3

Need for the Project

This chapter discusses the need for the Project. This includes consideration of recent thinking in the field of water resource management, particularly with respect to maintaining supply during drought periods. Reference is also made to current planning strategies for the Lower Hunter region, which is reliant on a secure water supply to support projected population growth.

3.1 Strategic context

3.1.1 International and national context

Around the world, the water industry has begun assessing the impacts of climate change on water resource management. Areas in the United States such as California and Arizona which have climates similar to that of Australia, have found that climate change impacts are requiring a different approach to water resource management. Increasingly, security of supply has become the dominant issue. New water sources and inter-basin transfer schemes are being investigated. Water efficiency and demand management initiatives are similarly being examined more frequently. These have been accompanied by a greater focus on issues such as stormwater capture, leakage management, pressure control to reduce leakage and consumption rates as well as an increase in the use of recycled water to meet appropriate needs.

Historically in the UK, there has been a need for only relatively small storages for bulk water as rainfall and consequently stream flows have been very reliable. However, over recent years these small storages have depleted in the unusually dry conditions resulting in some of the most severe restrictions that these areas have had to face. Recently the UK announced its first desalination plant to bolster supplies.

Australia has experienced a rise of 0.9°C in mean temperature since 1910 consistent with global mean temperatures which have increased by between 0.7-0.8°C since 1900 (Bureau of Meteorology 2007). While trends in annual rainfall are indicative of an increase in precipitation for the northwest, there has been a significant decline in precipitation in the southeast of the country as shown in Figure 3.1. During 2006, parts of southeast Australia experienced their driest year on record. The driest areas included catchments which feed the Murray and Snowy Rivers, consequently affecting supplies to major dams that year (Bureau of Meteorology 2007a).

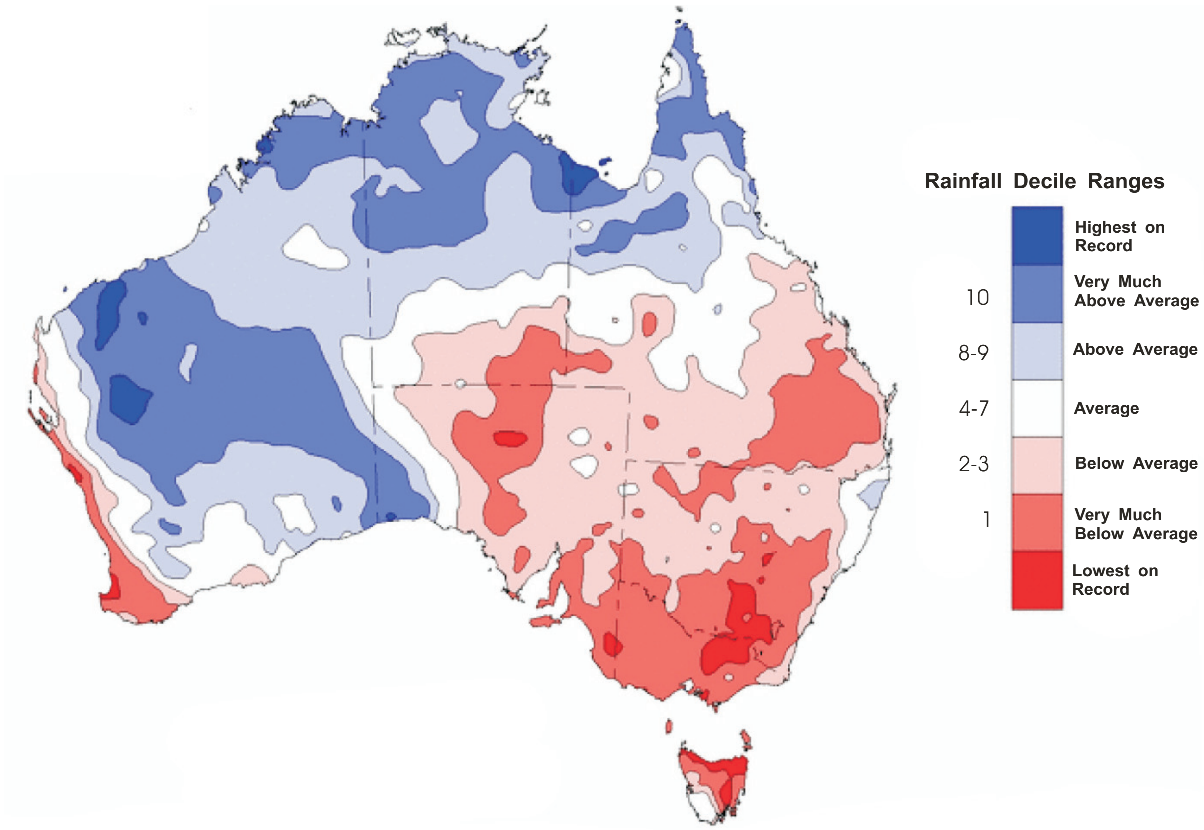

FIGURE 3.1 AUSTRALIAN RAINFALL DECILES 1 JANUARY TO 31 DECEMBER 2006 (NATIONAL CLIMATE CENTRE 2006)

Water management authorities are adopting a diversity of strategies to prepare for the forecast water shortages. Perth has invested in a number of new surface water storages and has had a strong focus on water use efficiency. Despite these efforts, the decline in rainfall has reduced inflows to the State's storage facilities to such a degree that to meet demand two desalination plants have been commissioned (Hunter Water Corporation 2007d). Sydney and Melbourne have followed suit and are also investing in desalination plants despite extensive demand-management programs which have reduced water usage by up to 30 per cent in some instances.

Significant drought problems have been felt in southeast Queensland with extremely severe restrictions imposed in Toowoomba, Ipswich, Brisbane and the Gold Coast. This area is focusing on the creation of a regional water grid, with supply drawn from sources such as a planned desalination plant on the Gold Coast, a large water recycling scheme in Brisbane and from a large new dam.

The Central Coast has been under drought conditions for the greater part of the past 10 years with water restrictions having being introduced around 2003. Despite these, storages suffered a significant decline requiring a link to be constructed to HWC's water supply system to supplement the Central Coast supply. Management regimes have lead to rainwater tanks being a mandatory requirement for all new developments and implementation of other water efficiency and recycling schemes. Recent rainfall has allowed the combined Central Coast storages to replenish from approximately 10–30 per cent over the last 12 months. Despite this, Gosford and Wyong Councils are investigating options to provide greater security to their existing supply. A pipeline to allow the transfer of water between Mardi and Mangrove Dams to improve the capacity for storage within the overall water supply system is currently under consideration.

3.1.2 Regional context

From a water supply perspective, since 2006 the Lower Hunter has been fortunate to have experienced greater than average rainfall and flows within its water supply catchment. This is in stark contrast to the significant drought which has been experienced across the rest of Australia. In 2007, 1,468 millimetres of rainfall fell at Newcastle. This compares to the long term annual average of about 1,100 millimetres that is normally experienced on the coast.

While rainfall has been high since 2006, the historic rainfall record and as well as modelling of river flows through the Williams River indicates that approximately every 25 years on average, the lower Hunter can expect a significant drought. The last such significant event was the drought that occurred in the early 1980s which lasted approximately two years. Current water storages in the lower Hunter do not have the capacity to handle such events without becoming severely depleted and at risk of running dry.

In April 2008, HWC released the *Draft $H_2$50 Plan* for public comment. The plan represents the first revision of HWC's *Integrated Water Resource Plan* (IWRP) which was released in 2003. The *Draft $H_2$50 Plan* sets out a framework for HWC's long term water resource planning to meet water demand in the Lower Hunter for the next 50 years. This is in contrast to the IWRP which addressed the Lower Hunter's water requirements over a 10-year time frame.

The IWRP indicated that a new water source would not be required within the next 30 years. Rather, HWC's first priority in the IWRP was to limit demand growth to avoid the economic and environmental costs of creating new sources (Hunter Water Corporation 2003). The IWRP outlined that the region's water requirements over a 10-year time frame would be met predominantly through demand management initiatives, leakage reduction programs and water recycling projects. The only project to increase water supply outlined in the IWRP was the optimisation of the existing Grahamstown Dam.

This was based on the following assumptions:

- a continuation of the existing climatic conditions with no allowance made for potential change in climatic conditions
- continuing with the existing reliability of supply criteria (yield), for managing existing sources
- a projected population growth of around 85,000.

Since 2003, there have been a number of very significant changes in the regional water resources planning environment. These include:

- recognition of the need to provide a higher level of security against drought, which is based on the premise that a major urban centre cannot be allowed to run out of water
- the *Lower Hunter Regional Strategy* (Dept of Planning 2006a) forecast of almost a doubling of growth over the next 25 years with an additional 160,000 people living in the region[1]
- a change in the assessment of system yield, indicating a shortfall between current demand and reliable yield

1 The latest (2008) projections from DoP forecast population growth at 158,000 for the region.

- an increasing awareness of the implications of climate change and of the experiences of other regions which have been in severe drought for some time.

Consequently the assumptions used in the IWRP are no longer considered valid with the recently finalised *$H_2$50* Plan now responding to these changes. These are also discussed further in Section 3.3.

3.2 Planning context

The NSW State Plan *A New Direction for NSW* (NSW Government 2006a) indicates that NSW faces many environmental challenges, notably climate change and drought. It identifies that meeting the State's water needs in the face of drought, climate change and population growth requires a sustained effort to balance supply and demand, increase recycling and improve efficiency of water use. The Tillegra Dam project, in partnership with the Kooragang Recycling Initiative, is seen as an integral component in providing a secure and sustainable water supply for the Lower Hunter region.

The *State Infrastructure Strategy* (NSW Government 2006b) notes that Newcastle is NSW's second largest urban centre and port outside Sydney and contains just under half the Hunter region's population. The Project would contribute significantly to underpinning settlement and development strategies and goals through provision of a secure water supply.

3.2.1 Lower Hunter Regional Strategy

The *Lower Hunter Regional Strategy* (Department of Planning 2006) provides the context for the NSW Government's 25 year land use strategy for the region to 2031. The Strategy plans for the provision of sufficient new urban and employment lands to meet expected strong demands for growth. This assumption is based upon a regional population forecast of 675,000 persons by 2031 and equates to a population increase of 160,000 over the period 2006-2031.

The Strategy also aims to ensure that the region develops in a strong and sustainable way. The objectives of the Strategy include;

- maintaining and improving biodiversity
- protecting natural and rural resource assets
- promoting growth in centres with a greater choice of housing and jobs in the Newcastle CBD and specified major centres
- providing for 115,000 new homes to cater for a projected population growth of 160,000 people.

The Strategy applies to the LGAs of Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock. Of particular relevance to the Project, the Strategy recognises the importance of adequate drinking water to meet the demands of the projected population increase in the Lower Hunter region. The Strategy also independently notes that the region's water supply is extremely volatile with resources depleting and replenishing very quickly depending on weather conditions.

The Strategy responds to current levels of growth and recognises that this would continue as the Lower Hunter region broadens its economic role in the context of the NSW and national economy. In particular, the Strategy identifies that infrastructure planning would need to take into account the broad planning framework to ensure that future population growth is supported by services and associated infrastructure. The Project is an important infrastructure requirement to support the objectives of the Strategy.

In late 2008 the Department of Planning issued revised population forecasts for the Lower Hunter. These forecasts are slightly lower than those adopted by the regional strategy. The population forecasts should not, however, be confused with the policy statement in the strategy which when achieved would still see the projected growth for the region realised.

3.2.2 Draft Central Coast Regional Strategy

The Draft Central Coast Regional Strategy (Department of Planning 2006b) is of relevance to the Project given the proximity of the Central Coast region to the Hunter region. The draft Strategy notes that the 2005 Sydney Metropolitan Strategy identifies the Central Coast as having the land resources to support a further 100,000 people by 2031 however ongoing drought conditions and sustainable water supply issues are impacting on the certainty needed to meet this demand. Key water challenges include, amongst others, providing a sustainable, long-term water supply.

The draft Strategy identifies the potential for water demand to be met in part through transfers from the Hunter region. The Project would be a significant component in the capacity to facilitate any such transfers in the future.

3.3 Project need

A comprehensive analysis of the need for Tillegra Dam has been undertaken by HWC. This gave particular consideration to:

- water resource planning
- climate change
- system yields
- demand for water
- water efficiency
- projected population growth of 160,000.

This analysis is documented in the *Draft $H_2$50 Plan* (Hunter Water Corporation 2008a) and *Why Tillegra Now?* (Hunter Water Corporation 2007d). The following discussion is a synopsis of relevant sections of these documents.

3.3.1 Current supply system

Figure 3.2 shows the performance of the existing system in terms of historic streamflows (1930s to 2006) and current demand, and then cumulatively with respect to:

- a population increase of 160,000 persons
- a 10 per cent reduction in rainfall due to climate change
- supply to the Central Coast.

Water restrictions are triggered when the storage volume reaches 60 per cent.

The following conclusions were drawn from this analysis:

- the existing system is extremely volatile; storage levels can rise and fall rapidly (storage volume in the Lower Hunter can fall more than twice as fast as storages in the Sydney region)

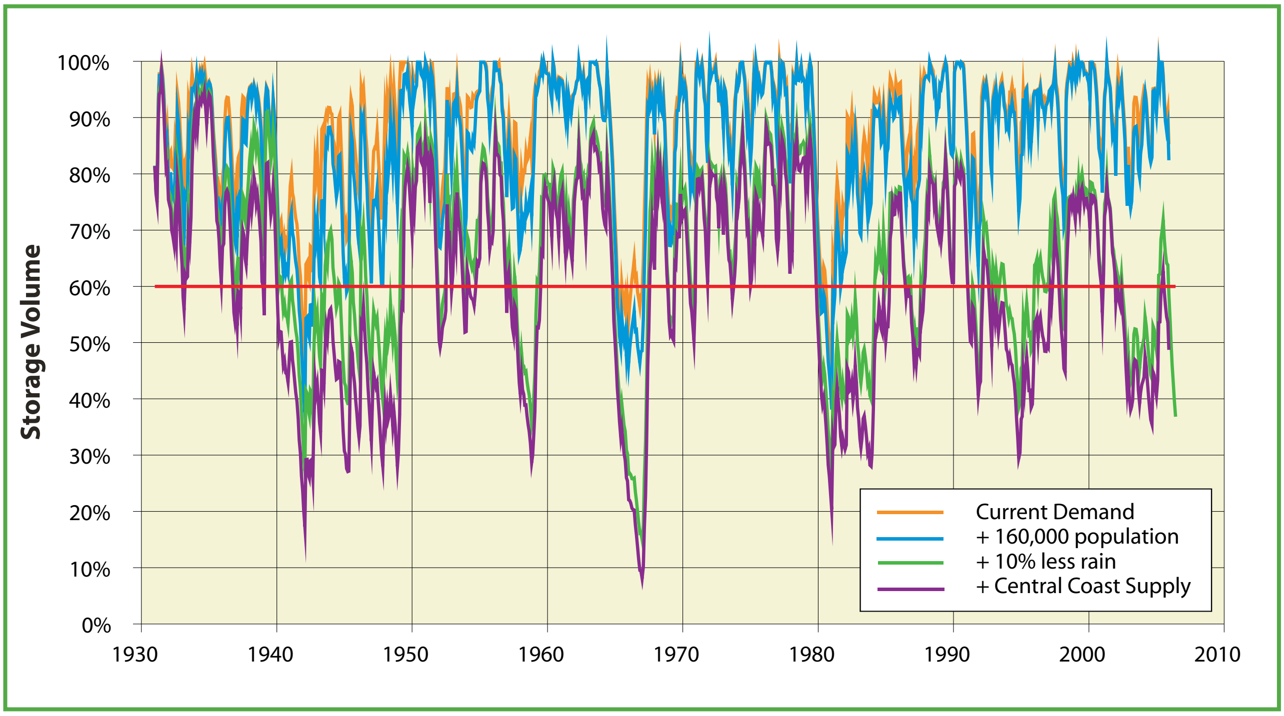

FIGURE 3.2 PERFORMANCE OF EXISTING LOWER HUNTER WATER SUPPLY SYSTEM

- a 10 per cent decline in rainfall has a significant impact on storage levels and the duration of water restrictions imposed on the community
- while the last 20 years have been relatively wet with little or no restrictions, 10 per cent less rain plus population growth would see the Hunter region in restrictions most of the time and facing the real risk of running out of water
- the addition of 160,000 people to the Lower Hunter region generally does not have a significant impact on storage levels except in the case of severe droughts such as occurred in the 1940s, 1960s and early 1980s
- adding the Central Coast makes little difference to whether the system goes in and out of water restrictions. Restrictions are triggered when storage capacity drops to 60 per cent.

While the Hunter region's water supply is considered good under average conditions, it is extremely volatile and vulnerable to long-term droughts and to the potential impacts of climate change. Storages have plummeted from 100 per cent full to 40 per cent in less than 18 months. Such a rapid depletion of storage volume means that the region would not have sufficient time to implement drought contingency measures to adequately meet the community's needs.

3.3.2 Climate change

In 2004 the CSIRO issued a report on the potential effects of climate change on NSW, which included the Lower Hunter region. The report found that by 2030 rainfall could rise or fall by 10 per cent, annual average potential evaporation could rise by up to eight per cent, temperature could rise by 0.2–1.6°C and the frequency and severity of extreme weather could increase (Hennessey *et al* 2004). The $H_2$50 Plan indicates that a 10 per cent reduction in rainfall would result in an estimated 25 per cent reduction in streamflow for the Williams River catchment (Hunter Water Corporation 2008a).

The NSW government report *Summary of Climate Change Impacts–Hunter Region* (Department of Environment and Climate Change 2008) notes that for the Hunter region, temperatures may rise in the future by 1–3°C. Rainfall will change with wetter summers and drier winters expected. Annual runoff may change by about –5 per cent to +12 per cent. The report notes that while rainfall may increase substantially during summer, at the drier end of the scale predicted, water storages in the Hunter risk annual inflow reductions of 5–10 per cent.

The DECC report is based on the results of four climate models. A complementary study by the NSW Department of Water and Energy considered climate change predictions from 15 different models and noted that runoff estimates could change by ±20 per cent in the eastern parts of New South Wales. The variability of these results indicates there is still an element of uncertainty in accurately predicting future climatic conditions.

Hydrological modelling undertaken by HWC for its own water supply works has shown that a 10 per cent decrease in rainfall as originally modelled by the CSIRO may equate to a 25 per cent decrease in runoff in the Lower Hunter. This is consistent with experience from Western Australia which has experienced roughly a 10 per cent reduction in rainfall that has equated to reductions in inflow to water supply storages by volumes well in excess of 25 per cent.

The HWC modelling also showed that an increase in rainfall does not necessarily correspond to an increase in runoff and consequent supply as evaporation rates can offset any gains.

Under a climate change scenario of a 10 per cent reduction in rainfall, it is estimated that the yield of HWC's water supply with Tillegra Dam in place would drop from around 120 GL/yr down to around 100 GL/yr which would still meet in excess of 30 years of projected growth. While it would be a climate-dependent source, the addition of Tillegra Dam is expected to be able to deliver substantially more water than the present system can deliver, even if there is a marked decrease in rainfall in the supply catchments.

Furthermore, the storage volume of Tillegra Dam would provide significant lead time in an extreme drought to allow construction of expensive drought contingency measures such as new groundwater infrastructure at North Stockton and a climate-independent desalination plant should they be required. Without Tillegra Dam there is currently a 1 in 10 annual risk of having to commence preliminary work on both the North Stockton boreline and the desalinisation plant. With the dam in place, this risk reduces significantly to less than 1 in 1,000,000 (Hunter Water Corporation 2008a). Tillegra Dam would therefore provide significant water security for the region and provide HWC with significant leeway in relation to the timing of financial decision-making for the costly drought contingency measures noted.

3.3.3 Assessment of system yield

The *$H_2$50 Plan* includes an assessment of reliable system yield. Yield is the average and annual volume of water which can be reliably supplied from a water supply system and is thus a fundamental measure of system capability (Hunter Water Corporation 2008a). The Plan provides a revised definition of reliable system yield taking into account new drought management criteria outlined in the plan and existing level of service criteria:

> Yield is the unrestricted annual average amount of water that can be supplied such that the system does not enter restrictions more often than once per 10 years, is not in restrictions more than 5% of the months, and such that the long run risk of reaching the '48 month trigger' in the Drought Management Plan does not exceed 1 in 100. These quantities shall be assessed using headworks simulation models. It should be

noted that the calculated yield is a function of specific system assumptions, namely assumptions regarding the performance of the Drought Management Plan, system configuration assumptions, demand assumptions and assumptions regarding climatic variability.

In adopting his new definition of yield, HWC has revised its predicted yield from the current water supply system from 90,000 ML/yr to 67,500 ML/yr resulting in a shortfall between current demand and reliable yield. Likewise, the calculated yield for the water supply system with the proposed Tillegra Dam has dropped from the 130 gigalitres announced in November 2006 to around 123 gigalitres, which is expected to meet demand growth for around 50 years.

3.3.4 Increase in demand

Since the 1980s when the Lower Hunter was in an extended drought period, HWC has invested in demand management practices including user-pays, recycling and loss minimisation in an effort to reduce the water demands of the Hunter region. These efforts have enabled water supply to remain at around 70 80 GL/yr over the past 25 years as is shown in Figure 3.3.

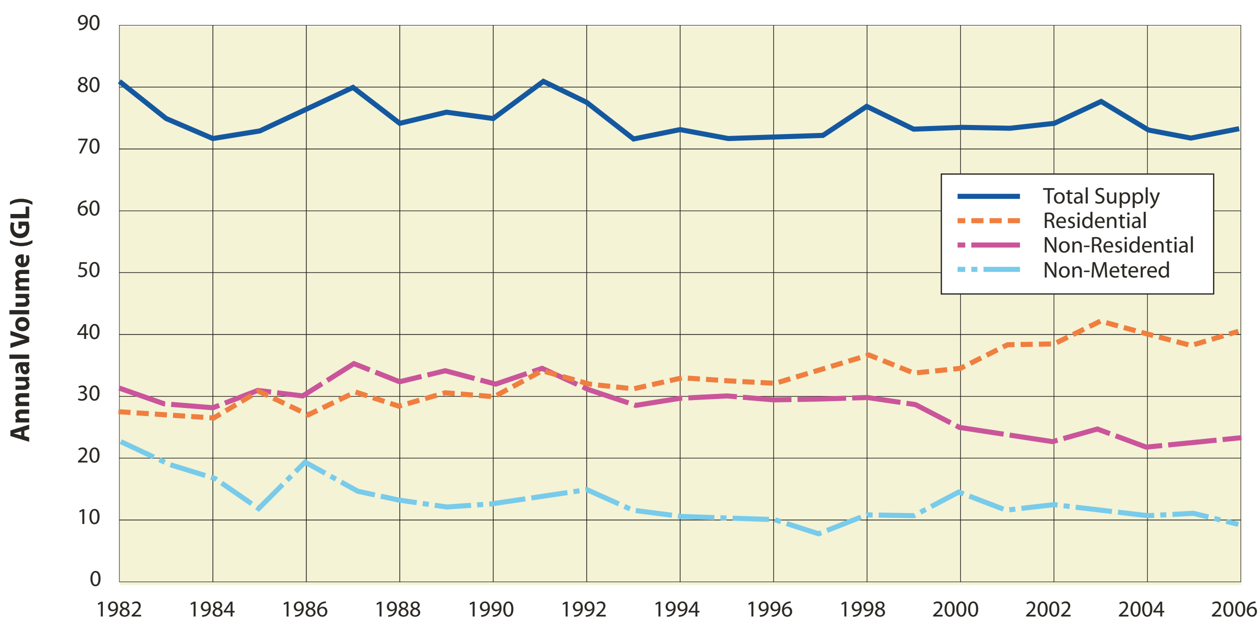

FIGURE 3.3 HISTORIC WATER DEMAND IN THE LOWER HUNTER REGION

Residential demand has increased higher than population growth (1.6 per cent against one per cent). This increase has been offset by a fall in non-residential demand (commercial, industrial and municipal) due to the closure of BHP steelworks, Pasminco and National Textiles, together with increasing water conservation efforts such as the recycling scheme at Eraring Power Station. Similarly, non-metered demand has also decreased largely due to greater accuracy in metering and an on-going loss minimisation program.

However, this 'steady-state' situation is not expected to continue and a return to growth in demand is now expected. Figure 3.4 depicts the predicted demand for water to 2031. The key drivers of this growth are predicted to be:

- an increase in population for the region (which also incorporates water efficiencies expected from demand management initiatives)

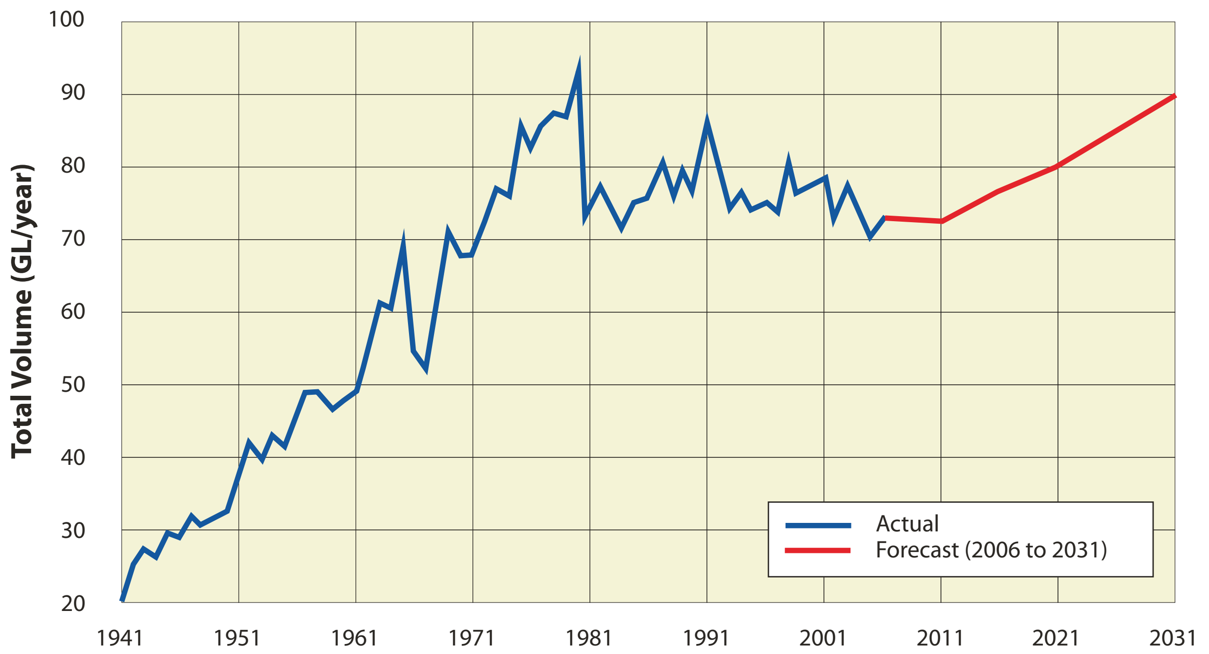

FIGURE 3.4 FORECAST DEMAND TO 2031

- a marginal increase in non-residential (commercial, industrial and municipal) demand in line with population growth and the likely increased employment, and therefore commercial and industry needs that would result.

The forecast has not anticipated any major new industrial or commercial connections. It is recognised that demand management initiatives would be maintained and would continue to deliver efficiencies into the future. However, when combined with population growth, the supply/demand balance (ie lower reliable yield) and the volatility of the system, these would not be sufficient in themselves to meet water demands during extended drought periods without unacceptable outcomes for the community.

3.3.5 Drought security

The *$H_2$50 Plan* identifies the region's capacity to withstand an extended drought as a key vulnerability in HWC's current supply system. A key focus of the Plan is to ensure the viability of HWC's Drought Management Plan contingency measures, especially given the increasing uncertainties generated by climate change (Hunter Water Corporation 2008a).

The Water Services Association of Australia (WSAA) has developed best practice guidelines to encourage industry cooperation to improve the water industry's productivity and performance and to ensure the regulatory environment adequately serves the community interest. In 2005 the WSAA published *Occasional Paper No. 14-Framework for Urban Water Resource Planning*. This recognises the need for water utilities to manage their water resources so that communities never run out of water or, in essence, provide 'drought-proofing. This is reflected in the Drought Management Plan detailed in the Draft H250 Plan which is based on this principle that no major urban community can accept the economic or social consequences of running out of water (Hunter Water Corporation 2008a).

The drought acceptability criteria in HWC's Drought Management Plan are set at an annual chance of 1 in 100 (or one per cent) of reaching the 48 month trigger. This trigger is the lead time required for the construction of a desalination plant. The construction of a major borefield in the North Stockton sandbeds and the subsequent water supply also plays an important role in extending water supply long enough for a desalination plant to be built. It is assumed that the borefield could be operated at full capacity for up to two years before salt water intrusion would start to threaten the water supply.

Considering the two year lead time for the construction of the borefield and the requirement that the borefield be operational two years prior to commissioning the desalination plant, the trigger point for the development of the borefield is also 48 months prior to potentially running out of water. The need to dedicate very significant levels of expenditure for emergency drought measures relatively early in a drought would be to protect against the risk of running out of water despite the knowledge that this risk would be very small (Hunter Water Corporation 2008a).

Under the current Lower Hunter water supply system and water demand, the first phase of emergency drought measures would need to be initiated at around 70 per cent of storage levels. On average, this situation could occur once every 10 years. Without source augmentation and with increasing demand, the trigger point would rise to around 80 per cent total storage with this storage level being reached in most years. The current risk is thus 10 times the acceptable risk of 1 in 100 identified for calculating reliable yield and would grow to 100 times the acceptable risk by 2012 without source augmentation (Hunter Water Corporation 2008a).

Figure 3.5 shows a comparison of the steps in the drought management response that would be implemented if the historical worst drought was to occur with the current system in place and with the addition of Tillegra Dam. The orange line shows the performance of the current system with projected 2012 demand through the worst drought on record. It can be seen that if HWC followed a logical drought management response, it would need to commit over $1 billion on desalination works and emergency borefield development before the drought broke. The consequence could be a significant waste of funds because in all probability the drought would break and the works would not be required. The green line indicates the performance of the system with the proposed Tillegra Dam built. This shows that if the worst drought period on record occurred, the system storage level would remain above drought restriction and investment triggers. The severe drought conditions would need to continue for nearly an additional four years before HWC would need to commit any significant funds for drought mitigation measures (Hunter Water Corporation 2008a).

3.3.6 Summary

Tillegra Dam would have the capacity to store 450 gigalitres of water. This additional storage volume would increase the reliable system yield by an additional 55,500 ML/yr.

The dam would provide almost three generations of growth potential for the region. Even with the prospect of climate change, Tillegra Dam is considered to be the best solution for the Lower Hunter region in adding to the diversity of supply options. The large storage volume provides significant lead time (even in a climate change scenario) to allow construction of expensive drought contingency measures such as new groundwater infrastructure at North Stockton and a climate-independent desalination plant, should they be required.

Without Tillegra Dam, there is a high risk of needing to trigger construction of these contingency measures at an estimated cost of approximately $1 billion. With Tillegra Dam in place, this risk becomes very low with the dam providing significant water security for the region.

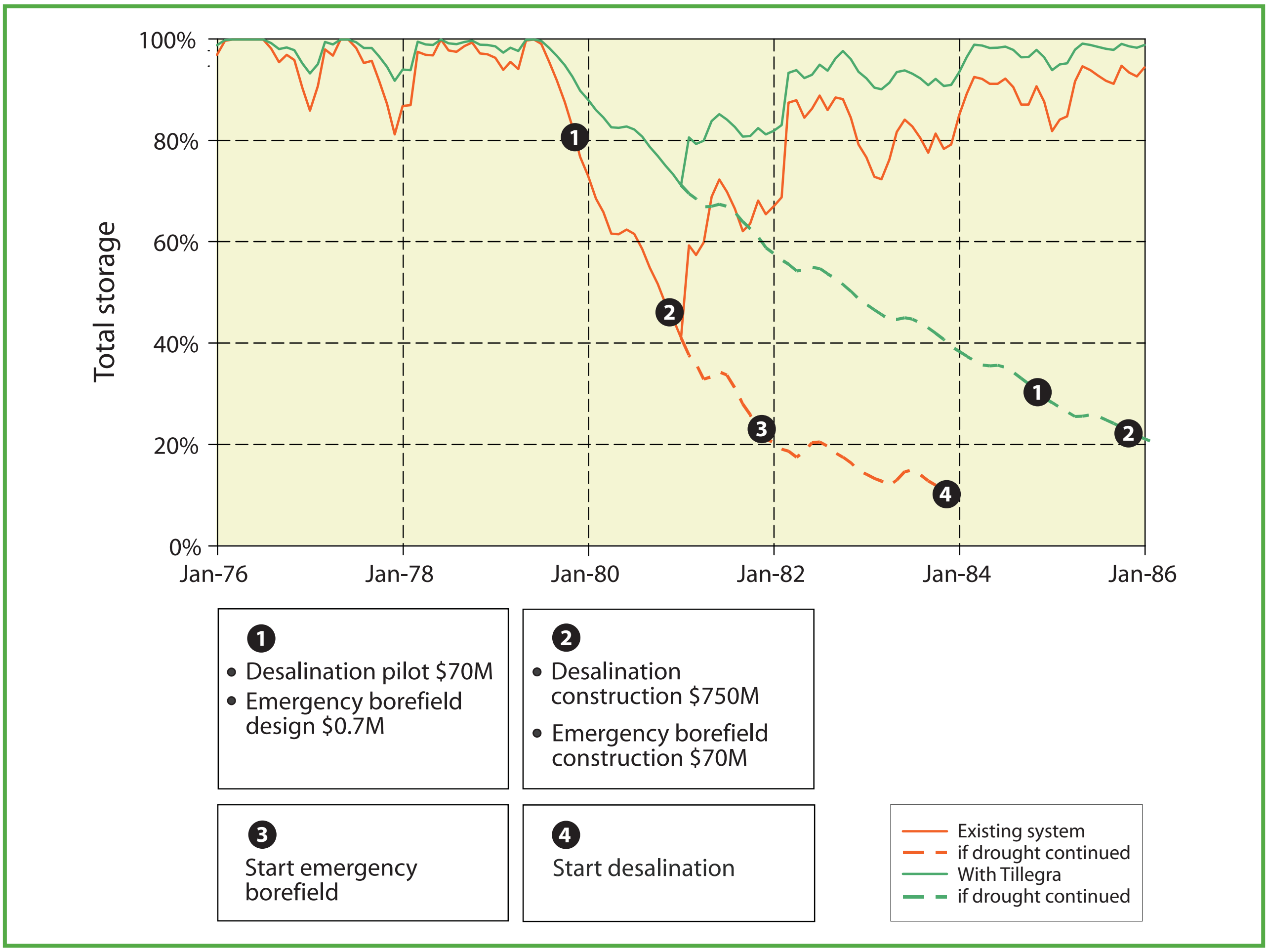

FIGURE 3.5 HUNTER WATER SUPPLY SYSTEM PERFORMANCE IN DROUGHT

3.4 Alternative water supply options

Supply augmentation options include new dam sites, upgrades to existing dams at Grahamstown and Lostock as well as climate independent options such as desalination and indirect potable reuse (the recycling of treated effluent to an environmental buffer such as a dam and then to the water reticulation system for general consumption purposes). In the Lower Hunter, new groundwater sources have not been considered as the current systems are already operating at their reliable limits. The only viable additional new groundwater resource is the North Stockton sandbeds. While this resource is part of the region's drought contingency plan, it does not have the available capacity to operate as an ongoing supply.

The following source options (refer Figure 3.6) have been investigated as part of the ongoing water resource planning process:

- Williams River Schemes, including new dams at Chichester and Tillegra
- further upgrades at Grahamstown Dam

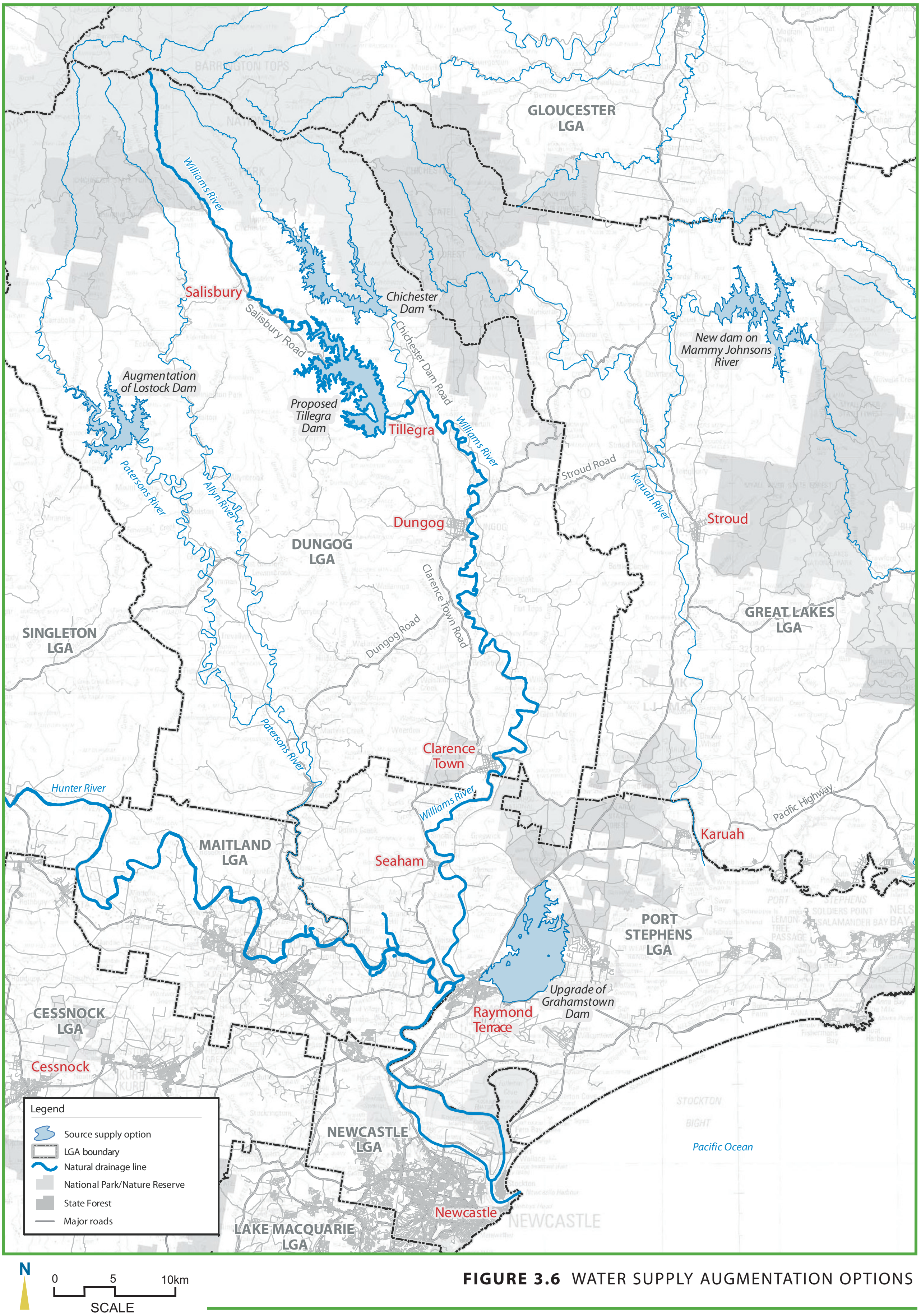

FIGURE 3.6 WATER SUPPLY AUGMENTATION OPTIONS

- Karuah Scheme (Mammy Johnsons Dam)
- Paterson River Scheme (Lostock Dam)
- desalination
- indirect potable reuse.

For each of these options, preliminary estimates of capital and operating costs have been prepared and an assessment of the various social and environmental impacts (in a qualitative sense) has been undertaken at a high level for comparative purposes based on information available in mid 2007. These options are described in detail in *Why Tillegra Now?* (Hunter Water Corporation 2007d). Cost estimates have been revisited by Hunter Water in 2008 to take into account inflation and construction cost escalation realised since the estimates were first completed. Revised costs for each potential augmentation source, with the key advantages and disadvantages of each option summarised in Table 3.1.

TABLE 3.1 COMPARISON OF WATER SOURCE OPTIONS

OPTION	COST	ADVANTAGES	DISADVANTAGES
Tillegra Dam	• Capital cost $397 million • Operating cost $640,000 per year	• Ensures the Hunter region's water future for the next 50 years (up to 2058) • Utilises the existing infrastructure • Energy efficient • Potential for recreational opportunities • HWC owns 78% of properties in the inundation area • Diversifies water source options	• Inundates major roadways • Inundates 2,100 ha of farmland • Not independent of climate change; yield would be affected by reduced rainfall
New Chichester Dam	• Capital cost $586 million • Operating cost $630,000 per year	• Ensures the Hunter region's water future for the next 43 years (up to 2051) • Utilises the existing distribution infrastructure • Relatively energy efficient • Potential for recreational opportunities	• Does not diversify the Hunter region's water sources • Disruption to supply from Chichester Dam during construction of new dam represents high risk of source depletion throughout this time • Not independent of climate change; yield would be affected by reduced rainfall • Inundation of 270 ha of Barrington Tops National Park including 80 ha of World Heritage Wilderness listed area

OPTION	COST	ADVANTAGES	DISADVANTAGES
Grahamstown Dam	• Capital cost $656 million • Operating cost $430,000 per year	• Ensures the Hunter region's water future for the next 26 years (2034) • Utilises existing infrastructure • Relatively energy efficient • Wilderness listed areas • Potential for recreational opportunities	• Does not diversify the Hunter region's water sources • Not independent of climate change; yield would be affected by reduced rainfall • Large surface area of dam would facilitate massive evaporation rates in summer • Shallow, warm water would be conducive to algal growth • Creates undesirable overshadow effect for surrounding residents
Lostock Dam	• Capital cost $425 million • Operating cost $800,000 per year	• Utilises existing infrastructure • Does not compromise existing water sources during construction • Potential for recreational opportunities	• High capital investment for short term security; ensures the water future of the Hunter region for only five years. • Does not diversify the Hunter region's water sources • Not independent of climate change; yield would be affected by reduced rainfall • Energy intensive pumping from the Paterson catchment to the Williams catchment required • Reduction in available water resource in the Paterson catchment • Inundation of 400 ha of farmland • HWC does not currently own land in the inundation area
Mammy Johnstons Dam	• Capital cost $565 million • Operating cost $850,000 per year	• Ensures the Hunter region's water future for the next 23 years (2031) • Utilises existing infrastructure • Potential for recreational opportunities • HWC currently owns approximately 30% of properties in the inundation area	• Not independent of climate change; yield would be affected by reduced rainfall • Energy intensive pumping from the Paterson catchment to the Williams catchment required • Reduction in available water resource in the Karuah catchment • Inundation of 1,700 ha of farmland and forest

OPTION	COST	ADVANTAGES	DISADVANTAGES
Desalination	• Capital cost $990 million • Operating cost $26.63 million per year	• Ensures the Hunter region's water future for the next 41 years (up to 2049) • Diversifies the Hunter region's water sources • Does not compromise existing water sources during construction • Independent of climate change; provides a guaranteed limitless water supply independent of precipitation rates	• Large ongoing operational costs • Does not utilise current infrastructure • Energy intensive reverse osmosis required; associated greenhouse gas emissions would need to be offset • Large quantities of concentrated saline by-product; environmentally responsible disposal would require additional infrastructure • No potential for recreational opportunities • Impacts include visual and noise pollution
Indirect potable reuse	• Capital cost $523 million • Operating cost $21.19 million per year	• Ensures the Hunter region's water future for the next 22 years (2030) • Diversifies the Hunter region's water sources • Utilises existing infrastructure • Reduces volume of treated effluent discharged to waterways	• Large ongoing operational costs • Treatment process is energy intensive • Does not utilise current infrastructure • Not independent of climate change; yield would be affected by reduced rainfall

3.5 Cost effectiveness analysis

A cost effectiveness analysis (CEA) has been undertaken for the Project and is documented in Working Paper G *Socioeconomic Assessment*. The CEA approach allows for comparison of competing project scenarios to be considered to determine whether construction of the Tillegra Dam represents a least cost option for meeting the region's yield objective. Implicit in data provided by the HWC is a long term planning horizon to ensure that water infrastructure projects meet the incremental yield over the next 50 years.

CEA is one of two economic evaluation measures that NSW Treasury's Project Evaluation Guidelines (NSW Treasury 2007) recommend (the other being a cost benefit analysis, CBA). CBA has inherent difficulties in monetising benefits where no markets exist, including issues like biodiversity protection, resource depletion, and social, cultural and other intangible impacts where stakeholder's values may differ from the views and values of the proponent. The inclusion of environmental and social effects in a CBA such as for a major dam project requires the monetisation of the environmental and social goods. Since no market for environmental and social goods generally exists, it is difficult to observe market prices that reflect marginal costs and benefits.

Although alternate valuation methods may produce monetised CBA benefit and cost streams, there is likely to be incomplete knowledge and high levels of uncertainty in the valuation of environmental and social impacts. The above factors may lead to distortions in the monetised benefits, which in turn may impact on the robustness of the resulting reported investment criteria results, the benefit cost ratio (BCR) and net present value (NPV).

Given that the primary benefit outcomes expected from the Project are a specific level of increased water security and that these are difficult to monetise in an economic analysis, CEA was considered an appropriate approach. This has been supplemented by additional qualitative analysis of other social and economic impacts, and CGE modelling of the impacts on the region (discussed in Chapter 15).

A levelised cost expressed in terms of dollars per megalitre was calculated. Levelised costs show the ratio of the present value of capital and operating costs of a scenario to the present value of the projected annual demand supplied. This allows for comparison between scenarios that satisfy demand for different periods of time. The CEA identifies Tillegra Dam as having the lowest levelised cost of the options considered.

The results of the CEA are summarised as follows for each option and collectively for all options in Table 3.2. Further details including methodology, data and assumptions are provided in Working Paper G.

Option 1: Tillegra Dam

This option has a storage capacity of 450 gigalitres and an annual yield of 56 gigalitres increasing the reliable system yield beyond 120 gigalitres per year. The proposed dam's location in an alternate subcatchment (to Chichester Dam) in the Upper Williams River provides supply diversity, double redundancy and drought security advantages.

Establishment and operational costs are similar to a new dam at Chichester and less than all other options as Tillegra Dam has the ability to gravity feed into the water network either through Grahamstown Dam or via the Chichester Trunk Gravity Main.

The total cost of the project in real 2008-09 dollars is $396.92 million accounting for refined design, inflation and construction cost escalation.

Option 2: New Chichester Dam

A new Chichester Dam immediately downstream of the existing Chichester Dam would have a storage capacity of 400 gigalitres and an annual yield of 48.5 gigalitres increasing the reliable system yield to approximately 116 gigalitres per year.

In addition to providing drought security, the ability to connect to existing infrastructure provides significant advantages. However, the drawback of this option is that it would require emptying the existing Chichester Dam and using it as a coffer dam for at least a two year construction period.

This would create significant operational difficulties in maintaining supply north of Seaham resulting in a supply risk during this period. The inundation of 270 hectares of Barrington Tops National Park of which 80 hectares is World Heritage listed is a further issue of concern.

The total cost of the scheme in real 2008-09 dollars is $585.59 million accounting for refined design, inflation and construction cost escalation.

Option 3: Grahamstown Dam Upgrade

The Grahamstown Dam upgrade would provide an annual yield of 30 gigalitres and increase the total system yield to around 97.5 gigalitres. This option would improve the drought security of the existing system, however this would not similarly contribute to the advantages inherent in source diversity.

The reliance on pumping from the Williams River as well as the shallowness and larger surface area of the dam makes this option more susceptible to climate change due to evaporation.

TABLE 3.2 KEY ELEMENTS OF WATER INFRASTRUCTURE PROJECT OPTIONS

KARUAH RIVER SCHEME (MAMMY JOHNSONS DAM)	TILLEGRA DAM	NEW CHICHESTER DAM	GRAHAMSTOWN DAM UPGRADE	PATERSON RIVER SCHEME (LOSTOCK DAM)	KARUAH RIVER SCHEME (MAMMY JOHNSONS DAM)	DESALINATION	INDIRECT POTABLE REUSE
Yield (GL/yr 2006/07)	52.5	48.5	27.5	30	9.5	32.5	32.5
Capex ($M 2006/07)	300	$330	$260	$410	$389	$400	$500
Opex ($M 2008-09)	$0.60	$0.60	$0.80	$0.4	$0.75	$22.00	$25.00
Levelised cost ($/kL)	$1.26	$1.39	$1.66	$1.91	$2.94	$2.62	$3.15
Yield (GL/yr 2008/09)	56	48.5	30	9.5	27.5	46.2	26.28
Capex ($M 2008-09)	396.92	585.59	655.80	425.00	565.22	989.76	523.14
Opex ($M 2008-09)	0.64	0.64	0.43	0.80	0.85	26.63	21.19
Satisfies demand up to and including:	2058	2051	2034	–	2031	2049	2030
Satisfies demand for (years)	45	38	21	–	18	36	17
Present value of total capital costs ($M)	$371.07	$547.45	$613.09	$397.32	$528.41	$809.17	$427.69
Present value of total ongoing costs ($M)	$6.58	$6.58	$4.39	$8.23	$8.78	$274.41	$218.35
Present value of total costs ($M)	$377.65	$554.03	$617.48	$405.55	$537.19	$1,083.58	$646.04
Levelised cost ($/ML)	$1,661	$2,450	$3,038	$4,760	$2,733	$4,803	$3,291
Levelised cost ($/kL)	$1.66	$2.45	$3.04	$4.76	$2.73	$4.80	$3.29

Source: Hunter Water Corporation.

The total cost of the scheme in real 2008-09 dollars is $655.8 million accounting for refined design, inflation and construction cost escalation.

Option 4: Paterson River Scheme (Lostock Dam)

Lostock Dam would provide an annual yield of 9.5 gigalitres raising the reliable system yield to around 77 gigalitres per year.

The advantage of this option is its ability to connect to existing infrastructure at the dam site. However, inter-basin transfers would result in high operation costs over the life of the scheme derived from the operation of substantial pump stations.

The total cost of the scheme in real 2008-09 dollars is $425 million accounting for refined design, inflation and construction cost escalation.

Option 5: Karuah River Scheme (Mammy Johnsons Dam)

The Karuah River Scheme would involve the construction of a 330 gigalitre dam on Mammy Johnsons River, a weir on the Karuah River one kilometre downstream of Booral and a pump station/transfer scheme to Black Camp Creek on the Williams River. This option would have an annual yield of 27.5 gigalitres and would increase the reliable system yield to 95 gigalitres per year.

Potential issues associated with this option are environmental impacts related to the damming of an unregulated river at two locations and impacts derived from inter-basin transfers to the Williams Valley.

The total cost of the scheme in real 2008-09 dollars is $565.22 million accounting for refined design, inflation and construction cost escalation.

Option 6: Desalination

A desalination option would provide an annual yield of 46.2 gigalitres increasing the reliable system yield to 113.7 gigalitres per year.

The principal advantages of this option are that it would provide a climate-independent source and improve system diversity. The disadvantages are its much higher operational costs relative to dams and environmental impacts including high energy use and brine disposal. Operational costs are estimated at $26.6 million per year.

The total cost of the scheme in real 2008-09 dollars is $989.76 million accounting for refined design, normal inflation and construction cost escalation.

Option 7: Indirect potable reuse

This option would involve the construction of a large scale collection, reticulation and advanced recycled water treatment network to supplement potable water supply via Grahamstown Dam. This option would feed water sourced from Kurri Kurri, Farley, Morpeth, Raymond Terrace, Shortland, Edgeworth and Toronto WWTW. It would provide around 26.28 gigalitres per year of highly treated recycled water increasing the reliable system yield to 93.8 gigalitres per annum.

The discharge of this water to the northern embayment of Grahamstown Dam would provide the opportunity to blend and store recycled water prior to further potable water treatment.

Brine disposal is a major consideration for this option. The outfall at the Burwood Beach WWTW could be used for this purpose as brine concentration is likely to have little impact on the treatment process if passed through the WWTW. A 29 kilometre long brine return line from Raymond Terrace WWTW would be required.

Like desalinisation, operational costs are significant, these being estimated at $21.19 million per year. The total cost of the scheme in real 2008-09 dollars is $523.14 million accounting for refined design, inflation and construction cost escalation.

3.6 Implications of doing nothing

For the Lower Hunter region, failure to take action to address the current limitations in the existing water supply system would result in:

- increased probability of water restrictions being brought routinely into force
- increased probability of triggering emergency drought management measures at significant social, economic and environmental cost to the community
- an inability to cater and provide for projected regional growth. Population growth of 160,000 people in the region and the creation of 66,000 jobs cannot occur, without a secure water supply
- significant risk to existing business reliant on water and risk of reduced future investment in the region's economy. The Lower Hunter is the sixth largest urban area in Australia and one of the State's major centres of economic activity.

In effect, the consequence of the 'do nothing' option would potentially place the community of the Lower Hunter routinely at risk of being placed on water restrictions and during extended periods of drought there would be the very real possibility of running out of water. The failure to invest in a secure water supply would greatly restrict regional growth, the creation of jobs and ongoing investment in the region's economy.

Without augmentation of the existing water supply, real and direct costs totalling hundreds of millions of dollars to in excess of a billion dollars may also eventuate during the implementation of existing drought emergency measures. The risk of these substantial costs being incurred increases every year concomitant to population growth.

Uncertainty with respect to climate change would only exacerbate these concerns.

3.7 Summary of Project benefits if approved

A full description of the Project's benefits are contained in Chapter 21, however, in summary the Tillegra Dam proposal would, if approved by the NSW Government:

- remove the risk of substantial water restrictions being brought routinely into service, for long periods of time.
- greatly reduce the economic consequences of reduced water supply on local and regional industries and business enterprises reliant on a secure water supply for ongoing operations
- in a severe drought, greatly reduce the likelihood of business and industry from being shut down to conserve water for essential household supply
- prevent reduced/rationed water supplies for essential social services such as emergency services, health facilities and educational facilities during a worse case drought scenario
- significantly reduce the likelihood of the community being forced to invest in alternative emergency sources of water (such as an emergency groundwater boreline and desalinisation plants) which would require a substantial financial commitment both in terms of capital investment and recurrent operating costs

- help avoid environmental impacts associated with the potential use of water resources within the recently declared North Stockton National Park, leased from and co-managed with the Worimi traditional Aboriginal owners (land clearing for a 20 kilometre emergency boreline would have an adverse environmental impact and operation of the boreline may also have an undesirable impact on groundwater dependant ecosystems as well as existing licensed irrigators and other third party users)
- facilitate regional population growth, remove uncertainty and cater for investment in the region's economy. This would encourage the creation of jobs both directly during construction and indirectly by supporting the region's population growth
- have the least cost, compared to other potential water supply solutions for the Lower Hunter region
- have the least environmental impacts on social, economic and environmental grounds, compared to other potential water solutions for the Lower Hunter region.