly the first-flush, so the treatment to potable standards is a non-trivial cost.

Generally, stormwater harvesting schemes such as the one at Parafield sources its water from an urban catchment and can contain a variety of contaminants. Stormwater is detained and treated in wetlands or reed bed basins which reduce most of the contaminants to levels that enable storage within suitable aquifers. As stormwater occurs in abundance during the winter months, it generally must be stored for use throughout the year. This is referred to as aquifer storage and recovery (ASR).

To potabilise stormwater, additional treatment is required after extraction from the ASR bores to ensure public health and allow the water to enter the water supply system.

Stormwater for non-potable use should be pursued in-line with the recommendations in WPA. Non-potable stormwater use will prevent the need for water restrictions where practiced and will reduce potable consumption. However, stormwater is a climate dependent water source. In drought years sufficient volumes of stormwater may not be available and in extreme cases affected stormwater users may want a back-up supply from the mains water supply system. In this circumstance the benefit to water security of non-potable stormwater use becomes marginal.

Risks

The Walkerton water quality incident occurred in May 2000 in Ontario, Canada[29]. Seven people died and an estimated 2,300 became ill due to bacteriological contamination of the township's drinking water supply. There were a variety of reasons why the event was so serious. Principally, the reason it occurred was that the township's source water (the groundwater system) became contaminated due to polluted surface water runoff. This event showed the importance of maintaining the so-called multiple barrier approach to water quality management.

The multiple barrier approach is characterised by four main barriers within a drinking water supply system[30]. The four barriers are:

1. Source water protection
2. Water treatment

[29] O'Conner, D. (2002). *Report of the Walkerton Inquiry: The Events of May 2000 and Related Issues. Part One: A Summary.* Ontario Ministry of the Attorney General.

[30] Hammer, *et al* (2006). *Water and Wastewater Technology.* Fifth Edition. Prentice-Hall

3. Disinfection and maintenance of disinfection residual
4. Positive pressure in water mains and backflow protection

The maintenance of water quality barriers is also heavily entrenched in the drinking water quality framework in the Australian Drinking Water Guidelines[31].

To protect public health the multiple barrier approach must be maintained. Given that stormwater, particularly the first flush, is heavily polluted, a range of barriers are required to potabilise stormwater. In the case of stormwater, the most important are treatment and disinfection. Generally, the level of treatment required to safeguard public health would include RO and disinfection. This level of treatment would need to be applied at each ASR site to allow direct injection into the water supply system.

In a potable stormwater/ASR scheme, there is high potential for private bores to intersect the source aquifer and cross contaminate the water supply, especially over multiple ASR bores. Therefore, the only way to ensure safe drinking water supply is to provide a membrane barrier such as RO to protect consumers.

<u>Large-scale stormwater harvesting concept for Adelaide</u>

According to Water Proofing Adelaide, 160 GL of stormwater is currently available from Adelaide in an average year (although this will reduce if the Water Proofing Northern Adelaide project proceeds as planned). However, in a dry year as little as 50 GL of stormwater is available.

In the Metropolitan Adelaide Stormwater Management Study (MASMS)[32] it was recognised that the potential for stormwater harvesting within the current urban growth boundary was likely to be around 25 GL/a. This number is consistent with the stormwater and rainwater reuse target in Water Proofing Adelaide of 20 GL/a. The 20 -25 GL/a target is likely to be cost effective and achievable through localized reuse schemes. However, to increase this target by a further 50 GL a significant investment in land acquisition and infrastructure would be required.

The MASMS report made a preliminary assessment of how large-scale stormwater harvesting could be employed within Adelaide (based on a proposal by Clark (2003)[33]). The MASMS concluded that to achieve high levels of non-potable stormwater reuse, wetlands would be required to detain and treat water and ASR used for storage.

The MSMS concluded that an individual ASR site would have the potential to harvest around 500 ML per year, provided it had a stormwater catchment area of around 650 Ha. Each ASR site would need to be around 4 Ha in size, would comprise two ASR wells and cost around $2.5 million each, not including land costs. The cost

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[31] National Health and Medical Research Council (2004). *Australian Drinking Water Guidelines. National Water Quality Management Strategy.* Endorsed by NHMRC 10 – 11 April 2003

[32] KBR (2004). *Metropolitan Adelaide Stormwater Management Study. Part B – Stormwater Harvesting and Use.* Prepared by KBR for the Metropolitan Adelaide Stormwater Steering Committee

[33] Clark, R. (2003). Water proofing Adelaide – modelling the dynamic water balances. *Australian Water Association – SA Branch Regional Conference, 6 August 2003, Stamford Grand, Glenelg,*

provided in the MASMS was in 2004 dollars. Escalating this cost to March 2007 dollars using the non-residential construction producer price index results in a cost of $2.9 million per site.

An estimate of treatment required for each site based on limited pre-treatment, RO and disinfection capacity of 1.4 ML/d is approximately $1.3 million per site[34]. This cost assumes that the waste stream can be discharged to sewer and that the electricity network does not require significant upgrading.

The median house price for Adelaide for April to June 2007 was $340,000. If each property has an average area of 1000 m^2, there are 10 properties per Ha and land is compulsory acquired (with ah allowance of 30% for compensatable items incurred by the dispossessed owner) then the land acquisition cost to acquire existing residential areas would be $4.4 million per hectare. Greenfields land in Adelaide can be assumed to cost around $1 million per hectare (including all costs).

It is acknowledged that some ASR facilities could be established at greenfields sites. However, in a large-scale 50 GL/a scheme, around half the sites could be assumed to be greenfields. The cost to retrofit such a proposal to brownfields or fully developed areas is substantial.

Table 12 presents a total cost for a small-scale potable stormwater harvesting scheme and a large-scale scheme that can supply 50 GL/a. The land acquisition cost is based on 50% greenfields sites and 50% residential retrofit sites.

Table 12: Hypothetical cost summary of potable stormwater harvesting scheme

Item	**Individual Site (2007/08 dollars)**	**Large scheme (2007/08 dollars)**
Volume	0.5 GL/a	50 GL/a
Area required	4 Ha	400 Ha
ASR infrastructure	$2.9 m	$290 m
Estimated land acquisition cost	$1 m - $4.4 m/Ha	
Average land acquisition cost (using average)	$10.8 m	$1,080 m
Treatment cost (pre-treatment, RO, disinfection and direct inject pumping)	$2.0 m	$200 m
Total CAPEX	**$15 m**	$1,570 m
ASR OPEX[32]	$75 k / year	$7.5 m / year
Treatment OPEX[34]	$200 k / year	$20 m / year
Less Murray pumping and treatment	N/A	-$8 m
Net OPEX	**$275 k / year**	**$19.5 m / year**

[34] Based on GHD (2006). *Feasibility Assessment of Small Scale Desalination Plants in SA.* GHD for SA Water Corporation, October 2006.

Notwithstanding the above, localized stormwater recycling schemes that provide non-potable water can be a very important adjunct to water supply by relieving demand on other potable sources, especially for the watering of public spaces and in new developments where dual reticulation infrastructure is installed by developers.

It is clear that stormwater can be a useful niche and planning and development policies should encourage its use for non-potable purposes, especially in new developments. There are good examples in Adelaide of local solutions developed by councils to cut their demand on mains water and these should be encouraged.

Stormwater for non-potable usage could increasingly be a useful addition to water supply but by itself it would not be sufficient to greatly enhance Adelaide's water security. Strategies to increase stormwater usage have already been outlined in the Water Proofing Adelaide strategy.

The Water Proofing Northern Adelaide strategy proposed by the Cities of Salisbury, Playford and Tea Tree Gully is a good example of how stormwater resources should be integrated into the urban water environment. It is estimated that around 12 GL of potable water can be substituted by stormwater for non-potable uses from this project. Although, some of the 12 GL potable savings targeted in Water Proofing Northern Adelaide is for future open space irrigation.

4.2.5 Extractions from the aquifers of the Adelaide Plains

The Adelaide Plains are formed by tertiary and quaternary sediments up to 600 metres thick, which contain several aquifer systems overlying basement rocks.

Most groundwater used in the Adelaide region occurs from the shallower quaternary aquifers, which are located at varying depths across the Adelaide plains. The quality of the water from the quaternary system is highly variable, which accounts for its highly localized use.

The tertiary aquifer system extends from the foothills of the Adelaide Hills to a western extent beneath Gulf St Vincent. Four main confined aquifers are located in the tertiary system designated first, second, third and fourth in order of increasing depth.

At present, approximately 5 GL per annum of groundwater is being pumped from the tertiary aquifers for use in industry and open space irrigation. A scheme to extract 25 GL and perhaps up to 50 GL of groundwater to provide water for periods of drought would involve around 300 bores at 1 km spacing, possibly clustered in a series of distinct bore fields located strategically to infrastructure. The water would either need to be individually treated at each bore before being injected into the distribution system, or more likely it would need to be collected and transferred to a common point.

The natural recharge rate of the aquifers is not known with any certainty, but is in the order of 6- 8 GL per year so the long term viability of any groundwater scheme would be dependent on artificial recharge to the groundwater (ie aquifer storage and recovery) to recover pressure levels in the aquifer system. Water could possibly be extracted at the rate of 25-50 GL per annum for 2-3 years before the aquifers would need to be recharged. The salinity of the water during this period may be variable.

Despite more than 15 years of study, there is insufficient knowledge of these aquifers to design a major ASR scheme. A case exists for the Government to review the opportunity for greater use of Adelaide's underlying aquifer system as a source of water to supplement traditional supplies in drought years with replenishment in wetter years. This could be investigated under a pilot trial scheme to test the feasibility for a larger scheme. This would test the response of the aquifer system to large rates of extraction and contribute water to the water supply system.

Further work needs to be undertaken to identify the quantity of good quality water that can be economically accessed and extracted over both the short and medium terms. This will also involve monitoring of the replenishment that occurs from natural recharge and if necessary from pumping into the aquifer from other potential sources.

The use of groundwater may be a viable alternative to supplement Adelaide water supply for drought periods and system upgrades beyond 2025.

There is a case for the government to consider opportunities to use Adelaide's underlying aquifers as a source of water. However, the long-term viability of this source will take time to prove and does not alter the recommendations of this report. The short-term mining of this water as a source of water during the current drought is a matter for the Water Security Task Force to consider.

4.2.6 Mobile offshore desalination

SeaStar Energy Corporation (SSEC) contacted SA Water and the Desalination Working Group regarding the possibility for deploying an ocean-going vessel with onboard desalination capability to Adelaide.

Contract periods can be as short as three years. However, the unit cost of water will be at a premium price for short contract periods. Unit costs would decrease for longer periods.

The SSEC desalination facility is onboard an ocean-going vessel and can be up to a nominal capacity of around 50 ML/d or 18 GL/a. Additional vessels can be used to increase water production capacity.

Treated water is pumped to shore via a flexible, submerged pipeline. The capital cost of this pipeline can be incorporated into the purchase price of water from the plant.

A commercial agreement would be based on providing potable water (to World Health Organization or Australian Drinking Water Guidelines) at the shore line. All other ancillary/integration works would be funded by SA Water. However, SSEC indicated that they would be able to fund ancillary works and recover the cost through water pricing.

Power for water production can be generated by onboard Caterpillar engine-driven diesel generators or via connection to electricity network. Based on information provided by SSEC, connection to the electricity network will be more economical (if an existing connection exists, ie Port Stanvac).

SSEC have provided energy consumption data for comparing different scenarios. A comparison between the diesel and electricity options is provided in Table 13. An electricity connection is likely to be the most economical energy source.

Ancillary works including on-site storage, electrical upgrades, 10.2 km of distribution mains to Happy Valley and a pump station is estimated at approximately $78 million (including contingencies and project delivery fees).

Table 13: Cost summary of mobile desalination scheme

Energy Source	**Diesel (2007/08 dollars)**	**Electricity (2007/08 dollars)**
Specific Energy Cost	$1.30/kL	$0.65/kL
Plant Fixed Cost	$1.90/kL	$1.70/kL
Total Desalination Unit Cost	**$3.20/kL**	**$2.35/kL**
Annual Water Cost for 50 GL	$160 m/a	$120 m/a
Electricity and Integration Cost	$95 m	$95 m
Integration OPEX	$8 m/a	$8 m/a
GreenPower premium	$7 m/a	$8 m/a
Total cost for three years at 50 GL per year	**$620 m**	**$500 m**

Brine discharge is via an onboard brine dilution station. Environment Protection Authority (EPA) approval for such an activity may be difficult to obtain without undertaking detailed environmental studies. However, special consideration may be given if the activity was temporary and only for a short duration of less than 3 years. Discussions with the EPA would be required to confirm their position on the matter.

SSEC has advised that their mobile offshore desalination facility could be deployed and commence operating in South Australia in around six months from the commencement of a commercial agreement.

For a plant size providing 50 GL/a over a three year contract, the total project cost would be around to $500 million. This is a considerable cost for a short-term solution. If a long-term solution is required, then a permanent desalination plant would be a preferred option.

4.2.7 Transporting Water from Tasmania

This option involves the transportation of water from Leith in Tasmania 1,200 km to the Adelaide coast. Water is proposed to be pumped into large flexible bags constructed out of marine-grade geotextile and towed to Adelaide. Fresh water is less dense than seawater and so the flexible bags will 'float' when towed.

Marecon (based in WA) is promoting this scheme (calling it WaterTow) and has been in negotiations with Tasmanian authorities, geotextile manufacturers, ship builders and biofuel suppliers.

Initial estimates have been calculated based on delivering a 50 GL quantity from Tasmania to Pt Stanvac off the coast of Adelaide. However, a larger quantity of 100 GL could also be provided and may achieve greater economies of scale.

Water would be delivered in 850 m long, 330 ML flexible bags towed by purpose-built ships running on marine grade bio-diesel. The WaterTow proponents have targeted carbon neutral operation by using bio-diesel to operate the ships. (Although, bio-diesel would not offset greenhouse emissions due to onshore energy use ie distribution pumping).

Water would be pumped from Pt Stanvac into the Happy Valley reservoir and mixed with raw water supplies for treatment at the Happy Valley water treatment plant.

Water is proposed to be supplied from Hydro Tasmania's Paloona Dam near Leith in northern Tasmania. Approximately 1,500 GL of water passes through Paloona Dam each year of which only 22 GL is used for consumptive purposes.

Tasmanian authorities have indicated their preliminary support for the proposal based on negotiation of a consumptive water charge. Initial indications are that this consumptive charge could be $300/ML. It should be recognised that climate change is likely to have an effect on the water resources of northern Tasmania and no long term guarantees can be made on water availability.

There would be significant infrastructure works required under the proposal including:

- Intake structure from Paloona dam and pipeline to single point mooring (SPM)
- Integration works from Pt Stanvac to Happy Valley reservoir (this would be the same as the pipeline required from Pt Stanvac to Happy Valley for the desalination plant option)
- Marine provisions including SPMs in Tasmania and Pt Stanvac, five towing and tender vessels, seven containers (bags) and ancillary marine works

Cost estimates for the scheme are provided in Table 14. Estimates were provided by WaterTow and have not been independently reviewed. A detailed business case was not provided and therefore the cost estimates must be treated with caution. A contingency of 40% has been placed on capital estimates because of this uncertainty.

It should be noted that this proposal is at a very preliminary stage. No prototype water bags have been commercially developed and there is likely to be a significant lead-time for prototype testing and full scheme design. It is unlikely that this scheme could become implemented for at least three to five years.

Table 14: WaterTow cost estimates for a 50 GL scheme

Item	Cost (2007/08 **dollars**)
WaterTow Nautical CAPEX	$380 m
WaterTow Civil CAPEX	$110 m
Integration works CAPEX	$90 m
Total CAPEX	**$580 m**
WaterTow OPEX	$46 m
Integration OPEX	$8 m
Consumptive Charge (based on $300/ML)	$15 m
Less River Murray Pumping	-$6 m
Total OPEX	**$63 m**

While the capital costs for this scheme are lower than other options analyzed, the operating costs are significantly higher, which results in this option being comparable to all other options considered. The water would need to be treated in the Happy Valley WTP prior to going to the distribution system.

A disadvantage with this option is that it remains climate dependent. While northern Tasmania generally has an abundance of water, long-term water security cannot be assured. Hydro Tasmania's storages reached a 40-year low of 17% in May 2007. As a result Hydro Tasmania is pursuing cloud seeding and other options to improve rainfall in the region. Drought impacts and climate change are more likely to impact on Hydro Tasmania's power generation operations than water supply. However, because Paloona Dam is operated by Hydro Tasmania, there exists a real risk that provision of water from this storage would be subject to Hydro Tasmania's power generation options.

4.3 System Interconnection

Adelaide's water supply system does not currently have the capability for large volume inter-zone transfers required for contingency planning and operational flexibility. If water could be transferred between the major water treatment plant zones then the system would have an increased capacity to manage exceptional circumstances, such as:

- Water treatment plant outage
- Water quality problems/bacteriological outbreaks (ie cryptosporidium in source water)
- Algal blooms in Mt Lofty Ranges reservoirs and the River Murray
- Security breaches or possible terrorist attacks on the water supply system

To lessen the impact of these problems some major infrastructure upgrades are required. The main component of the system interconnection works is the connection of the Hope Valley and Happy Valley water treatment zones by a 30 kilometre, 2.1 metre diameter pipeline. This pipeline will allow the transfer of 370 ML/d within the treated water network between distribution system tanks at Happy Valley and Hope Valley.

In addition, a section of main is required from the Hope Valley system (at terminal storage) to the Barossa trunk main. Several pump stations are also required to transfer water between WTP zones. These works are shown in Chart 31 and listed in Table 15. These works have an annual operating cost of $7.5 million. Chart 31 also shows the location of the desalination plant at Pt Stanvac and the location of the pipeline connecting the plant to the water supply system.

Table 15: Integration works estimate

Item	Cost (2007/08 dollars)
Happy Valley to Hope Valley pipeline	$191 m
Terminal Storage to Barossa Trunk Main pipeline	$41 m
Pump stations, storage and other items	$70 m
Greenhouse offset for construction activities	$2 m
CAPEX	**$304** m
Pipeline OPEX	$6.7 m
GreenPower premium	$0.8 m
OPEX	**$7.5 m**

A significant cost is associated with excavating and removing the volume required for the 2.1 m diameter pipeline. It has been estimated that a volume of over 200,000 m^3 will need to be disposed. A suitable area(s) for disposing this volume of fill will need to be identified during the next stage of work.

The feasibility of this option has been investigated in detail by United Water[35]. Chart 32 shows the different routes assessed by United Water. They concluded that the preferred route was along Marion Road, through the Glenelg transport corridor and along Linear Park, shown as the western route. The preferred route from terminal storage to the Barossa trunk main is referred to as the southern route.

Importantly, the works listed in Table 15 are required to utilise the additional storage capacity that the Mt Bold reservoir upgrade provides. Without these works, the Mt Bold upgrade on its own will not deliver the full water security benefit. These works will also allow for the integration of a desalination plant including possible future upgrades. It should be noted that there may need to be further works to achieve the objectives of SA Water's contingency plans. These works are outside the scope of this report.

The interconnection works required for contingency planning purposes (even with the additional works proposed by United Water) are not designed to meet unrestricted summer demand. If there was a major water quality incident or a metropolitan water treatment plant suffered an outage during summer, it is likely that some water restrictions would be needed as a short-term contingency planning measure so there is enough treatment and transfer capacity within the system to meet demand. This may be the case even if there was enough water resource available. This is considered to be a special case and is outside the level of service objective as discussed in Section 3.9.

[35] UW (2007). *Mt Bold Interconnection Works. Pre-feasibility study report.* United Water for SA Water

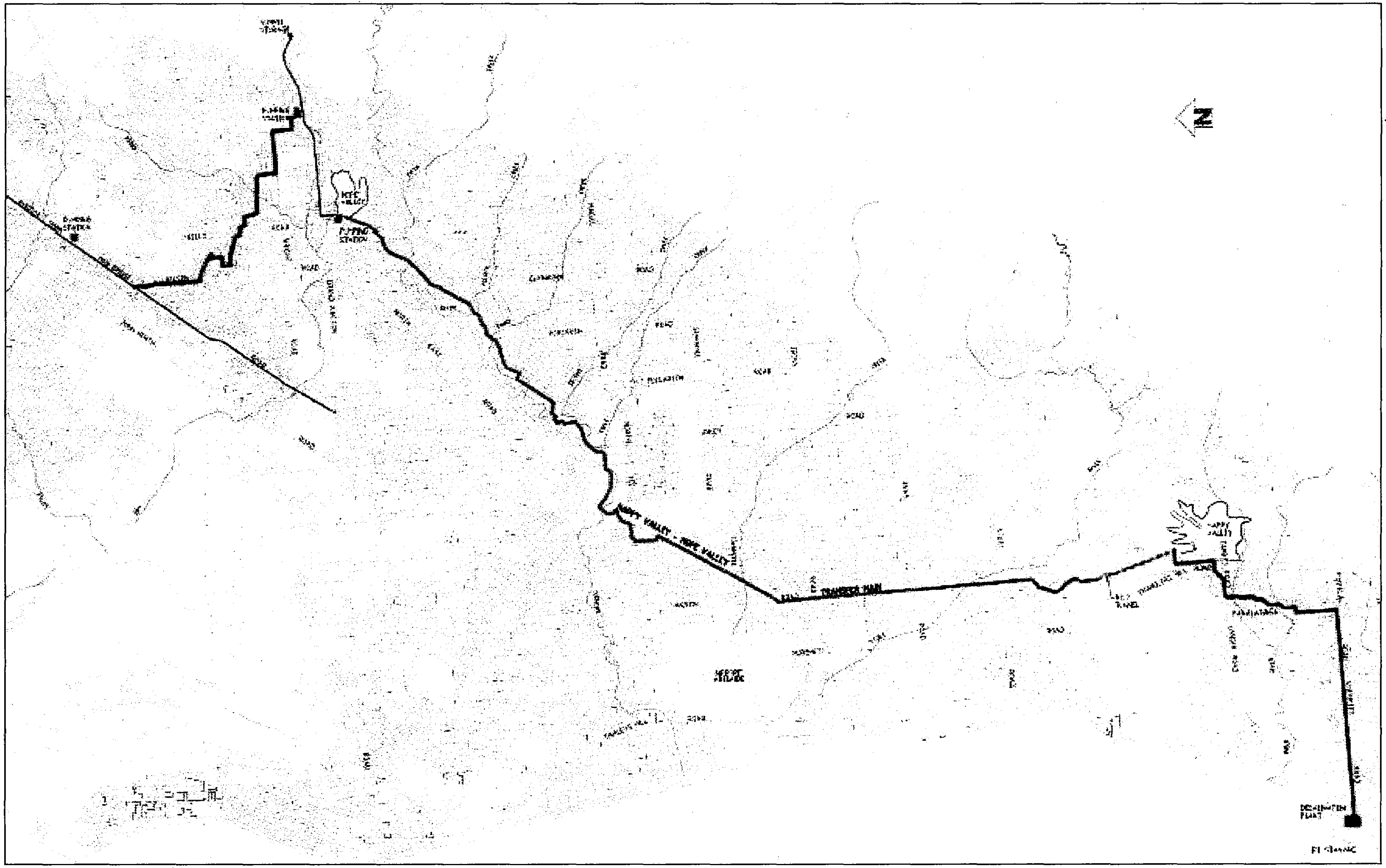

Chart 31: Integration works for Pt Stanvac desalination plant and system interconnection works

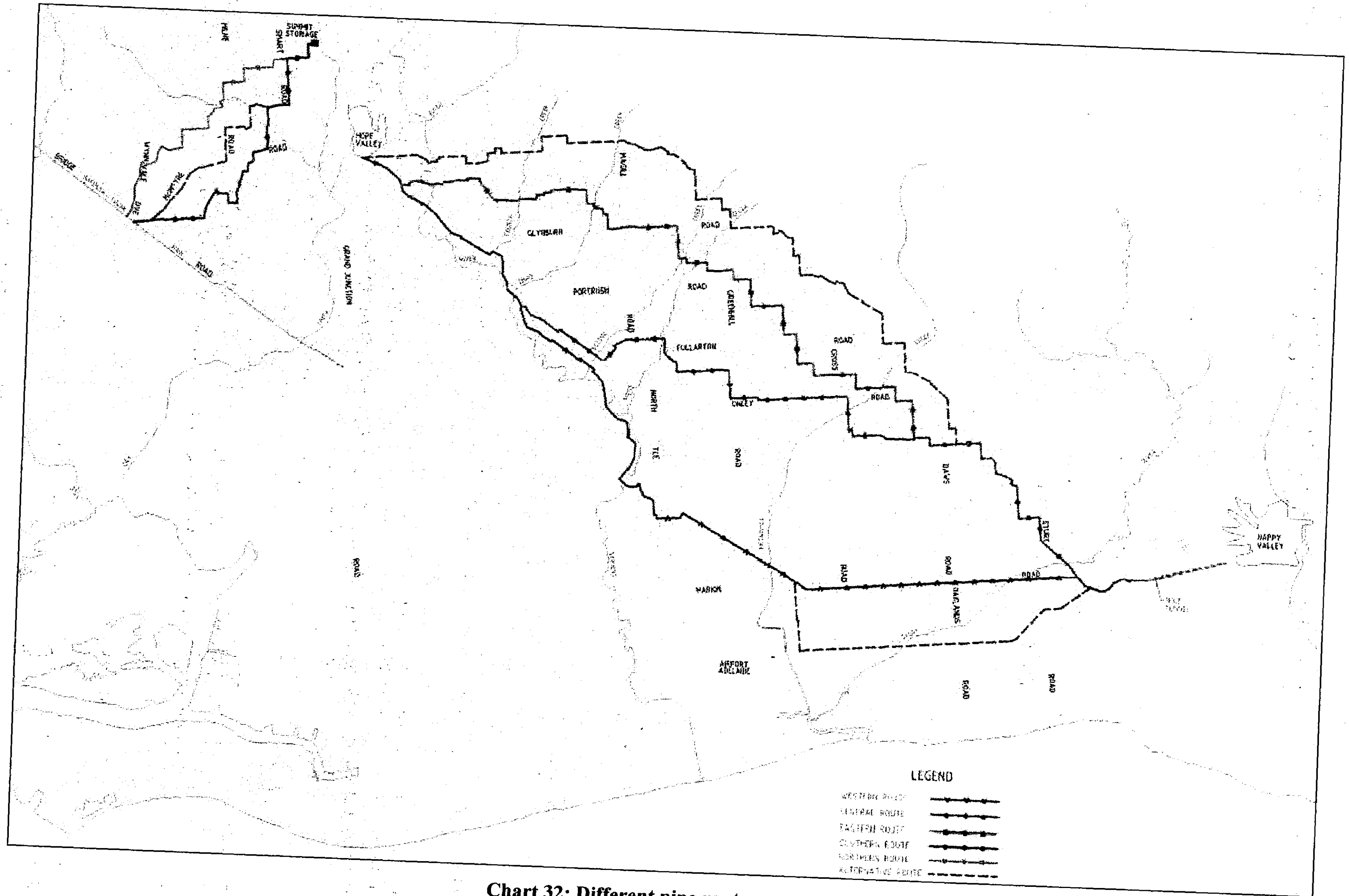

Chart 32: Different pipe routes assessed

5 The Way Forward – A Proposed Strategy

While the reliability of Adelaide's water supply system must be modelled as a whole, in the development of a strategy for the improvement of future reliability, it is instructive to review the individual components. The problem can be decomposed into four distinct issues:

- Average increases in demand due to growth and changed climatic conditions
- Managing variability of in-flows
- Reduced inflows due to environmental impacts and environmental flow releases
- Balancing security across the distribution system

5.1 Average increases in demand

Table 16 shows that in the absence of any other changes except for growth, demand would increase by 45 GL by 2025. There would be a further increase of 6 GL due to changed climatic conditions from expected hotter average temperatures, increased numbers of days over 30 ^{0}C and increased evaporation, plus a 1 GL increase in evaporative losses. All of these outcomes are the predicted result of climate change.

Table 16: Average demand

Item	**Existing**	2025	2040
Business as usual demand (GL)*	213	258	282
Demand increase due to climate change (GL)	-	6	13
Evaporation (GL)	17	18	18
Demand (GL)	230	282	**313**
WPA savings (GL)	-	-47	-50
Net demand (GL)	**230**	**235**	**263**

* based on 2000/2001 MAWSS demand

These increases in demand could be met by the purchase of additional water licences on the River Murray, but even in the absence of any other changes this would increase the average reliance on the River Murray from 40% to 50% of Adelaide's water needs.

A better alternative is the Water Proofing Adelaide strategy comprising demand reduction and re-use initiatives that target a 47 GL savings in potable water. These savings largely balance the expected increases in demand up to 2025 and hence do not result in any greater reliance on the River Murray. While the cost per gigalitre to achieve the potable water savings under Water Proofing Adelaide is higher than simply purchasing additional River Murray allocations, it is less than the cost of desalinated water.

5.2 Managing variability of inflows

We already have a problem in managing extreme drought periods, such as the one currently being experienced and this is predicted to get worse by 2025. The fundamental issue is the extreme range of in-flows that can be experienced in the Mt Lofty Ranges. Despite the problems, the natural intakes in the Mt Lofty Ranges still represent the lowest cost water available.

The solution is to have an alternative supply of water that can be made available when in-flows in the Mt Lofty Ranges are below average, and there are a number of options:

1. *Extractions from the River Murray*

   This has been a very successful strategy for Adelaide until the current drought. It should still form a part of the future water supply strategy, but now that the last 6 years of in-flows have redefined the reliability of the River Murray, it would be unwise to increase Adelaide's reliance on the River. Adelaide needs ways to diversify the risk, not add to it.

2. *Extractions from upstream storages on the River Murray*

   Holding a strategic reserve of water in upstream River Murray storages provides greater certainty than simply relying on a water licence, which during periods of drought might have a zero or a very small allocation. A significant downside to this option is that South Australia neither owns, nor controls, these storages, and would be reliant on agreements with the other states to hold "carry over" water in the storages. During periods of drought, Adelaide would also be depending on there being sufficient water to allow the strategic reserve to flow down the river to be extracted for Adelaide.

   At this stage, this option has major uncertainty associated with it, but it may form part of any future augmentation. Negotiations should continue on this option, possibly as part of the changed arrangements as the Commonwealth government takes control of aggregate diversion from the river.

3. *Extractions from storage(s) in the Mt Lofty Ranges*

   Holding a strategic reserve of water in the Mt Lofty Ranges is likely to be more expensive than utilizing the existing upstream storages, but it has much greater certainty. While extra dam capacity does not create any new water, it does provide management options for storing water in the good times for use when in-flows are low.

   The MAWSS Security Investigation has shown that a 200 GL increase in storage capacity is sufficient to deal with current in-flow variability and is also suitable out to 2025 for all but the highest of the climate change scenarios modelled. If the highest of the climate change scenarios does eventuate, augmentation would be required before 2025.

   Increased storage capacity in the Mt Lofty Ranges is the recommended strategy for managing variability in in-flows.

4. <u>*Desalination plant*</u>

Another way to manage variability in Mt Lofty inflows is to have a desalination plant "just in case". While the plant might operate every year, it could not be used to cover growth or reductions in River Murray licences, because if it did then the capacity would not be available in periods of extreme drought.

A 50 GL desalination plant would not be sufficient to manage current in-flow variability; a 100 GL plant would be required to achieve this. The capital cost and operating cost of such a plant greatly exceeds the cost of increased storage in the Mt Lofty Ranges.

While a desalination plant is a viable option when additional water is required each and every year, it is not a cost effective way of managing in-flow variability.

5.3 Reduced inflows due to climatic impacts and environmental flow releases

Table 17 shows that by 2025 in-flows in the Mt Lofty Ranges are expected to reduce on average by 30 GL and River Murray licences will be reduced by 15 GL, giving a 45 GL reduction in water availability. When combined with 5 GL of demand increases that are not met by Water Proofing Adelaide savings, there is a need for 50 GL of additional water to Adelaide.

Table 17: Average supply

Item	**Existing**	2025	2040
MLR inflows (GL)	180	150	136
MLR spills (GL)	-40	-40	-40
MDB pumping (GL)	103	88	78
MLR eflows (GL)	-13	-13	-13
Average supply (GL)	230	**185**	**161**

This could be provided by the purchase of further allocations from the River Murray, and while this would increase South Australia's average reliance on the river from 40% to 60% it would be the lowest cost option. It is only viable after the increased storage capacity is available and full, so it would take 10 years before any increased reliability was realised.

The additional water could also be provided by a 50 GL desalination plant. In this case Adelaide's water supply in 2025 would be supplied 40% local in-flows, 40% River Murray and 20% desalination. This option does not increase reliance on the River Murray and achieves a further level of diversification. These benefits come at a cost, but one that is considered to be justified. There are clear signals that the people of Adelaide are seeking a higher level of reliability for their water supply system such that water restrictions should never need to go beyond level 3.

If the 50 GL desalination plant is constructed ahead of the storage option, there would be some increase in reliability in the 4-5 year timeframe, compared to the 10 year timeframe in respect of the Mt Bold proposal. Given the current outlook for recovery of the Murray-Darling Basin storages, this is an important short term consideration.

5.4 Balancing security across the distribution system

The SA Water distribution system is roughly split by the River Torrens into a northern system and a southern system and there is limited capacity for flows from one part of the system to the other. Business continuity planning has shown the need for a more significant inter-connection between the systems to cover the possibility of the Happy Valley reservoir and/or treatment works being unavailable.

Some of the proposals increase the reliability on one side of the system to a greater extent than on the other, for example an additional 200 GL of storage at Mt Bold does not benefit the northern part of the system to the same extent as the southern part of the system. Similarly a 100 GL desalination plant at Pt Stanvac improves the supply to the southern part of the distribution system but sufficient water cannot be transferred to the northern part of the system.

The interconnection pipework to balance reliability across the system is very similar to the pipework identified in the business continuity plans, although capacity and pipe sizing differs for the various options. At this stage the pipework has been costed for the largest size needed.

5.5 Summary of the proposed strategy

There is no one solution to long-term water security. The multi-faceted nature of the overall water security strategy is summarized in Table 18, including options for upgrades beyond 2025.

Table 18: Summary of the recommended water security strategy

	Up to 2025	**Beyond 2025**
Increases in demand	Water Proofing Adelaide demand reduction and re-use initiatives	To be pursued in conjunction with the reduced in-flows category
Managing variability	200 GL increased storage (Mt Bold or equivalent)	Strategic reserve in River Murray upstream storages
Reduced in-flows	50 GL desalination plant	Desalination plant or additional River Murray allocations (Note 1)
Balancing security across the distribution system	North-south interconnection pipework	(Included in first stage works)

Note 1: Beyond 2025 the purchase of additional River Murray allocations may be an option in lieu of further desalination but this would depend on suitable arrangements to guarantee the reliability of the additional water. This could be through changes to the Murray-Darling Basin Agreement or a greater strategic reserve held in upstream storages.

5.6 What does the strategy deliver?

By 2012 the initial 50 GL desalination plant provides some increased protection against in-flow variability, but it will not prevent the need for special water sharing agreements in an extreme drought. In 2007/08 Adelaide needs 150 GL from the River Murray (or alternative source) to met critical human demands, in a period when SA Water's licence might give around 40 GL.

By 2017 the strategy would allow Adelaide to survive a repeat of the current drought without emptying the storage reservoirs in the Mt Lofty Ranges.

5.7 Cost Summary

A summary of costs for the preferred strategy is shown in Table 19. The table only shows the costs for the recommended long-term water security projects and will form the basis for any proposed water charge increases, refer Section 5.7 for more details.

Table 19: Cost summary of proposed strategy

Project	**Capital Cost** (**2007/08 dollars**)	**Annual Operating Cost** (**2007/08 dollars**)
System inter–connection works	$304 m	$7.5 m
50 GL desalination plant	$1,097 m	$45.5 m
Mt Bold capacity increase	$1,110 m	$4 m
Total project contingency	$250 m	$5 m
Total	$2,761 m	**$62 m**

It should be emphasised that these are preliminary estimates and do not include escalation costs, which would be significant over the duration of the project. A total project contingency sum of $250 million and operating cost of $5 million per year has been included to allow for any significant variation of scope or significant additions to the water security projects and is approximately based on a 10% contingency sum.

It is possible that unforseen circumstances could prevent a water security project from proceeding as proposed in this document. For example, there exists a real risk that the concentrate outfall for the seawater desalination plant may need to be longer than proposed, or the plant may need to be located in a completely different location.

6 Environmental Considerations

The major infrastructure options considered by the Desalination Working Group have significant impacts on the environment. The impact of each option is considerably different and a range of different assessments and approvals will be required to undertake each activity.

The environmental impacts and approvals necessary each for desalination and the Mt Bold expansion are discussed in the following sections.

6.1 Desalination

Environmental impacts associated with seawater desalination relate to both the construction and operation phases of a plant. The primary potential environmental impacts include:

- Greenhouse gas emissions – which can be mitigated in a number of ways including purchasing green power or other accredited offsets.
- Concentrate (brine) discharge/disposal and subsequent potential impacts to receiving environments,
- Impingement and entrainment of marine organisms
- Direct infrastructure footprint at the plant site and along transmission pipeline routes, including potential impacts to native vegetation, fauna habitats.
- Noise generated from the plant
- Visual amenity of the plant and associated infrastructure

6.1.1 Site selection

The identification of potential suitable desalination plant locations included broad environmental evaluation criteria including: existing land use, zoning, receiving environment and potential impact of constructing intakes and outfalls, site vegetation, presence of threatened plant or animal species, and heritage. The evaluation process undertaken included broad desktop assessments relating to these criteria.

All the locations identified as warranting further investigation present potential challenges in terms of environmental and social issues. These issues will need to be addressed in more detailed during the environmental and social impact assessment process. Specific issues include potential impacts associated with concentrate discharge, vegetation, threatened species, noise, heritage (indigenous and non indigenous), contamination, proximity to residential areas and potential amenity impacts.

The contamination issues at the Port Stanvac site will require further investigation and management to assess the impact these may have on project costs and timing.

Final site selection will require further evaluation of these issues, particularly the potential impacts associated with concentrate disposal.

Good plant design and good management practice will be critical to avoiding and managing environmental impacts.

6.1.2 Energy and greenhouse impacts

The net change in energy use (and potential greenhouse gas emissions) associated with this project are determined by the additional energy required for the desalination plant and additional energy for the integration of desalinated water into SA Water's headworks and distribution network less the avoided energy for pumping and treatment from the River Murray.

A 50 GL desalination plant at Pt Stanvac is likely to have a peak power load around 40 MW and an annual energy requirement of around 300 GWh, including distribution pumping. However, there will also be energy savings. A desalination plant will result in less pumping from the River Murray and less treatment at metropolitan water treatment plants resulting in savings of around 85 GWh per year. Therefore, the net energy change if a 50 GL desalination plant is constructed is an increase of around 215 GWh per year.

The potential greenhouse gas emissions associated with operation of the desalination plant would be 309,000 tonnes CO_2-e per year[36]. To avoid these emissions SA Water should purchase accredited renewable energy such as GreenPower. The cost to offset these emissions has been estimated at $12.5 million per annum. Construction of the desalination plant is estimated to release around 15,000 tonnes CO_2-e. The one-off cost to offset these emissions is estimated at $530,000. If greenhouse gas emissions related to plant construction and operation were completely offset then the project could claim to be carbon neutral.

Operation of a 50 GL desalination plant will reduce the need for pumping from the River Murray and reduce the amount of water treated at Adelaide's conventional water treatment plants. These reductions will result in less greenhouse gas emissions. If these emissions were not offset, the project would result in no net additional greenhouse gas emissions and there would be a saving of around $3 million per annum compared to offsetting all desalination-related emissions. However, the project could not claim to be carbon neutral.

6.1.3 Construction impacts

Construction based impacts will be typical for those associated with infrastructure or development projects within coastal locations. Support infrastructure including integration into the network will also be associated with a range of potentially complex environmental and social impacts. Many of the integration issues in particular will require careful planning and management as works will be within built up and developed areas.

The potential issues to be addressed include impacts to vegetation and fauna, heritage (indigenous and non-indigenous), noise, dust, traffic, greenhouse construction footprint. Impacts will be associated with the plant, intake and outfall structures and other supporting infrastructure.

Appropriate planning and management, including consideration of siting of infrastructure and the implementation and auditing of a construction environmental management plan will assist in minimising and managing these impacts.

6.1.4 Environmental investigations

The outcome from the environmental investigations will be used to inform feasibility assessments and will provide critical information for the detailed design of the plant. These studies will also form the basis for any Environmental Impact Assessment

[36] Based on the AGO Factors and Methods Workbook (2006) - aggregated greenhouse gas emissions factor for standard electricity in South Australia.

The environmental investigations including marine ecological investigations and hydrodynamic modelling will incorporate any available information such as that collected as part of the Adelaide Coastal Water Study.

Marine Ecological Characterisation Study

A marine ecological characterisation study is to be undertaken by the Australian Water Quality Centre (AWQC) in collaboration with SARDI aquatic sciences. The study will take 12 to 18 months to complete.

The scope of works involves the characterisation of marine habitats and biota in the vicinity of potential discharge and intake zones at the three locations under investigation.

The purpose of the studies will be to characterise the habitats as part of determining the sensitivity of the marine environment at each of the sites. The information will also assist in identifying habitats, species or communities that may be impacted by the various elements of a desalination plant either during the construction or operation phases.

Impacts to threatened species or communities identified under environmental legislation, in particularly the *Environment Protection Biodiversity Conservation Act 1999* will also be identified. This study will inform the approval process.

The outcomes of the proposed study identifying current habitat conditions at each of the sites and in the surrounding waters will assist in planning and site selection process and will enable relative impacts at the sites to be assessed.

Water Quality monitoring

Baseline water quality monitoring is being undertaken as part of the marine ecological investigations. The objective of the monitoring is to determine ambient water quality characteristics in the vicinity of the three sites being investigated. This information will provide baseline information for both the environmental assessment process and inform the planning and design of treatment processes, in particular the pre-treatment requirements.

The outcomes of both the marine ecological characteristic study and water quality monitoring will also be utilised in the development of a framework for future marine monitoring to assess the environmental performance of the desalination plant, particularly in regards to the seawater concentrate discharge.

Hydrodynamic modelling

Tenders have also been sought for hydrodynamic brine dispersion modelling. The study is expected to commence in late 2007 and is expected to take 6-9 months and will build on knowledge and understanding developed as part of work associated with the Adelaide Coastal Waters study.

The modelling work will include a number of phases addressing;

- whole of gulf model
- mid field and
- near field

The information collected as part of the study will assist in the planning and site selection process, including assisting in determining the regions where the discharge of a hypersaline concentrate stream would have least impact on the marine environment. The outcomes of the modelling work will also inform the design process, particularly the location and length of the outfall and the type of dissipators.

Ecotoxicological studies
Development of an assessment program to determine potential impacts of the concentrate discharge on the marine environment from an ecotoxicological perspective will occur once further information is available from the marine characterization study on biota and once a pilot plant has been established.

Expert Review
To ensure the environmental investigations undertaken are robust and will address the key environmental issues a process of engaging independent experts to undertake technical reviews has been established. The experts selected have expertise in areas addressing each of the key environmental issues including marine ecology, modelling and dispersion, ecotoxicology. Experts include both local and interstate representation to bring technical expertise from interstate desalination assessment processes as well as local knowledge. Each of the nominated experts has been contacted and invited to participate. Expert input will be sought at all key stages of the environmental investigation process.

6.1.5 Social impacts

In addition to the key environmental issues outlined above, there are a number of potential social impacts. These may include proximity of sites to residential areas, construction impact, traffic, noise and visual amenity issues. Concerns relating to potential impact, particularly associated with the concentrate discharge will also need to be addressed. Further assessment of potential social impacts will be required.

6.1.6 Environmental Approval Requirements

The desalination plant will require approval from the Environment Protection Authority in the form of a licence to operate.

Other environmental approval requirements associated with the project will be subject to the outcomes of the environmental investigation process and may include approvals under the following legislation;

- Native Vegetation Act
- Development Act
- Aboriginal Heritage Act
- Native Title Act
- Environment Protection Biodiversity Conservation Act (Commonwealth)

With respect to approval requirements under the *Development Act 1993*, the decision on whether the project would be deemed a major project under the provisions of the Act is still to be resolved.

6.2 Mt Bold

There are several significant environmental issues and impacts associated with increasing the capacity of the Mount Bold reservoir. These issues are discussed in detail in the Mt Bold Scoping Study Report[16]. A summary of the major impacts are provided here.

6.2.1 Vegetation removal

Increasing the storage capacity of the Mount Bold reservoir and creating a new reservoir upstream of the Clarendon weir would require extensive native vegetation removal. The area of native vegetation that would require removal is estimated as 470 Ha in Mount Bold reservoir reserve.

More than half of the Mount Bold reservoir reserve land has highly diverse, remnant native vegetation in moderate to excellent condition[37] and as such is considered to be an important area of remnant vegetation within the southern Mount Lofty Ranges[38]. Specifically, the north-eastern area of the reserve is almost entirely uncleared, with remnant vegetation that is generally in excellent condition[37].

There are a number of significant species within the reserve (listed at national, state and regional levels), including some of the most endangered flora species in South Australia and one species not known outside the reserve.

The Native Vegetation Council (established under the *Native Vegetation Act*) is responsible for making decisions on matters concerning native vegetation in South Australia. The Council is an independent body appointed by the Governor of South Australia. One of its key tasks is to makes decisions on applications to clear native vegetation in South Australia, and establish conditions under which native vegetation can be cleared[39].

When considering applications to clear native vegetation, the Council considers assessment advice from the Department of Water, Land and Biodiversity Conservation as well as comment from the local NRM board and the local district council. One key aspect of the *Native Vegetation Act* is that it prevents the Council granting consent to the clearance of an 'intact stratum' of native vegetation, unless the landholder can provide a compensating significant environmental benefit (SEB).

Of particular importance for the Mt Bold option, the *Native Vegetation Act* provides that native vegetation should not be cleared if in the opinion of the Council:

- it comprises a high level of diversity of plant species
- it has significance as a habitat for wildlife
- it includes plants of a rare, vulnerable or endangered species
- the vegetation comprises the whole, or a part, of a plant community that is rare, vulnerable or endangered

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[37] Earth Tech (2004). *Mt Bold reservoir reserve Incorporating Clarendon Weir Land Management Plan.* SA Water Corporation.

[38] Pound, L.M. (2006). *Mount Bold reservoir reserve: a Biological Survey of Flora and Fauna.* Nature Conservation Society of South Australia, Adelaide.

[39] http://landcaresa.org.au/native/nvc/index.html#WhatistheNativeVegetationCouncil

- it is significant as a remnant of vegetation in an area which has been extensively cleared

Mt Bold is a sensitive area with substantially intact stratum of native vegetation and the Native Vegetation Council is likely to show significant interest in any proposal to clear native vegetation at the site. The project may also require referral and assessment under the Commonwealth's Environment Protection and Biodiversity Conservation Act.

Approval for clearance would be conditional on the achievement of a 'significant environmental benefit' (SEB) elsewhere on the property or region to offset and compensate for the vegetation loss, in-line with legislative requirements.

The SEB can be achieved in a number of ways including direct revegetation, providing for the management of other native vegetation, or the restoration of native vegetation in the region. Alternatively, an application can be made to the Native Vegetation Council to make a payment in the Native Vegetation Fund. The amount would need to commensurate the value of acquiring and revegetation of the land at the determined revegetation ratio. The SEB may incorporate a combination of the measures.

The cost for acquiring land for the maximum offset ratio would be substantial, given the total area required. In addition, the revegetation works would require long term legal protection, potentially through a heritage agreement with the landholder or other legal commitment to ensure protection.

6.2.2 Fauna

The large size and generally good condition of the vegetation at Mount Bold reservoir reserve makes it suitable habitat for a large number of common and rare native fauna species. A range of mammals, birds, reptiles, amphibians and fish have been identified in the Mount Bold reservoir reserve and a number of these fauna species are listed under the Commonwealth Environment Protection and Biodiversity Conservation Act and State National Parks and Wildlife Act schedules.

The proposed vegetation clearance and flooding will significantly impact fauna habitat including species of conservation significance.

A baseline flora and fauna survey has been commissioned. The survey will be undertaken over a 12 month period (at least) to provide baseline information against which the potential impacts of the works can be assessed. On-ground vegetation survey work is proposed to commence in mid-October 2007, with the Spring fauna survey to follow in November. It should be noted, that this survey will cover terrestrial flora and fauna, investigations covering impacts to aquatic flora and fauna will be undertaken as further information is known about hydrological impacts eg. altered flow regimes.

6.2.3 Greenhouse gas impacts

The greenhouse gas impacts associated with the proposed vegetation clearance requires consideration, in terms of the carbon storage currently provided by the vegetation. The removal of around 470 Ha native vegetation (excluding any native vegetation clearance on private land, non-native vegetation and pasture) would potentially release 100,000 t to 140,000 t CO_2 equivalent into the atmosphere (final calculations to be based on national carbon accounting tool box and on site assessment for the Mount Bold area). The offset required to compensate for this greenhouse gas contribution could be linked to the native vegetation clearance offset required. However, there would be a significant time delay before the greenhouse gas benefits are realised due to the time required for the vegetation to grow to the same condition.

There are will also be greenhouse gas impacts associated with construction of the project, incorporating diesel fuel used by construction machinery, embodied emissions in concrete and embodied emissions in steel.

6.2.4 Other Issues

The proposal is likely to have additional impacts as outlined below:

- Cultural heritage. A cultural heritage survey is required to determine potential Aboriginal heritage impacts. Approval under the Aboriginal Heritage Act may be required. Tenders are being sought to undertake a preliminary cultural heritage study
- Groundwater system in the area. Further investigation is required to determine the potential impacts to groundwater, for example leakage into fracture zones.
- The proposal will impact surface water movement and therefore aquatic ecosystems within the reservoir and downstream and may impact on private users.
- Construction related impacts such as the source for imported fill, weed management, Phytophthora management, traffic impacts, dust control and erosion control.
- Social impacts related to land acquisition and forestry plantations

6.2.5 Legislative approvals

The key external environmental approvals that are likely to be required include the following (however note this information will be confirmed during further project assessment). Early and detailed consultation with relevant government agencies, and other stakeholders, would be necessary to ensure relevant issues are considered and addressed.

Environment Protection and Biodiversity Conservation Act (Commonwealth)

Approval from the Commonwealth Department of the Environment and Water Resources would be required to undertake an activity that may significantly impact on a matter of national environmental significance. The key matters of national environmental significance that are likely to apply to this proposal are listed threatened species and communities and listed migratory species. There are statutory timelines within the assessment and approval processes, including opportunity for public and government agency comment.

Development Act (SA)

Whilst installation of water supply infrastructure is generally exempt, development (planning) approval may be required for the proposal. If so, the major projects process could potentially be triggered due to the scale and impacts associated with the proposal, which includes opportunity for government agency and public comment.

In addition, impacts to 'significant trees' as defined by the Development Act and relevant local council development plans require approval under the Development Act.

Native Vegetation Act (SA)
Approval to impact native vegetation, including grasses, shrubs, trees, single plants, both aquatic and terrestrial that are indigenous to South Australia. 'Impact' includes clearance, branch trimming, root disturbance, smothering, dredging, etc.

Aboriginal Heritage Act (SA)
The Act requires that Aboriginal sites of significance must not be disturbed without prior approval from the Minister for Aboriginal Affairs and Reconciliation. The approval process requires firstly that a determination is made that Aboriginal heritage site(s) of significance are present in the project area, followed by approval to disturb the site(s) if necessary, including consultation with the relevant Aboriginal people and groups. The Commonwealth Aboriginal and Torres Strait Islanders Act may also apply.

Native Title Act (Commonwealth and SA)
Requirement to provide notification to the relevant Native Title claimant groups if native title rights exist in an area(s) impacted by the proposed works.

Heritage Places Act
The Act requires that listed heritage sites must not be impacted without prior development approval. There are a number of SA Water sites listed on the state heritage register, including the Clarendon weir.

Natural Resources Management Act (SA)
Approval from the Dept. for Water Land and Biodiversity Conservation, or the relevant natural resource management board, is required to undertake a 'water affecting activity' including building in a watercourse or floodplain, impacting vegetation in a watercourse or on a floodplain, etc.

6.3 Interconnection Works

Subject to final pipeline routes, there will be a range of potentially complex environmental and social impacts. Many of the integration issues will require careful planning and management as works will be within built up and developed areas. In particular, the preferred route between Happy Valley and Hope Valley is along Marion Road and through the Glenelg transport corridor. The disruptions to traffic along Marion Road in the context of the South Road transport upgrade will need to be carefully considered during feasibility investigations. The Glenelg to Adelaide Park Lands project also proposes to use the Glenelg transport corridor for a 750 mm diameter recycled water main. The easement width required for both pipelines will need to be carefully considered to avoid any potential conflict between the two projects.

There may also be potential issues regarding impacts to vegetation and fauna, heritage (indigenous and non-indigenous), noise, dust, traffic, disruptions for the public and the greenhouse construction footprint.

The outcomes of the environmental and social impact investigations will need to be considered as part of the pipeline design and route finalisation. During the construction phase environmental management plans will be required to as part of mitigating and managing identified impact and to ensure environmental approval conditions are met.

7 Implications for Water Charges

COAG and National Water Initiative water charging principles call for full cost recovery in respect of all go forward investment decisions in water supply, including a risk adjusted required rate of return on assets employed, taking into account community service obligations revenues and capital grants.

This principle has been adopted by the South Australian Government such that charges to SA Water customers should reflect full cost recovery for all go forward investment decisions. The required rate of return on assets, also known as the weighted average cost of capital is set for SA Water at 6% real (pre income tax).

The Desalination Working Group is aware that work has commenced on assessing the implications for water charges. This matter is being considered by SA Water and the Department of Treasury and Finance.

The primary purpose of increasing water charges is to generate revenue over time that will pay for the capital costs and operating costs of the water security projects – by whatever mix of water usage charges and supply (water service availability) charges for various customer classes the South Australian community considers appropriate.

8 Procurement Options

A major desalination plant for Adelaide will be a high profile, high value, iconic project involving unique complexity of technical, environmental and stakeholder management challenges.

The most critical element to ensure a successful project is to get the optimum balance of project governance across government and individual accountability for a successful outcome. It is recommended that this be achieved by utilizing a multi agency steering committee to coordinate government input to the project, while SA Water should be responsible for delivering the project.

There are a number of key issues that will influence the procurement method and these are discussed below.

8.1 Plant Ownership

Desalination will be an integral part of Adelaide's long term water supply. Contracting options must therefore provide for control and security of supply;

including protection against the risk of the site being converted to some other use in the future, possibly at a time when alternative sites are not available or are highly expensive. The optimum location for a desalination plant is close to the sea, where land is going to become increasingly more valuable.

This security can only be achieved through government retaining control of the site, the plant and associated infrastructure.

8.2 Relationship between the Desalination Plant and the Energy Supply

The Working Group has investigated options of procuring a desalination plant in conjunction with a power plant, either at an existing site or a greenfield site. While there are some synergies in such arrangements, they generally do not yield significant savings in the overall cost, and these savings are often more than off-set by increased costs for integration into the water distribution system and for environmental considerations. The requirements for power stations and desalination plant might appear on the surface to be similar, but when examined in detail this is not always the case. For example, both power stations and desalination plants need to discharge a waste stream. For a power station, this is generally seawater of slightly elevated temperature and typically the power stations at Torrens Island and Pelican Point discharge into the Port River. By comparison, a desalination plant discharges highly concentrated brine that needs to be properly dispersed into deep water. A desalination plant at Torrens Island or Pelican Point would need a discharge pipe many kilometers in length and could not share the current discharge pipes from the power stations into the Port River. It is therefore recommended that the desalination plant be procured independently of any power station. This is common with most desalination plants, including the first plant at Perth which is built adjacent to a power station.

8.3 Delivery Timeframe

In the absence of major rainfalls in the Murray-Darling Basin catchments, completion of the plant is the proposed solution to end the current water restrictions, so there will be significant pressure to deliver the plant as quickly as possible. The selected procurement method should facilitate the construction of the plant being fast tracked to the maximum extent.

A range of procurement methods could be used to deliver the desalination plant, as indicated in Table 20.

Table 20: Different procurement methods suitable for the proposed Adelaide desalination plant

Conventional Contracts	Relationship Contracting	PPP Projects
• Design and construct (D&C), with separate operations and maintenance contract (O&M) • Design, build, maintain and operate (DBMO)	• Pure alliance (team selected on non-cost criteria including experience, ability to innovate, people & attitudes • Competitive alliance (two teams develop and cost a project bid, with the winning team being awarded the project) • Both methods assume an open book commercial approach with SA Water as a member of the alliance team	• Public Private partnership – Design, Build, Finance and Operate (DBFO)

The selection of a preferred procurement approach should be based on a comprehensive assessment of the lifecycle risks of the plant and associated infrastructure in the context of the key deliverables of the project. A risk-based approach will facilitate the identification of the key risks that the State will have to manage over the life of the project, as well the risks it may seek to share with or transfer to a private sector firm.

Flexibility of supply is also a key consideration for a major desalination plant for Adelaide. In the first instance the desalination plant is likely to operate at full capacity to offset the impact of the drought, but when more normal conditions return in the Murray-Darling Basin there is scope to reduce the output from the plant; for example, it would make no sense to continue to operate the plant at maximum capacity while water was spilling over Mt Bold dam. In the longer term the need for the plant is linked to future climate change, and the timing of upgrades to the plant capacity is anything but clear. The best outcome will be achieved by maintaining maximum flexibility in future operating strategy.

8.4 Design and Construction Contract

D&C contracts are less conducive to fast tracking the project, with the environmental investigations, concept development and tendering being undertaken sequentially. They also have rigid terms and conditions which cause delays in managing variations.

The key benefit of the D&C is that the State retains control over all aspects of the project, but as a consequence retains all of the risks. An assessment is therefore required whether the State, through SA Water, can bring the necessary resources and expertise to a project of this scale to manage a multiplicity of complex risks.

Plant operations would be managed by SA Water under the D&C option, either in-house or outsourced to a specialist operator. If outsourced, the contract would be awarded on a cost-plus basis, with limited transfer of operational risk to the contractor outside of specified performance requirements.

8.5 Relationship Contracting

By comparison, both Relationship and PPP contracts tend to take longer to establish, but generally result in an accelerated delivery timeframe due to the financial incentives in the contract.

Public Private Partnership (PPP)

PPPs are widely used in the water treatment industry. SA Water has completed a number of water treatment projects under the build, own operate, transfer (BOOT) model, although the model has been extensively refined in recent years. PPP are also employed extensively in Victoria and NSW to deliver water treatment infrastructure.

The Victorian Government recently announced its intention to build its desalination plant as a Partnerships Victoria PPP project.

PPP contracting is better aligned with projects where the where project scope, related risk and long term requirements for the output can be clearly defined. As already demonstrated by existing SA Water contracts, a PPP arrangement can derive several benefits including the transfer of construction and lifecycle risks of managing the plant to the private sector. However it is difficult, to vary PPP contracts for unforeseen events or risks. The contract must explicitly contemplate potential variations and define these outcomes in detail.

The key benefit of the PPP approach is an integration of design, build and operations within a single contract where the operator's equity is fully exposed to the operational performance of the infrastructure. However, PPP contracts rely on highly detailed output specifications as the contractual basis of the performance regime, which limits flexibility to accommodate future changes outside of the contract specification.

It should be expected that the State will retain demand risk for the plant as the contractor will not be able to manage this risk or the likely variation in plant output over time. The PPP contract would therefore take the form of a lease rather than a 'take and pay' contract. While operating costs are a straight pass-through cost, the operator bears the risk of unit cost increases due to inefficient plant operations including deficient design and substandard construction.

The clear benefit of the PPP however is that certain outputs relating to the plant's management and operations in terms of the quantity and quality of water can be subject to performance standards, with abatements applied in regard to quantity and/or quality failures.

The tendering process for the PPP, which previously was structured along traditional lines and as such highly constrained by outdated probity practices, has evolved over recent years to adopt many of the features of the alliance process (see below). PPPs currently involve 'interactive' tendering, whereby shortlisted bidders present their design and operating solutions during the selection process. The project requirements can be refined in detail up to the selection of the preferred bidder (with usually a second bidder in reserve). This process helps to overcome the rigidity of prior PPPs arrangements and allows greater design latitude

Alliance Contracting

The desalination plant involves a unique complexity of technical, environmental and stakeholder management challenges where significant issues and scope changes are likely to emerge continuously through all phases of the project. It is considered that these issues are best managed dynamically under a partnership arrangement.

Alliance contracting allows the specialist design and construction team to commence work prior to key information such as the environmental monitoring becoming available. SA Water would be a member of the alliance and could maintain an appropriate amount of influence and control at key stages of the process.

Risks and opportunities are shared via a pain / gain incentives model. Project transactions would be "open book" and audited by an independent assessor. The partners in the alliance would be SA Water, a designer, a construction contractor and an operation and maintenance contractor.

Alliance is the process employed for the desalination projects in Perth, the Gold Coast and to a lesser extent Sydney. Perth used a competitive alliance where two separate interim alliance groups were established to competitively develop a concept solution and target cost estimate. Both groups were paid on a cost reimbursable basis for the development work and following evaluation one successful group was selected to implement the agreed delivery plan based on an agreed target cost.

The Gold Coast plant is being delivered via a pure alliance. This is claimed to be slightly faster than the process used in Perth, but the target cost is set without the benefit of competition.

The Sydney desalination project is established on an alliance contract for the water distribution infrastructure and design, build, operate and maintain (DBOM) for the desalination plant. The DBOM model is suitable for Sydney as there has been substantial investment over several years in concept design, with investigations into the critical environmental and energy factors. Therefore the project scope is well defined with supporting strategies established prior to proceeding to design and construct contracts.

Compared to a PPP, a key challenge for the alliance approach therefore is whether the operational component can be as effectively integrated into design and construction as the PPP approach.

The early contractor involvement (ECI) contract model has been successfully adopted as an enhancement of DBOM in some project environments. The contractor is involved in the early design development phase and engaged in risk identification and mitigation strategies prior to the D&C contract. This involvement enables early definition of scope leading to a higher confidence level in cost estimates. However for highly complex projects such as desalination an alliance is much more effective than ECI in managing emerging issues throughout the life of the project. The owner is not required to pay the contractor to manage potential risks that may not eventuate. Gains from innovation are managed openly and equitably.

Table 21 summarises the allocation of the key project risks under the above procurement options.

Table 21: Allocation of risk under different procurement options

R = Retained risk S = Shared risk T = Transferred risk	DBMO	Govt	Alliance	Govt	PPP	Govt
Capital						
Site		R		R		R
Design		R	S	S	T	
Construction	S	S	S	S	T	
Commissioning		R	S	S	T	
Residual value		R		R		R
Operating						
Performance (1)		R	S	S	T	
Demand		R		R		R
Energy (2)		R		R	S	S
Maintenance	T		T		T	
Capital maintenance (3)		R		R	T	

1. Assumes sharing of some performance risks under the Alliance approach due to the early involvement of the operations contractor
2. The State usually accepts volume risk for energy as it relates to the volume of water produced, but price risk and energy efficiency risk may be transferred to the operator, with the price risk usually capped.
3. Capital maintenance would normally be carried through a sinking fund in the PPP vehicle, which is transferred to the Contractor.

8.6 Conclusion

The objective of the procurement strategy is to define the risk allocation between the government and private sector in order to ensure successful project delivery, value for money outcomes and sustainable water supply. An initial assessment indicates an Alliance approach offers some advantages. However, it is recommended that further investigation be undertaken on the key factors influencing the procurement strategy and that an evaluation framework be established to determine the optimal project delivery method.

9 Conclusions and Recommendations

Inflows into Mt Lofty catchments and the Murray-Darling Basin have reduced over the last seven years and are likely to continue to remain at reduced levels, and with increased variability, as a consequence of climate change.

Adelaide is faced with developing strategies to deal with four challenges:

- Average increases in demand due to growth and changed climatic conditions
- Managing variability of in-flows
- Reduced inflows due to environmental impacts and environmental flow releases
- Balancing security across the distribution system

The recommended actions to meet these factors are:

Average increases in demand

It is recommended that the existing Water Proofing Adelaide strategy continue. It comprises demand reduction and re-use initiatives that target 47 GL savings in potable water. These savings almost completely balance the expected increases in average demand and hence do not result in any greater reliance on the River Murray.

The substitution of non-potable water for potable water for agricultural and green space use (e.g. local storm water schemes and waste water recycling) will continue to be an important contributor to the Water Proofing Adelaide strategy but they are ***not viable as a direct source of potable water***. Indeed the use of recycled water i.e. potable re-use is both more expensive than alternatives and involves risks that are unacceptable.

There is a case for reconsidering opportunities to use Adelaide's underlying aquifers as a source of water. However, the long-term viability of this source will take time to prove and does not alter the recommendations of this report. The short-term mining of this water as a source of water during the current drought is a matter for the Water Security Task Force.

Managing variability of in-flows

The natural intakes in the Mt Lofty Ranges still represent the lowest cost water available so the solution is to have an alternative supply of water that can be made available for those years when in-flows in the Mt Lofty Ranges are below average. There are a number of options to achieve this:

- Extractions from the River Murray

  Extractions from the River Murray should still form a part of the future water supply strategy, but it would be unwise to increase Adelaide's reliance on the river. Adelaide needs ways to diversify risk, not add to it.

- Extractions from upstream storages on the River Murray
  At this stage, this option has major uncertainty associated with it, but it may form part of any future augmentation. Negotiations should continue on this option, possibly as part of the changed arrangements as the Commonwealth government takes control of the aggregate diversion from the river.

- Increased storage in the Mt Lofty Ranges
  A 200 GL increase in storage capacity is sufficient to deal with current in-flow variability but the highest climate change variability modelled indicates augmentation of supply would be required before 2025.

  Increased storage capacity in the Mt Lofty Ranges is a recommended strategy for managing variability in in-flows.

- Desalination plant
  A 50 GL desalination plant would not be sufficient to manage current in-flow variability; a 100 GL plant would be required to achieve this. While a desalination plant is a viable option when additional water is required each and every year, it is a very inefficient way of managing in-flow variability.

Reduced inflows due to environmental impacts and environmental flow releases

By 2025 in-flows in the Mt Lofty Ranges are expected to reduce on average by 30 GL and River Murray licences will be reduced by 15 GL, giving a 45 GL reduction in water availability. When combined with 5 GL of demand increases that are not met by Water Proofing Adelaide savings, there is a need for 50 GL of additional water for Adelaide.

It is recommended that this be provided by a 50 GL desalination plant because this option does not increase reliance on the River Murray and achieves a further level of diversification.

Balancing security across the distribution system

Some of the recommendations increase the reliability on one side of Adelaide's water distribution system to a greater extent than on the other. For example, an additional 200 GL of storage at Mt Bold does not benefit the northern part of the system to the same extent as the southern part of the system. Similarly a desalination plant at Pt Stanvac improves the supply to the southern part of the distribution system but sufficient water cannot be transferred to the northern part of the system.

Therefore it is recommended that interconnection pipe work be built to balance reliability across the system.

The role of the River Murray

Adelaide's use of River Murray water is not a major impost on the viability of the Murray-Darling Basin. Rather, the question is: ***to what extent can Adelaide's water supply rely on water pumped from the River Murray during periods of drought?***

Locations for a desalination plant

A range of issues must be considered when determining the feasibility and location of a seawater desalination plant. Sites considered stretched along the Adelaide coast of Gulf St Vincent and a south coast location near Waitpinga.

A site assessment study concluded that, while seawater was generally deeper at sites to the south of Pt Stanvac (ie around Myponga), there were concerns over potential influence of the Myponga eddy in this region which could severely limit the movement and dispersion of brine. The cost of constructing infrastructure in southern areas to transfer water back to Adelaide was also much more significant than locations around Pt Stanvac to Pelican Point.

Seawater depth significantly decreases from Pt Stanvac north along the Gulf and is associated with poor marine dispersion characteristics. This has substantial ramifications for length of seawater intake and brine outfalls for areas north of Pt Stanvac.

A multi-criteria analysis (MCA) of twelve plant sites was conducted with three nominal locations chosen for further assessment and cost estimation by United Water. They concluded that the Pt Stanvac site was the preferred location for a seawater desalination plant in Adelaide based on proximity to existing infrastructure, ease of integration into the water supply system and the depth of seawater off the Pt Stanvac coast.

Electricity supply

Based on information supplied by ETSA there is capacity within the network to support a seawater desalination plant at any of the three sites, although some network upgrades are required. However, the cost of this relatively insignificant compared to the cost of constructing a desalination plant and integrating it into the water supply. All estimates include the cost to upgrade the electricity network.

It should be recognised that it has been assumed that green power would be purchased from the market for all water security projects. This does raise the operating cost of the seawater desalination plant and proposed pump stations. However, it has been assumed that the projects would need to be carbon neutral in-line with the greenhouse target in South Australia's Strategic Plan.

Summary of the recommendations

In summary, the DWG has recommended that:

- The Water Proofing Adelaide strategy continue to be supported as the means to address increases in Adelaide's average demand for water, noting in particular the pursuit of recycled water and stormwater for non-potable uses;

- Mt Lofty Ranges storage capacity be increased by 200 GL to store water in normal years for use during dry years as a buffer against rainfall variability. The expansion of Mt Bold reservoir would achieve this goal;

- A 50 GL desalination plant be constructed to address reductions in inflows in the Mt Lofty Ranges and River Murray, noting that available information indicates Pt Stanvac is the preferred site for a plant;
- Interconnection pipe work be built to balance reliability across the north and south of Adelaide's water distribution system.

Together, these recommendations form a comprehensive, multi-faceted approach to providing Adelaide with long-term water security, as set out in Table 22.

Table 22: Summary of recommendations

	Up to 2025	Beyond 2025
Increases in demand	Water Proofing Adelaide demand reduction and re-use initiatives Completion date:~ 2025	To be considered in conjunction with reduced in-flows
Managing variability	200 GL increased storage (Mt Bold or equivalent) $1,110 million Completion date:~ 2017	Strategic reserve in River Murray upstream storages
Reduced in-flows	50 GL desalination plant $1,097 million Completion Date:~ 2012	50 GL desalination upgrade or purchase of River Murray licences †
Balancing security across the distribution system	North-south interconnection pipe work $304 million Completion date:~ 2014	(Included in first stage works)

(†Beyond 2025 the purchase of additional River Murray allocations may be an option in lieu of further desalination but this would depend on suitable arrangements to guarantee the reliability of the additional water. This could be through changes to the Murray-Darling Basin Agreement or a greater strategic reserve held in upstream storages.)

What do these recommendations deliver?

By 2012 the initial 50 GL desalination plant and interconnection pipelines provide increased protection against in-flow variability, but will not prevent water restrictions and the need for special water sharing agreements in extreme drought. (The other states are unlikely to agree to alternative water sharing arrangements unless Adelaide is on major water restrictions.)

By 2017, when the increase in Mt Bold storage becomes available, the strategy would allow Adelaide to survive a repeat of the current drought with restrictions no worse than level 3.

Is a desalination plant necessary?

Desalination is not a water supply option to be chosen lightly. The plants are energy intensive and lock water supply into high-energy usage that is likely to be subject to ongoing increases in real prices. The water is expensive. The energy intensity, of itself, means desalination is not "green" and needs to be implemented with great care to avoid environmental damage.

There is currently a level of support for desalination as a water supply solution that risks unthinking decision making that could lead to a bad long-term outcome. The Working Group has been careful to ensure that its recommendation that a desalination plant be constructed is based upon a real need and that there are no easy alternatives.

Desalination is the only climate independent solution and therefore diversifies Adelaide's water supply. Desalination caps Adelaide's average extraction from the River Murray at the current level (about 40% of average annual supply). Future upgrading of desalination capacity is related to the future management of the Murray-Darling Basin.

Seawater desalination technology

All plants being constructed or proposed in Australia use reverse osmosis as the desalination process. The Desalination Working Group (through SA Water) let a consultancy to assess the different technologies available for large-scale desalination. The consultants concluded that reverse osmosis is the most energy and cost efficient technology currently available.

A seawater desalination plant for Adelaide should use reverse osmosis as the preferred technology.

Emerging technology

This report is based on the best current technology and knowledge of desalination. It is possible that new water technologies will emerge and will need to be evaluated from time to time.

Appendix A -

Desalination Working Group Terms of Reference

Terms of reference:

To research and report to the Minister for Water Security on:

- How desalination fits with the Water Proofing Adelaide strategy for an integrated and diversified water supply system;
- Feasible options and optimal technology for seawater desalination;
- Options for sizing and location, and integration with the existing metropolitan Adelaide water supply system;
- The estimated capital and operating costs of desalination as a resource for metropolitan Adelaide, including funding options and implications;
- Environmental implications of constructing and operating a desalination plant, including in the context of climate change;
- Appropriate arrangements for constructing and operating a desalination plant.

Membership:

Ian Kowalick (chair)	Independent Murray-Darling Basin Commissioner for South Australian
John Williams	Head of Strategic Projects SA Water
Rod Hook	Executive Director Office of Major Projects and Infrastructure
Robert Schwarz	Assistant Under Treasurer Department of Treasury and Finance

Coordination/executive officers:

Anne Westley	Manager, Ministerial Liaison Unit SA Water
Matthew Baines	Specialist Engineer, Strategic Projects SA Water

Appendix B –

List of Consultancies

The following tables list the consultancies that have been let to further investigate the desalination and Mt Bold upgrade proposals.

DESALINATION

Project	Scope of Work	Consultant
Metropolitan Adelaide water supply system security investigation	Investigation to assess metropolitan Adelaide water supply system (MAWSS) reliability, including at two future time steps, 2025 and 2050 in order to estimate the most appropriate future time at which major upgrades to the MAWSS will be required. The effect of increased storage capacity in the Onkaparinga system, and increased supply through a supplementary source such as a seawater desalination plant on the reliability of supply is also assessed.	Tonkin Consulting (completed)
Desalination scoping study update	Revise and expand the November 2006 scoping study to cover the three nominated sites, including intakes and outfall and storage requirements for plant operation, but not balancing storage required within the system, nor integration with the water network. The study includes scenarios of both a 50GL/a and a 100GL/a plant for each of three nominated plant sites; Pelican Point, West Torrens and Pt Stanvac. The 50GL/a scenarios allow for future upgrading to 100GL/a capacity, with particular attention given to items such as intake and outfall infrastructure. The plant site also allows enough room for upgrade from 50 GL/a to 100 GL/a including any buffer areas required.	United Water International (completed)
Desalination inter-connectivity	Provide a pre-feasibility study for interconnection works plus the linking pipeline to the desalination plant and any plant side buffer storage, plus the desalination plant intakes and outfall, covering two plant capacities; 50GL/a and a 100GL/a for each of the three nominated plant sites. The works required for a 50GL/a plant allow for possible future upgrading to a 100GL/a plant.	United Water International (completed)
Assessment of feasibility and economics of cogeneration desalination and power plants in Adelaide	An analysis of specific energy consumption (in MWh/ML) within a plant (ie not including raw water, outfall or distribution pumping): • Comparing energy use between different technologies (including complete energy required for thermal processes with and without waste heat) • Providing a breakdown of specific energy consumption of components within the plant itself • Advice on the advantages of collocation of seawater desalination and power plants	GHD (completed)
Provision of forward energy market prices for operation of large-scale desalinated seawater plants for metropolitan Adelaide	Provide modelling of forward wholesale and retail electricity contract prices (peak and off-peak) in yearly increments for the operation of large-scale seawater desalination in metropolitan Adelaide at two different capacities requiring 225 MWh/annum and 450 MWh/annum.	Creative Energy Solutions (completed)

Project	Scope of Work	Consultant
Hydrodynamic brine dispersion modelling	The scope of the study involves the development of a hydrodynamic model to assist in determining regions where the discharge of a hyper-saline concentrate stream would have minimal impact on the marine environment. The information acquired from the model will also assist in planning for future environmental monitoring programs. The requirements for the hydrodynamic model include: • A review of existing hydrodynamic modelling, oceanography and meteorology information for the Gulf St Vincent • An assessment of seasonal variability in tidal movements and temperature changes, including worst case scenarios (e.g. dodge and neap tides). • Calibration, validation and sensitivity analysis to test model integrity and ensure reliability of predicted outcomes.	Scope being reviewed to allow call in Oct 07
Marine ecological characteristics	Phase 1 Undertake a desktop review to identify and classify marine habitats and biota at each of three sites. The review will consider the marine zone both immediately offshore and within the area of a proposed outfall for each site, as well as the significant habitats or habitat features in a broader area of up to several kilometres from each site. Phase 2 marine survey Undertake marine surveys to identify and classify the distribution and abundance of marine habitats, species and communities, covering the full range of depths from shore to intake and outfall structures and including mixing zone areas. Marine surveys will occur over a period of (at least) 12 months to detect any seasonal variability. Surveys will be undertaken each season. Identify habitat, species or communities that may be impacted by the various elements of the desalination plant (discharge, intake/outfall structures). Identify species or communities of conservation significance, including those of national environmental significance under the *Environment Protection Biodiversity Conservation Act 1999* that may be impacted by a desalination plant (discharge, intake/outfall structures)	In process of being awarded
Eco-toxicological analysis	Development of an assessment program to determine potential impacts of the brine discharge on the marine environment. This assessment would be undertaken once a preferred site(s) is identified and marine habitats and biota in the vicinity of the site have been characterised; and once a pilot desalination plant has been installed.	To be done after pilot plant established.
Water quality characteristics study	Baseline Water Quality Monitoring Undertake a monitoring program to determine ambient water quality characteristics in the vicinity of intake/discharge sites. Consideration will be given to the selection of sampling sites based on the outcomes of the hydrodynamic model. Reference sites (control sites) should be included in the design of the monitoring program. Physical, chemical and biological parameters will be assessed, including parameters currently not monitored as part of the EPA water quality monitoring program.	Now on call.
Issues identification study	The objective is to identify all information needed to adequately prepare an environmental impact assessment for both the new dam and the desalinaiton plant, and to do a gap analysis with the information that will become available from the various studies currently planned or completed	Parson Brinkerhoff
Preparation of EIS document	Preparation of EIS document	To be let late in 2008 when results of other studies are available

MT BOLD EXPANSION

Project	Scope of Work	Status
Mt Bold internal study into alternative Mt Lofty ranges storages	A scoping study to investigate and define all feasible water storage options within the Mt Lofty Ranges for the storage of water pumped from the Murray River, for later transfer into the metropolitan water supply system. The ultimate aim of the study will be to identify an area or areas suitable to achieve a minimum additional 200 GL of storage. This additional volume could be achieved at one location or at a combination of locations	Started
Mt Bold fauna & flora study	Baseline terrestrial fauna and flora study.	Started
Mt Bold preliminary heritage study	Research and review archival material relevant to the study area, including documents relating to the development history, previously recorded traditions, mythologies, stories and oral history, as well as reports of any previous Aboriginal cultural heritage surveys (where relevant). Identify and assess the anthropological, historic, traditional or archaeological significance of previously recorded sites in the study area, including those recorded in Aboriginal Affairs and Reconciliation Division (AARD) register of sites and SA Museum records. Identify any previously recorded Aboriginal sites that may be directly impacted upon as a result of the Mount Bold reservoir capacity expansion project. Undertake field investigations to assist with broadly identifying potential significant or sensitive areas, with respect to Aboriginal heritage within the study area. Note: Private property will not to be accessed at this stage.	Started
Mt Bold interconnectivity pre-feasibility study	A pre-feasibility study for the interconnection works. The study includes: i) Determination of appropriate pipe sizes and pump station sizes. ii) Determination of interface options to existing water infrastructure. iii) Determination of any buffer water storage requirements. iv) Determination of possible pipeline routes and sites. v) Determination of appropriate technology and engineering.	United Water
Mt Lofty Ranges bulk water transfer scoping study	A scoping study to allow the transfer of around 200 ML/day of Mt Bold reservoir water into the MA pipeline.	Tonkin Consulting
Mt Bold geotechnical investigations	Geotechnical studies including: i) A review of background material and earlier assessments. ii) Site geological mapping iii) Excavation of test pits and trenches in key areas iv) Borehole drilling at targeted locations v) Laboratory testing	Coffey

In addition to the consultancies listed below, there are a number of items being pursued internally by SA Water. Including:

- Detailed assessment of storage sites within the Mt Lofty Ranges
- Full supply level study of the Mt Bold reservoir proposal to evaluate/confirm the most appropriate height of dam wall

Appendix C –

MAWSS Security Investigations Assumptions

A range of assumptions were made to assess the reliability in each stage of the investigation.

Inflows to the Mount Lofty Ranges storages have been assumed to be climatically independent to River Murray flows past Lock 7. As part of the MAWSS Security Investigation, Tonkin Consulting concluded that there was insufficient evidence to suggest that there two system were not independent. Given that flows over the South Australian border are highly regulated and governed by operating rules of the MDBC, the assumption of independence was satisfactory for the modelling work performed in the MAWSS Security Investigation.

One of the key challenges encountered in modelling the MAWSS headworks was how the rolling-average licence was modelled. As described above, Tonkin Consulting reported two major reliability scenarios, each based on:

1. The rolling average licence.
2. The rolling average licence plus a first use licence of 16 GL

The frequency of shortfalls for each scenario is shown earlier in Table 2. In assessing these scenarios, water availability has been based on South Australia's entitlement flow and South Australia's predicted monthly allocation using the MDBC monthly simulation model. In this case, there are years when SA Water's River Murray extractions are expected to be constrained by the limitations of the licence. The 16 GL first use licence is enough to remove these constraints.

Water availability has been calculated based on the ratio of South Australia's total predicted allocation to South Australia's entitlement flow (1850 GL). This method considers the available licence based on extractions from the previous four years and licence restrictions due to South Australia receiving less than entitlement flow. MAWSS extractions each year are subject to the same restrictions as irrigators and other urban users. The volumes available for the MAWSS are influenced by the annual allocation of water to South Australia as well as the rolling licence availability.

River Murray losses are around 1130 GL under average conditions from the South Australian border to the Murray Mouth. However, under drought conditions it is assumed that the losses are up to 1235 GL; this represents a drought case where the net evaporation rate is higher. The higher figure of 1235 GL has been used to calculate system reliability. This recognizes that water security is more critical under drought conditions.

In the MAWSS Security Investigation the River Murray flows past Lock 7 are based on Murray-Darling Basin Commission (MDBC) modelling of historical inflow data and under current operating conditions, ie no reduction in rainfall due to climate change. Any potential change to River Murray operating rules will have an affect on flows past Lock 7.

Appendix D –

Detailed Cost Estimates

Mt Bold Reservoir Expansion

Currie & Brown review

Mt Bold - CAPEX

Description	Qty	Unit	Rate	Sub Total	Total
Construction Works					
Main Dam					$ 170,000,000
2.5 million cubic metres of phyllite	2,500,000	m3	$ 35	$ 87,500,000	
0.5 million cubic metres of imported filter + good rockfill	500,000	m3	$ 60	$ 30,000,000	
35 000 cubic metres of concrete	35,000	m3	$ 1,000	$ 35,000,000	
Excavation of weathered rock	31,633	m3	$ 30	$ 948,981	
Preparation of dam foundation	63,264	m2	$ 11	$ 695,907	
Pressure grouting of foundation	6,600	m	$ 130	$ 858,000	
Outlet Works	1	LS	$ 15,000,000	$ 15,000,000	
Saddle Dam					$ 80,000,000
1.25 million cubic metres of phyllite	1,250,000	m3	$ 35	$ 43,750,000	
0.25 million cubic metres of imported filter + good rockfill	250,000	m3	$ 60	$ 15,000,000	
17 5000 cubic metres of concrete	17,500	m3	$ 1,000	$ 17,500,000	
Excavation of weathered rock	20,303	m3	$ 30	$ 609,090	
Preparation of dam foundation	40,607	m2	$ 11	$ 446,677	
Pressure grouting of foundation	6,600	m	$ 130	$ 858,000	
Drainage Tunnel	1	LS	$ 2,000,000	$ 2,000,000	
Service Spillway					$ 40,000,000
Breaching the existing dam	1	LS	$ 2,000,000	$ 2,000,000	$ 2,000,000
Vegetation Clearance (SA Water land)					
Exotic Vegetation 100 Ha	100	Ha	$ 12,000		$ 1,200,000
Native Vegetation 468 Ha	468	Ha	$ 12,000		$ 5,620,000
Pasture 31 Ha	31	Ha	$ 2,000		$ 60,000
Vegetation Clearance (Private land)					
Exotic Vegetation 60 Ha	60	Ha	$ 12,000		$ 720,000
Pasture 150 Ha	150	Ha	$ 2,000		$ 300,000
Revegetation (SA Water land)					
Purchase Land - value $25,000/Ha	6,000	Ha	$ 25,000		$ 150,000,000
Revegetate 6,000 Ha (at 10:1 clearance ratio)	4,700	Ha	$ 8,000		$ 37,600,000
Land acquisition - buffer zone at reservoir tail					
Purchase land - 30 properties (around 300 Ha)	300	Ha	$ 225,000		$ 67,500,000
Purchase land - improvements	30	No	$ 75,000		$ 2,250,000
Purchase land - other compensatable items (40%)	1	Item			$ 27,850,000
Purchase land - property owner acquisition costs	30	No	$ 30,000		$ 900,000
Revegetate 80% of 300 Ha	250	Ha	$ 8,000		$ 2,000,000
				Sub-total (a)	$ 588,000,000
Construction Preliminaries, Overhead & Margin (15%) (excluding land purchase)					$ 51,000,000
Principal Controlled Insurance (0.8%) (excluding Land Purchase)					*$ 3,000,000*
				Sub-total (b)	$ 642,000,000
Contingencies (30%)					*$ 193,000,000*
				Sub-total (c)	$ 835,000,000
Project Delivery 20% (excluding land purchase)					$ 117,000,000
Total					$ **952,000,000**
Other Items					
Water Licenses					
200 GL	500,000	/GL			$ 100,000,000
Increased Pumping					
Three years on MB-O (300 GWh) @ $70/MWh					$ 21,000,000
Green Power premium (at $42/MWh for 300GWh)					$ 12,600,000
Construction offset					
Greenhouse offset for Mt Bold construction activities					$ 22,000,000
Estimated Total Project Cost					$ **1,110,000,000**

Mt Bold - OPEX

O&M at Mt Bold	$ 4,000,000
Total	$ 4,000,000

Desalination Plant

DESALINATION PLANT FOR ADELAIDE WATER SUPPLY - COST ESTIMATES

Non-Staged Construction

	Pelican Point		West Beach		Port Stanvac	
	152 ML/d	304 ML/d	152 ML/d	304 ML/d	152 ML/d	304 ML/d
Land Acquisition Costs	30	30	44	44	36	36
Land Remediation Costs	5	5	2	2	0	0
Electricity Network & Sub-Stations	28	42	83	110	23	36
Sub-Total	63	77	129	156	59	72
Inlet Pipework/Tunnel (inc. shafts)	42	64	202	254	70	117
Inlet Pump Station	37	37	37	42	57	86
Outfall(s) (Inc. Shafts and Risers)	310	337	139	142	29	54
Investigations and Preliminaries	14	21	14	21	14	21
Pretreatment	83	152	65	124	65	124
Reverse Osmosis System	201	396	201	396	201	396
Potabilisation System	12	15	12	14	12	14
Drinking Water Storage	15	17	15	17	15	17
Power & Controls	53	67	53	67	53	67
Wastewater	13	23	13	23	13	23
Miscellaneous	65	86	65	86	65	86
Commissioning, Performance Testing	23	45	23	45	23	45
Sub-Total	868	1,259	838	1,231	617	1,050
Total Construction Costs (TCC)	931	1,336	967	1,387	676	1,122
Contingency & SA Water Costs (30% TCC)	279	401	290	416	203	337
Desalination Plant Costs (inc. Contingencies)	1,210	1,736	1,257	1,803	879	1,459
Pump Stations & Pipeline(s) to WTP(s)	135	162	99	189	76	90
WTP Balancing Storage & Mixing Works (excluded)	0	0	0	0	0	0
Network Upgrade Costs (inc. Contingencies)	135	162	99	189	76	90
Total Project Costs	1,345	1,899	1,356	1,992	955	1,549

Staged Construction Approach

	Pelican Point		West Beach		Port Stanvac	
	152 ML/d	304 ML/d	152 ML/d	304 ML/d	152 ML/d	304 ML/d
Land Acquisition Costs	30	30	44	44	36	36
Land Remediation Costs	5	5	2	2	0	0
Electricity Network & Sub-Stations	42	42	110	110	36	36
Sub-Total	77	77	156	156	72	72
Plant Increase in Costs Over Non-Staged (%)	9.4%	4.8%	8.6%	4.3%	13.8%	5.2%
Sub-Total	949	1,319	910	1,284	702	1,105
Total Construction Costs (TCC)	1,026	1,396	1,066	1,440	774	1,177
Contingency & SA Water Costs (30% TCC)	308	419	320	432	232	353
Desalination Plant Costs (inc. Contingencies)	1,334	1,815	1,386	1,872	1,007	1,530
Network Upgrade Costs (inc. Contingencies)	162	162	189	189	90	90
Stage 1 Project Costs	1,497	1,497	1,575	1,575	1,097	1,097
Stage 2 Project Costs	0	481	0	486	0	523
Total Project Costs	1,497	1,977	1,575	2,061	1,097	1,620

Cost Penalties

Total Project Costs	Pelican Point	West Beach	Port Stanvac
Non-Staged Construction	1,899	1,992	1,549
Staged Construction Approach	1,977	2,061	1,620
Cost Penalty	79	69	71

Desalination Plant

Staged Construction Approach

Stage 1 - 152 ML/d	Pelican Point	West Beach	Port Stanvac
Land Acquisition Costs	30	44	36
Land Remediation Costs	5	2	0
Electricity Network & Sub-Stations	42	110	36
Sub-Total	**77**	**156**	**72**
Cost for Non-Staged 152 ML/d Plant	868	838	617
% Increase For Staged 152 ML/d Plant	9.4%	8.6%	13.8%
Desalination Plant Construction Costs	**949**	**910**	**702**
Stage 1 Total Construction Costs (TCC)	**1,026**	**1,066**	**774**
Stage 1 Contingency & SA Water Costs (30% TCC)	**308**	**320**	**232**
Network Upgrade Costs (inc. Contingencies)	**162**	**189**	**90**
Stage 1 Project Costs	**1,497**	**1,575**	**1,097**

Stage 2 - Additional 152 ML//d	Pelican Point	West Beach	Port Stanvac
Cost for Non-Staged 304 ML/d Plant	1,259	1,231	1,050
% Increase For Staged 304 ML/d Plant	4.8%	4.3%	5.2%
Desalination Plant Construction Costs - 304 ML/d Plant	1,319	1,284	1,105
Desalination Plant Construction Costs - 152 ML/d Plant	949	910	702
Implied Additional Cost of Stage 2 Infrastructure	370	374	402
Stage 2 Total Construction Costs (TCC)	**370**	**374**	**402**
Stage 2 Contingency & SA Water Costs (30% TCC)	**111**	**112**	**121**
Network Upgrade Costs (inc. Contingencies)	**0**	**0**	**0**
Stage 2 Project Costs	**481**	**486**	**523**
Total Project Costs (Stage 1 + Stage 2)	**1,977**	**2,061**	**1,620**

Consolidated estimate – Plant and integration works

PROPOSED ADELAIDE DESALINATION PLANT INTERCONNECTION WORKS - CONSOLIDATED ESTIMATED COSTS

No.	Capital Works	Civil $k	Mechanical $k	Electrical $k	Total Capex $k	Opex $k p.a.
1	Pt Stanvac 50 GL/a Desalination Plant (Stage 1)					
	ETSA Supply			$46,800		
	Inlet Works & PS	$142,548	$95,032			
	Land Acquisition and Remediation	$46,800				
	Process	$154,373	$360,203			
	Outfall	$70,123				
	Switchboard & Controls			$69,351		
	Storage Tanks	$21,502				
	Sub Total	**$435,345**	**$455,235**	**$116,151**	**$1,006,731**	**$49,407**
2	Pt Stanvac - Happy Valley PS (300ML/d - Option 2A without storage)					
	ETSA Supply (covered under item 1)					
	Building	$3,167				
	Pumps (3480L/s)		$4,459			
	Pipework in PS	$3,481				
	Switchboard & Controls			$4,350		
	Sub Total	**$6,648**	**$4,459**	**$4,350**	**$15,457**	**$6,022**
3	Pt Stanvac - Happy Valley Pipeline (300 ML/d - Option 2A without storage)					
	Supply Pipe (1629mm)	$27,644				
	Install Pipe (1629mm)	$39,692				
	Valves		$1,885			
	Other Services Alterations	$5,207				
	Sub Total	**$72,544**	**$1,885**	**$0**	**$74,420**	**$744**
4	Happy Valley 2 x 95 ML Storage Tanks (370ML/d Mt Bold Expansion Scheme)					
	Excavation & Civil	$6,163				
	Pipework & Valves		$2,878			
	Liner & Roof	$5,459				
	Sub Total	**$11,622**	**$2,878**	**$0**	**$14,560**	**$145**
5	Happy Valley - Hope Valley Pipeline (370ML/d Mt Bold Expansion Scheme)					
	Supply Pipe (2159mm)	$81,913				
	Install Pipe	$85,863		$609		$1,850
	Valves		$5,014			
	Chlorination Building	$503	$2,395	$1,073		$176
	Hope Valley Inlet	$435	$943	$363		$20
	Other Services Alterations	$11,557				
	Sub Total	**$180,271**	**$8,352**	**$2,045**	**$190,668**	**$2,046**
6	Hope Valley EL 103/170 PS (3750L/s at 70m)					
	ETSA Supply			$5,800		
	Building	$2,888	$1,103			
	Pumps & Pipework	$3,397	$2,932	$795		
	Switchboard & Controls			$3,222		
	Sub Total	**$6,286**	**$4,035**	**$9,817**	**$20,138**	**$1,996**
7	Terminal Storage EL 170/336 PS (1000L/s at 17km)					
	ETSA Supply			$4,350		
	Building	$3,815	$1,090			
	Pumps & Pipework	$3,481	$2,168	$551		
	Switchboard & Controls			$2,958		
	Sub Total	**$7,296**	**$3,257**	**$7,859**	**$18,412**	**$1,359**
8	Terminal Storage - Barossa Trunk Main Pipeline (150 ML/d Mt Bold Scheme)					
	Supply Pipe (1283mm)	$9,660				
	Install Pipe	$23,547		$203		$381
	Valves		$603			
	Tank HOBVs	$725	$1,450	$870		$52
	Other Services Alterations	$4,048				
	Sub Total	**$37,980**	**$2,053**	**$1,073**	**$41,100**	**$433**
9	Salisbury East EL 170 Booster PS (1100L/s at 60m)					
	ETSA Supply			$4,785		
	Building	$3,196	$1,090			
	Pumps & Pipework	$3,481	$934	$249		
	Switchboard & Controls			$1,672		
	Sub Total	**$6,677**	**$2,024**	**$6,706**	**$15,408**	**$659**
10	Barossa Trunk Main Bypass Valve (20ML/d)					
	Valves		$1,160	$290		
	Building	$725				
	Sub Total	**$725**	**$1,160**	**$290**	**$2,175**	**$25**
	TOTAL	**$705,394**	**$485,338**	**$148,290**	**$1,399,023**	**$62,836**

Notes:
1. Desalination Plant prices include 30% contingency and engineering fees
2. All other prices include 45% contingency and engineering fees