Final Report to

Independent Pricing and Regulatory Tribunal

Review of Consumption Forecasts

NSW Metropolitan Water Agencies

21 December 2004

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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
AIR	Annual information return
BASIX	Building Sustainability Index
DIPNR	NSW Department of Infrastructure, Planning and Natural Resources
DM	Demand management
DMF	Demand management fund
DoH	Department of Housing
EDC	"Every drop counts"
EUM	End-use model
GCC	Gosford City Council
GSP	Gross State Product
GWCWA	Gosford-Wyong Councils' Central Water Authority
HIA	Housing Industry Associations
HWC	Hunter Water Corporation
ISF	Institute of Sustainable Futures
IWRP	Integrated water resource plan
LCD	Litres per capita per day
MMA	McLennan Magasanik Associates
PRV	Pressure reduction valve
RUB	Ration utility billing
SCA	Sydney Catchment Authority
STP	Sewage treatment plant
SWC	Sydney Water Corporation
WSC	Wyong Shire Council

EXECUTIVE SUMMARY

Independent Review of Water Consumption Forecasts

The Independent Pricing and Regulatory Tribunal (the Tribunal) is conducting a price path review of the maximum water, sewerage and drainage/stormwater charges for each of the metropolitan water agencies and the water supply charges for Sydney Catchment Authority.

The price path review is to apply from 1 July 2005 and is expected to continue for a period of up to five years depending on the Tribunal's findings during the review. As part of the review process, the agencies were asked by the Tribunal to submit their annual information returns (AIRs) together with their review submissions which include water demand forecasts.

The Tribunal engaged McLennan Magasanik Associates (MMA) to independently review the agencies' water consumption forecasts and customer numbers over the period 2004/05 to 2009/10 contained in the AIRs.

Review process

The objective of this review is to provide the Tribunal with advice on whether the water agencies' proposed consumption forecasts are reasonable, the robustness of the forecasting approaches used in determining the forecasts, the validity of the underlying assumptions that form the basis of these forecasts and the key uncertainties surrounding the forecasts.

The review has been based on information supplied by the agencies and other publicly available material. The review has focused on two areas: underlying demand growth and demand management activities. Given that each of the agencies faces a very different operating environment, the approach taken to both the forecasting and these reviews has been different. It must be stressed that the discussion and any forecasts prepared by MMA need to be considered indicative and are to form the basis of the final assessment of the agencies' forecasts.

This final report is based on a consultative process with the agencies during the pricing review period. Following the release of the draft report, MMA presented the findings of the draft report to each of the agencies and discussed the differences between MMA's and the agencies forecasts. For most agencies, this resulted in a narrowing of the differences between the MMA and the agencies' forecasts.

Sydney Water Corporation forecasts

Sydney Water Corporation (SWC) has prepared its forecast based on a baseline average consumption of 426 litres per capita per day (LCD). This consumption has been multiplied by the projected growth in population and then has been subtracted from this the impact of a very comprehensive range of demand management activities.

MMA's review of SWC's baseline forecasts

Water usage in Sydney has grown only slightly over the longer term, despite a growing population and economy. The long-term trend indicates a growth in consumption of less than 1% per annum. The low growth has been driven by a sharp decline in per capita consumption.

According to SWC, the outlook is for these trends to continue in the absence of concerted action to curb consumption. SWC has provided a forecast of baseline water consumption, which is the consumption that would have occurred without the demand side strategies. They then forecast the water savings from the demand side management programs and deduct the savings from the baseline forecast to arrive at the final water consumption.

In summary, water demand is forecast as follows:

- First, a baseline water demand forecast per capita is developed. For this submission, the baseline forecast has been set to 426 litres per capita per day (LCD) for each year of the review period. This is a weather corrected estimate of the average daily consumption and is meant to be representative of current trends in this variable.
- The LCD estimate is multiplied by projections of population, obtained from the NSW Department of Infrastructure Planning and Natural Resources.
- The estimated savings in water consumption due to the implementation of a range of demand management initiatives are then deducted from the baseline forecasts to arrive at the final consumption forecasts.

SWC's estimate of 426 LCD was arrived at by an inter-departmental committee. Support for the estimate is provided by a separate analysis undertaken by Sydney Water. MMA has reviewed this analysis and undertaken some statistical analysis to assess the veracity of the assumption.

After correcting for weather impacts, both the SWC and MMA analyses indicate a small upward trend in the average litres per capita per day consumed. The SWC estimate is for an average of 428 LCD over the review period; the MMA estimate is for around 427 LCD over the review period. This is less than 1% higher than the estimate of 426 LCD derived by the inter-departmental panel.

Thus, although MMA has concerns with the use of the LCD estimate as a tool for forecasting demand, the agreed estimate used by SWC appears reasonable.

Because of limitations with using an LCD as the basis of forecasting, MMA developed alternative forecasts based on an econometric model of water demand. This model indicates the relationship between water demand and key economic and demographic variables. Although the model results are only indicative, the forecasts derived from the model are similar to the forecasts derived by SWC. In most years, the difference is less than 2%.

Based on the above analysis, MMA believes the forecasts provided by SWC are reasonable given the data relied upon and the difficulties of building suitable and robust demand models.

MMA's review of SWC's demand management activities

SWC has found itself in a situation where demand could outstrip sustainable yield, so it has undertaken a comprehensive range of demand management (DM) activities and also relied on activities expected to be undertaken by the federal and state governments. By the year 2009/10 SWC expects these programs to achieve water savings of about 82 GL beyond those already generated. SWC expects that the major contributors to customer demand reduction will be business savings, the BASIX program for new houses, pricing and recycling.

MMA has reviewed each of the major areas within the DM program. Overall, MMA accepts that they will result in significant water savings, although not quite to the extent proposed by SWC.

Over the pricing review period, 2005 to 2010, MMA projects most of the savings proposed by SWC will be achieved. The differences between MMA's and SWC's savings are spread across the programs. In most cases MMA expects the programs to achieve somewhat less than expected by SWC, but MMA has also included a new program – efficiency for house sales – and expects significantly higher outdoor savings over the next year or two as a legacy of the recent drought and current mandatory restrictions.

It must also be stressed that quite a high degree of uncertainty is associated with many of the expected savings. Actual results could be significantly higher or lower than expected.

MMA's forecasts for final water consumption, after water savings from demand management are deducted, are higher than those forecast by SWC. The difference is less than 4% in most years, reaching a peak difference of 3.6% in 2008/09 or 18 GL.

Table 1 and Table 2 show MMA's baseline and metered consumption forecasts for both scenarios, with restrictions continuing beyond January 2005, and with restrictions being lifted as of January 2005.

Table 1 – MMA forecasts for SWC consumption – with continuing restrictions

Item	*MMA forecast assuming continued restrictions (all data in GL)*	2005	2006	2007	2008	2009	2010
	Metered consumption						
a	Houses	300	304	309	313	318	322
b	Flats/units	102	107	110	114	117	121
c	Non-residential	161	162	162	162	162	164
d	**Basline metered consumption (=a+b+c)**	563	573	581	589	598	608
	DM savings						
e	Existing 2004 DM savings	14	14	14	14	14	14
f	Additional savings from new DM programs	4	15	23	31	41	50
g	**Savings from continued water restrictions**	52	52	52	52	52	52
h	**Final metered consumption (=d-e-f-g)**	492	492	491	491	490	491
i	**Billed unmetered consumption**	5	5	5	4	4	4
j	**Unbilled unmetered consumption**	3	3	3	2	2	2
k	**Baseline unaccounted for water**	77	78	78	79	79	79
l	**Baseline total consumption (=d+i+j+k)**	649	658	666	675	683	694
m	Existing 2004 leakage reduction	15	15	15	15	15	15
n	Additional savings from leakage reduction program	2	3	6	10	15	15
o	**Net unaccounted for water**	60	59	57	54	49	49
p	**Final total consumption (=h+i+j+o)**	561	559	556	552	546	547

Table 2 – MMA forecasts for SWC consumption – without restrictions

Item	*MMA forecast assuming restrictions are lifted in January 2005 (all data in GL)*	2005	2006	2007	2008	2009	2010
	Metered consumption						
a	Houses	300	304	309	313	318	322
b	Flats/units	102	107	110	114	117	121
c	Non-residential	161	162	162	162	162	164
d	**Basline metered consumption (=a+b+c)**	563	573	581	589	598	608
	DM savings						
e	Existing 2004 DM savings	14	14	14	14	14	14
f	Additional savings from new DM programs	23	31	36	45	58	68
g	**Lagged savings from water restrictions lifted in January 2005**	26	0	0	0	0	0
h	**Final metered consumption (=d-e-f-g)**	500	528	530	530	526	526
i	**Billed unmetered consumption**	5	5	5	4	4	4
j	**Unbilled unmetered consumption**	3	3	3	2	2	2
k	**Baseline unaccounted for water**	77	78	78	79	79	79
l	**Baseline total consumption (=d+i+j+k)**	649	658	666	675	683	694
m	Existing 2004 leakage reduction	15	15	15	15	15	15
n	Additional savings from leakage reduction program	2	3	6	10	15	15
o	**Net unaccounted for water**	60	59	57	54	49	49
p	**Final total consumption (=h+i+j+o)**	568	595	594	590	582	582

Hunter Water Corporation forecasts

The Hunter Water Corporation (HWC) services water demand in the local government areas of Cessnock, Lake Macquarie, Maitland, Newcastle and Port Stephens. The region covered has a population of nearly half a million people as well as a large industrial base located in the principal centre of Newcastle.

Like other regions in Australia, water demand in the Hunter region has undergone substantial changes over the past decade. The variety of changes makes it difficult to discern key underlying trends. However, the key trends appear to be that residential usage of water consumption is increasing, whilst consumption in the non-residential sector has fallen. The fall in the non-residential sector is mainly due to the closure of several large industrial plants over the last five years as well as improved water use efficiency in the industrial sector as a whole. However, commercial and government use of water has risen steadily.

MMA's review of HWC's baseline forecasts

HWC forecast water usage by customer segments. The method applied was as follows:

- For separate dwellings, the projected number of households was multiplied by the assumed average consumption per household after weather correction.
- For flats and units, the projected number of flats and units was multiplied by the assumed average consumption per household after weather correction.
- For large, non-residential customers, usage was forecast for each individual customer. This was based on a "detailed review of individual customer intentions". Usage was assumed to be similar to 2003/04 levels for most customers, with growth coming from the net impact of the addition of three customers and the removal of two customers.
- For small, non-residential users, a small growth trend was projected of about 0.63% per annum.

HWC's forecasts rest on two key assumptions: that demand per residential dwelling remains constant, and that demand for non-residential users is largely driven by plant closures, expansions of existing plants and opening of a new plant.

The estimate of demand per residential dwelling is based on long-term average consumption per dwelling from 1982 to 2004. An estimate of 206 kL pa for separate dwellings and 131 kL pa for flats and units is assumed.

MMA's analysis indicates that the assumption of 206 kL pa as contained in the annual information return (AIR) is different from the assumption stated in HWC's response to questions asked by MMA and in their integrated water resource plan (IWRP) reports. In both cases, an estimate of 210 kL pa is quoted. The average over the period from 1993 to 2004 has been 214 kL pa.

In addition, a constant demand per dwelling assumes that historical trends continue. However, the observed values for the use per dwelling reflect the outcome of two trends. Firstly, the adoption of water saving devices such as dual-flush toilets and low flow showerheads. Adoption of these devices would tend to put downward pressure on water use per dwelling. The fact that the use has remained relatively constant implies that there is a second counter trend, which statistical analysis indicates is probably driven by rising incomes.

Analysis by HWC also indicates that water use per separate dwelling is higher for new dwellings. This trend has been evident for houses built after 1990. As the proportion of new homes increase relative to older homes, this would lead to an upward trend in the average consumption level.

The level of 131 kL pa for flats and units appears to be based on five years of data. MMA found that data on the number of flats and units appeared to be inconsistent across different information sources. Regardless of the reason for this difference, it means that obtaining a reliable estimate of water consumption per flat or unit is difficult.

Given the difficulty of using average consumption to forecast demand, MMA has developed alternative forecasts based on information provided by industrial customers and statistical models of demand for residential customers and small non-residential customers. These forecasts do not include the impacts of the demand management programs currently being investigated.

MMA's forecasts are presented in Table 3. Based on MMA's model, water releases under the baseline scenario are expected to increase slightly in 2004/05 as a result of population growth. Water consumption is expected to increase slightly in line with growth in population and incomes.

MMA's forecasts are slightly higher in the earlier years and slightly lower in the later years than the forecasts provided by HWC. However, the difference is small and is typically less than 2.2%. The lower forecast is mainly due to lower consumption in the separate housing segment due to smaller growth rates in incomes, a small increase in real prices and continuing penetration of water efficient appliances. Consumption in medium density dwellings is expected to grow strongly as is industrial demand.

Table 3 – MMA's forecasts for HWC consumption, ML

Item	*MMA forecast (all data in ML)*	2004 (actual)	2005	2006	2007	2008	2009	2010
	Metered consumption							
a	Houses		35,137	35,396	35,604	35,849	36,390	36,349
b	Flats/units		4,249	4,428	4,609	4,816	5,026	5,240
c	Non-residential		22,059	23,077	22,977	23,173	23,366	23,205
d	**Basline metered consumption (=a+b+c)**	61,494	61,446	62,902	63,191	63,838	64,782	64,794
e	**Unaccounted for water**		11,950	11,950	11,950	11,940	11,940	11,970
f	**Baseline total releases (=d+e)**	72,882	73,396	74,852	75,141	75,778	76,722	76,764
g	**DM Savings**		56	205	439	710	1,136	1,721
h	**Final metered consumption (=d-g)**	61,494	61,390	62,697	62,752	63,128	63,646	63,073
i	**Final total consumption (=f-g)**	72,882	73,340	74,647	74,702	75,068	75,586	75,043

Based on this analysis, the forecasts provided by HWC appear to be reasonable.

MMA's review of HWC's demand management activities

Given that HWC has projected demand which falls well within sustainable yield expectations, relatively low average residential demand, comfortable levels of storage and economic supply augmentation possibilities, it is understandable that HWC's DM programs are very modest compared to those of SWC. Indeed, HWC has not explicitly taken DM activities into account in producing its forecasts.

MMA has assessed the likely water savings from DM activities, both those undertaken by HWC (mainly retrofit) and those relating to state and federal regulations such as BASIX and labelling and standards for water efficient products.

Overall water savings from these DM programs are expected to build to almost 2 GL pa by the end of the forecast period. This might be taken into account in HWC's forecasts.

Final demand

With the inclusion of the savings from demand side measures, MMA forecasts are lower than HWC's forecasts for the last three years of the projection period. The difference is less than 1%, for example, MMA's forecasts are 0.7% lower in 2008/09. On this basis, and on the basis of the uncertainty of our analysis due to limited information, MMA has concluded that HWC's forecasts appear somewhat conservative.

Although HWC has not explicitly included DM savings in their forecasts, MMA believes that their final forecasts are conservative and therefore are reasonable.

Gosford City Council and Wyong Shire Council

MMA's review of baseline forecasts

Gosford City Council and Wyong Shire Council are considered together in this review as they share supply operations, management, costs and also have a common approach to water issues and to forecasting and pricing strategies for the price review. The Councils have used population growth and per capita water releases as a basis for their forecasting. However, forecasting attempts have been hampered by a lack of consistent historical data which means that significant assumptions have had to be made.

GCC and WSC use the same methodology for estimating future water demand. There are three components in the forecasting technique. Firstly, the trend in unrestricted total water releases is estimated based on historical data prior to the introduction of water restrictions and expected population growth rates.

Secondly, projections of metered consumption are obtained by assuming a constant value for the percentage of unaccounted for water.

Thirdly, estimated savings from water restrictions are subtracted from the unrestricted metered consumption forecast in order to arrive at the final estimate of future metered consumption.

The lack of reliable data makes it difficult to determine with confidence the veracity of the method used. MMA's concerns with the forecasts include:

- Both GCC and WSC have used 2002 as the starting point for demand projections. However, part of the 2002 financial year was impacted by water restrictions. Therefore, MMA believes that 2001 should be used as the base year, as it excludes any impact of water restrictions.
- Both agencies have assumed constant per capita demand and based future unrestricted total demand projections entirely on expected population growth rates. MMA has shown that this assumption seems reasonable, however, for WSC there is a possibility of decreasing per capita consumption.
- MMA believes that GCC's estimate of unaccounted for water is feasible based on typical leakage rates experienced by other agencies around the world.
- WSC's estimate of unaccounted for water seems quite low, but may be feasible given the young age of the WSC system.

In our initial review, we showed a sudden fall in our total demand forecast in 2004 due to a negative population growth of 6.2% as calculated from data in WSC's AIR. However, after consultation with WSC about the discrepancies between WSC's and DIPNR's historical population data and adjusting WSC's population data MMA undertook a final review of their forecasts which showed the differences are not substantial.

MMA's review of GCC's and WSC's demand management activities

GCC and WSC find themselves in a difficult situation at the moment. After a prolonged drought, storage levels are very low, about 25%, and are likely to keep dropping unless there is significant rainfall. The councils' response to this has been to institute increasingly stringent water restrictions. Level 3 water restrictions, which essentially mean a prohibition on most external uses, are expected to be brought in within the next month or two and to remain in place for much of the pricing period.

This, together with significant price increases and facilitation of traditional demand management programs, is expected to yield savings of about 24% of non-restricted yield. While the evidence to support the target number of 24%, and its allocation between Level 1 and Level 2 restrictions is patchy, MMA considers the estimates made to be reasonable within the context.

Assuming average rainfall levels occur over the determination period, MMA believes Gosford-Wyong Councils' Central Water Authority's assumptions regarding future water storage levels are quite reasonable.

Table 4 and Table 5 show MMA's forecasts for GCC's and WSC's water consumption respectively.

Table 4 – MMA water consumption forecasts for GCC, ML

MMA Forecast for GCC	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total releases (ML)	18,232	18,337	18,302	18,510	18,603	18,730	18,921	19,123	19,213	19,349
Unaccounted for water	2,589	2,604	2,599	2,628	2,642	2,660	2,687	2,715	2,728	2,748
Unrestricted metered consumption	15,643	15,733	15,703	15,882	15,962	16,070	16,235	16,408	16,485	16,602
Savings from water restrictions and DM programs (scenario 1), ML	0	438	1,256	1,423	3,187	3,857	3,896	3,285	2,638	1,328
Savings from water restrictions and DM programs (scenario 2), ML	0	438	1,256	1,423	2,554	2,571	2,598	2,625	2,638	1,328
Final Metered Consumption, ML	15,643	15,295	14,447	14,458	12,775	12,213	12,338	13,123	13,847	15,274

Table 5 – MMA water consumption forecasts for WSC, ML

MMA Forecast for WSC	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total releases	15,364	15,573	15,786	16,050	16,235	16,474	16,635	16,877	17,028	17,226
Unaccounted for water	1,137	1,152	1,168	1,188	1,201	1,219	1,231	1,249	1,260	1,275
Unrestricted metered consumption	14,227	14,421	14,618	14,863	15,034	15,255	15,404	15,628	15,768	15,951
Savings from water restrictions and DM programs (scenario 1), ML	0	401	1,169	1,332	3,002	3,661	3,697	3,129	2,523	1,276
Savings from water restrictions and DM programs (scenario 2), ML	0	401	1,169	1,332	2,405	2,441	2,465	2,501	2,523	1,276
Final Metered Consumption, ML	14,227	14,019	13,449	13,531	12,032	11,594	11,707	12,499	13,245	14,675

Sydney Catchment Authority

Over 99% of the water supplied by Sydney Catchment Authority (SCA) goes to SWC. Consequently, SCA used the SWC forecasts as the basis of its own forecasts for the Tribunal. MMA has compared the SCA forecasts against its own indicative forecasts for SWC, after adding leakage back in and un-metered use.

Over the entire period, the forecasts are similar, but they have a different distribution over the period under consideration. Table 6 shows SCA's and MMA's water consumption forecasts with and without restrictions.

Table 6 – MMA forecasts for SCA, ML

Financial Year ending June	2005	2006	2007	2008	2009	2010
SCA Forecasts	562,100	591,201	583,100	573,582	561,422	554,700
MMA Forecasts No Restrictions	572,863	599,499	598,911	594,988	586,452	586,542
MMA Proposed Forecasts With Restrictions	565,250	563,299	560,404	556,831	551,211	552,188

1 INTRODUCTION

The Independent Pricing and Regulatory Tribunal (the Tribunal) is conducting a price path review of the maximum water, sewerage and drainage/stormwater charges for each of the metropolitan water agencies and the water supply charges for Sydney Catchment Authority. The price path review is to apply from 1 July 2005 and is expected to continue for a period of up to five years depending on the Tribunal's findings during the review. The Tribunal was primarily established in 1992 to provide independent oversight of the prices charged by monopoly service providers, including water agencies. In its price path review, the Tribunal will take into consideration the broad social issues and matters specific to each agency as required by Section 15 of the IPART Act. The Tribunal determines the maximum charges with the objective of achieving the required level of revenue over the regulatory period.

The Tribunal engaged McLennan Magasanik Associates (MMA) to independently review the agencies' water consumption forecasts and customer numbers over the period 2004/05 to 2009/10.

This report reviews water consumption forecasts for the four metropolitan water agencies and the catchment authority[1], namely:

- Sydney Water Corporation (SWC)
- Hunter Water Corporation (HWC)
- Gosford City Council (GCC)
- Wyong Shire Council (WSC)
- Sydney Catchment Authority (SCA)

The four metropolitan agencies supply water to about 5 million people and cover the area from south Wollongong to north of Newcastle. The Sydney Catchment Authority supplies bulk water mainly to Sydney Water and to some small customers and manages the water catchment areas and infrastructure within its jurisdiction.

While these water agencies provide their own forecasts of water consumption, sewerage and drainage and customer numbers, the Tribunal uses an independent assessment of the proposed forecasts as the basis to determine the maximum charges.

The Tribunal is undertaking this price review during a period of extensive debate on water resources and conservation measures in NSW. This is reflected in the increasing prominence of demand management measures, including water restrictions and changes to pricing structures, and government initiatives in the area. For example, the NSW government's *Metropolitan Water Plan*, which has significant bearing on water consumption, was released during the course of the demand review. This adds a new driver, and increased uncertainty, to demand forecasting.

1 For the purpose of this proposal, we refer to the Sydney Catchment Authority as an agency.

As part of the process in this price review, the Tribunal requested water consumption forecasts from the agencies through the annual information return (AIR). These were made available to MMA to undertake the review.

The objective of this review is to provide the Tribunal with advice on whether the water agencies' proposed consumption forecasts are reasonable. Furthermore, to analyse the robustness of the forecasting approaches used, the validity of the underlying assumptions that form the basis of these forecasts and the key uncertainties surrounding the forecasts. The Tribunal required MMA to consider the following questions:

- Is the approach to consumption forecasting used by each agency reasonable, for the purposes of setting prices?
- Are the assumptions used by the agencies reasonable and fit for their purpose?
- Is the methodology properly applied?
- Is there a balance between the use of historical trends and key drivers in generating the forecasts?

MMA's review of the water consumption forecasts for the four metropolitan water agencies and the catchment authority focused on issues of approach, assumptions and methodology. The review largely relied on water consumption data and information provided by the agencies. MMA would like to express its appreciation of the time and effort the agencies spent in collating and providing the information and in responding promptly to questions and requests.

2 FACTORS AFFECTING WATER DEMAND

2.1 OVERVIEW

Water consumption has in the past generally increased with rising population. More recently there has been recognition of the new paradigms of limited and uncertain water resources, the identification and management of sustainable yield and the balance between supply and demand management options.

Forecasting demand for water needs to take into account several inter-related components, including the underlying drivers of customer demand, the available demand management measures and government policy.

Although all the agencies are located within a relatively small geographic area, each of them is faced with a very different operating environment and set of challenges. This has required specific consideration when reviewing the demand forecasts.

2.2 CONSUMPTION FORECASTS UNDER REVIEW

Water is purchased by the agencies to meet several demands:

- metered customer demand which is billed
- un-metered customer demand which is billed (for example, when houses without meters are billed on a ratio basis)
- metered demand which is not billed (for example, use by sewage treatment plants)
- un-metered demand which is not billed (for example, use in fire fighting)
- filtration losses
- system leakage
- apparent losses (including customer meter under-registration and theft).

In the price review, the Tribunal is generally only concerned with demand which is billed. MMA has, therefore, concentrated on reviewing forecasts of billed consumption. The exception is SCA's review of supply, which sells on a wholesale basis, where other components are considered.

2.3 THE KEY DRIVERS OF WATER DEMAND

This section outlines key factors in determining water consumption forecasts for residential and non-residential consumption:

2.3.1 Residential

For the agencies considered residential consumption generally accounts for between 60% and 90% of total consumption and is thus of major importance. There are nine key drivers:

- Population growth rates. These are a key driver of residential demand growth, especially as residential water usage is increasing in importance.

- Household formation patterns, number of dwellings and dwelling density, in particular, the shift towards multi-unit dwellings and flats. The proportion of multi-unit dwellings has increased over the last ten years. In addition, the trend towards smaller households increases internal water usage on a per capita basis, although the difference is likely to be relatively small,[2] while potentially reducing external water usage.
- Economic growth rates impact on water usage at several levels. High economic growth will accelerate other trends such as the purchase of more efficient water using appliances.
- Price. The pricing structure for utilities in NSW is currently undergoing review and could change significantly during the forthcoming regulatory period.
- Trends in appliance purchases and usage. There has been a move towards multiple toilets and showers in residences, which tends to increase water usage. The installation of automatic sprinkler systems is also likely to increase water usage.[3] Countering this has been the trend towards more water efficient appliances, such as dual-flush toilets and low flow showerheads and more recently front-loading washing machines.
- Water demand management programs and restriction policies which result in a reduction in water consumption.
- Government policies which have a bearing on water use, for example, the implementation of the BASIX program in NSW and the NSW Metropolitan Water Plan.
- Weather and the impact of current and proposed water restrictions. External water usage is strongly impacted by weather and water restrictions, internal water usage is to a lesser degree. It is vital to understand the impact these factors have on setting “base year” forecasts.
- The state of storages at the start of the forecasting period which provides an understanding of the likelihood and level of water restrictions to be imposed.

In residential demand forecasting, MMA initially looks at changing customer numbers and average usage. Changes in average usage over time take into account variables such as dwelling size, number of persons per dwelling, comfort (income) effects and impact of conservation measures. One challenge is to assess the impacts of weather and restrictions separately, and then to forecast for normal weather taking into account the continuing impact of restrictions. The definition of what constitutes normal weather, given the potential for climate change, is also an important consideration.

The second step is to take into account impacts of fundamental changes to key drivers, such as conservation measures and pricing mechanisms. Where possible, MMA attempts to disaggregate demand into external (garden, pool) and internal demand, and then look at the impacts of various measures on usage by appliance. However, this requires

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[2] WA Water Corporation,2003, *Domestic Water Use Study in Perth, Western Australia 1998-2001*, Perth, March.

[3] Ibid.

adequate data – which is often not available. In the absence of such data, average usage trends combined with estimated key driver impacts have been used.

2.3.2 Non-residential

This category includes commercial, institutional, small industrial, large industrial and rural users. These users have different water demand drivers to the residential users, which mainly relate to economic growth for business and irrigation needs for rural users.

The mix of industrial and commercial activities has a significant impact on water usage and the ability to implement programs to minimise water consumption. Economic growth and process and plant efficiency are significant factors in determining the future trends of water consumption for this sector.

Larger customers in this group have also been affected by the drive for water conservation and in some cases have been implementing a number of measures to conserve potable water and substitute it with reclaimed, recycled or bore water.

3 PROCESS AND APPROACH TO THE REVIEW

The process employed for this review commenced when:

The five NSW metropolitan water agencies submitted their draft Annual Information Returns (AIRs) and review submissions to the Tribunal and these were provided to MMA.

MMA then requested historical and forecast information from the five agencies. The information was examined for adequacy at the different levels of disaggregation.

MMA reviewed the consumption forecasts based on the information provided by the agencies and material available in the public arena. The information reviewed included:

- economic indicators relevant to the agencies' service areas
- trends in annual water consumption
- demand management programs including pricing and voluntary, mandatory and permanent restrictions
- NSW state environmental strategies (for example, the Metropolitan Water Strategy)
- federal water programs including labelling of, and standards for, appliances
- consumption trends for each of the agencies' top 20 customers
- weather conditions that affect water demand
- number of single dwellings and multi-dwelling sites in the residential sector.

Meetings were held with each of the water agencies to ensure all the data required for the review was provided and to clarify any queries raised. Further questions and information supply continued over the course of the study.

Telephone interviews were held with a selected number of large customers to identify expectations about their water consumption and conservation measures.

MMA carried out a detailed review of underlying growth rates and water demand against key socio-economic variables including housing/dwelling data, and regional economic output. The forecasts provided by the agencies were reviewed against MMA's forecasts and an opinion was formed as to the reasonableness of the agencies' forecasts.

Overlaid on this was an evaluation of demand management programs, initiated by either the agency or government, which would materially affect demand over the period. Because each of the agencies faces a different sustainability environment the evaluation carried out was very specific to each agency.

A draft report was prepared and submitted to the Tribunal. The intention of the draft report was not to provide an alternative forecast for the agencies, but to review the methodology, assumptions and outcomes and provide comment on whether these are reasonable. Where considered appropriate, the draft report also provided indicative outcomes derived from alternative methodologies and assumptions. The draft report was thus intended as the basis for consultation with the agencies about items which were material to their forecasts.

The Draft Report was provided to the agencies with a presentation by MMA as part of the consultation process.

The agencies responded to the Draft Report during meetings that were held with each of the agencies. Further responses were received from the agencies following the meetings which were considered by MMA.

MMA finalised its report, taking into account comments from the Tribunal and the agencies.

4 SYDNEY WATER CORPORATION

4.1 OVERVIEW

Demand for water in Sydney is outgrowing the available supply. Apart from the last year, when restrictions reduced water consumption, the level of recent consumption has been above long-term sustainable yield. In addition, with growing population and social trends, water consumption may increase even further in the future.

4.2 HISTORICAL TRENDS

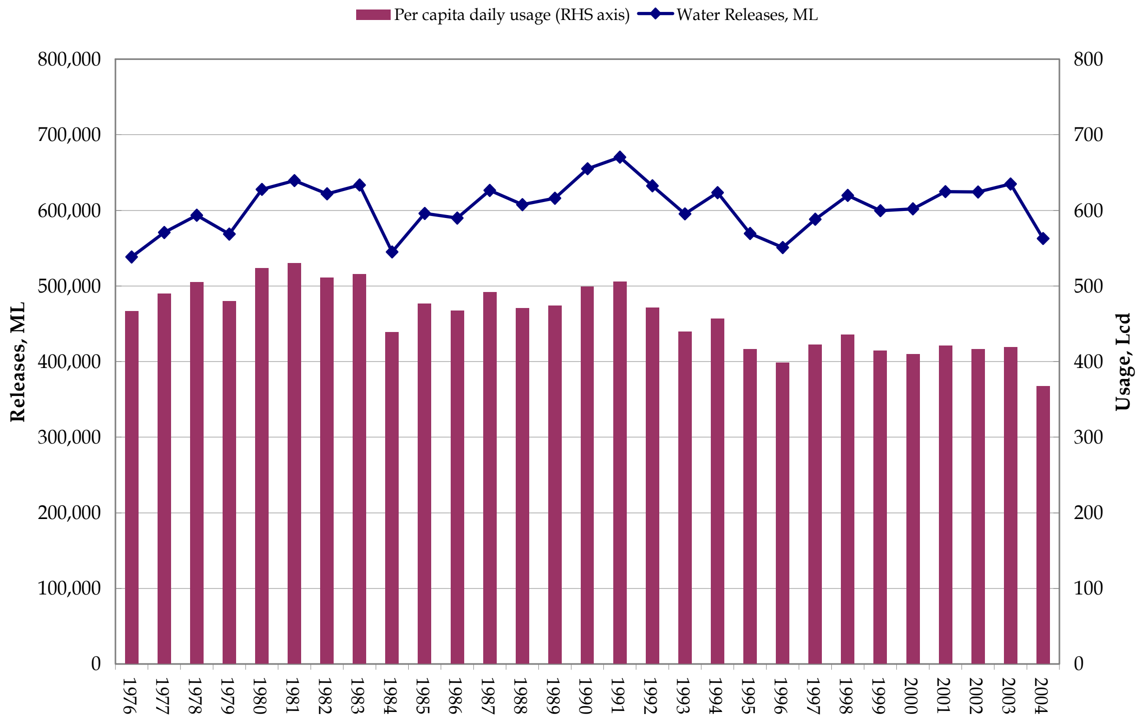
Water usage in Sydney has fallen in recent times due to a number of factors. The historical trends in water usage and the key factors affecting water usage are summarised in this section.

Water usage in Sydney has grown only slightly over the longer term, despite a growing population and economy (see Figure 1). Considering data from 1976, the long-term trend indicates a growth in consumption at less than 1% per annum. The low growth rate has been driven by a sharp decline in per capita consumption.

Trends in more recent times are more difficult to discern. Although there was a sharp drop in water use from 1991 to 1996, it recovered thereafter to be at similar levels to these in 1993/94. Part of the drop was due to the introduction of volume-based pricing and changes to underlying demand, particularly for industrial water usage. The decline was also due to the enforcement of water restrictions from late 1994 to late 1996.

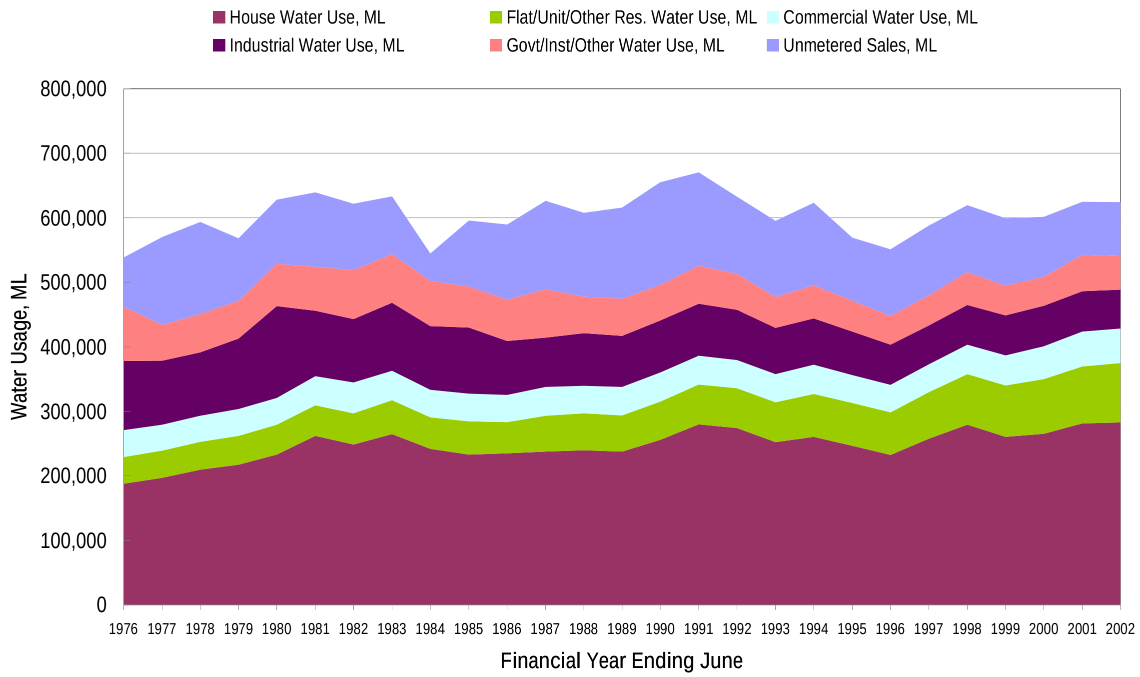
Since the restrictions were removed, water usage has increased to levels prior to the restrictions and remained relatively steady at that level. Even on a weather corrected basis, water usage has been relatively steady since 1998. Again, some underlying trends may be masked by looking at aggregate usage, since further demand side measures were implemented in 1999/00, which may have dampened demand since then. More recent data also indicates that water usage corrected for the dry weather picked up in 2002/03 prior to new restrictions being implemented.

Figure 1 – Water usage in Sydney



There are different trends in water use by customer segments (see Figure 2). Water use has increased for the residential sector, but declined in the industrial and government/institutional sectors. The residential sector now accounts for over 60% of water releases and over 70% of water sales. Population growth and the changes to household formation patterns mean that the importance of the residential sector will continue to grow.

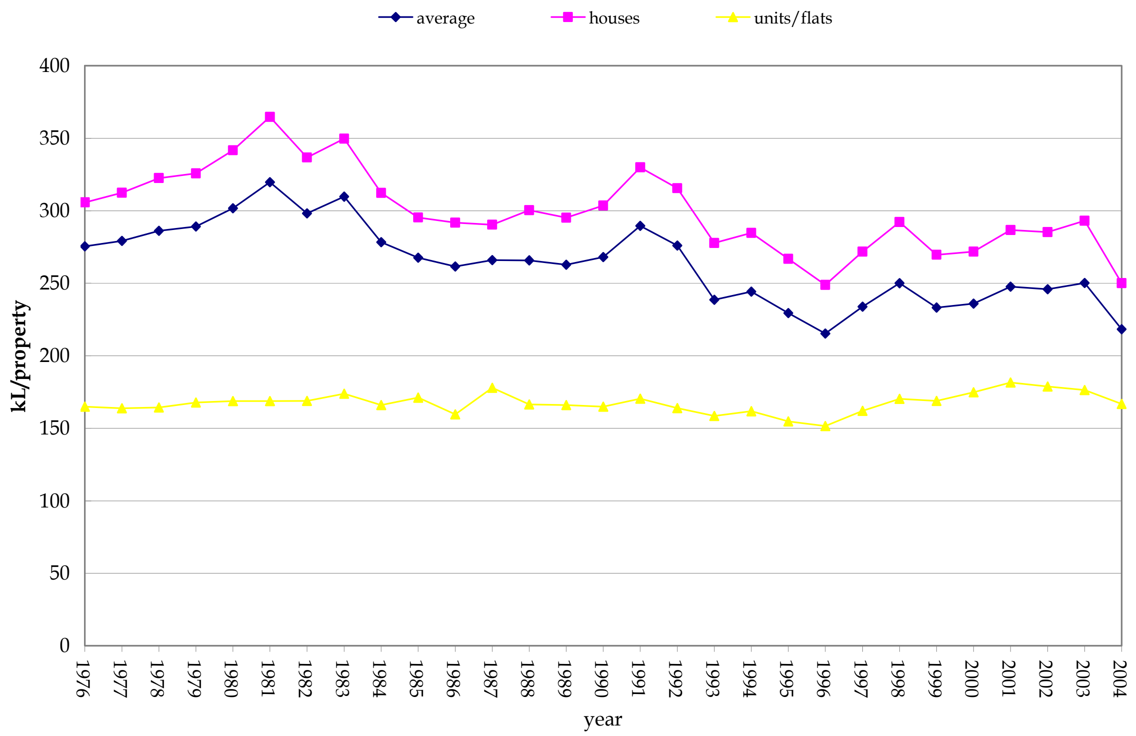
Figure 2 – Trends in water use by customer segment, ML



Average consumption of water per capita has fallen (as can be seen in Figure 1) over the last 30 years. Since 1990, per capita consumption has fallen from around 506 litres/capita/day (LCD) to 367 LCD at June 2004. According to SWC, the long-term average is around 426 LCD. The decline in usage has been attributable to:

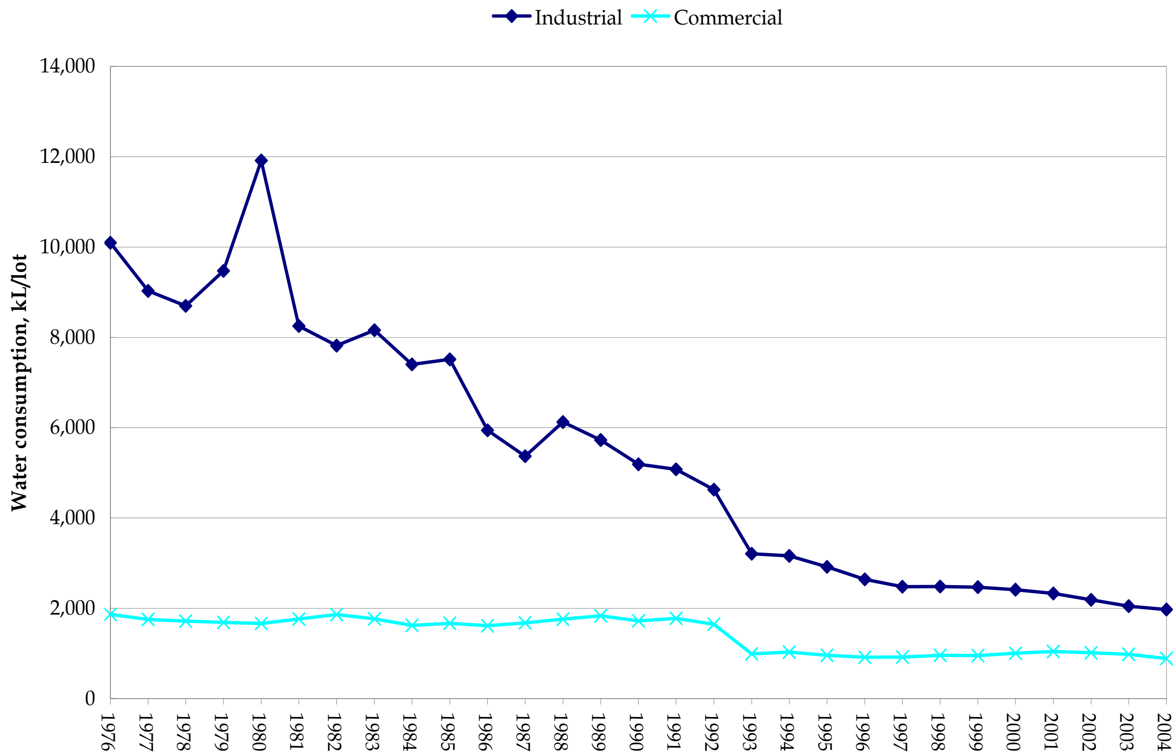
- community conservation awareness programs
- introduction of dual-flush toilets
- improving water efficiency for showerheads and water using appliances
- trends towards smaller lot sizes and garden area in single dwelling housing
- changes in the industrial property mix including a decline in high water use heavy industries
- improved water efficiency and recycling by industry
- implementation of user pays pricing
- demand management programs.

Figure 3 – Average water consumption in the residential sector, kL



Average consumption has fallen consistently for most end-use segments over the long-term (see Figure 3), although there have been signs of a reversal in more recent times for some segments. Average usage has fallen sharply for the industrial sectors, as shown in Figure 4, although the rate of the decline has been modest since 1997. Usage in the commercial sector has exhibited only a small decline over the long-term, although there appears to have been a small increase in the average usage since 1999. Average consumption by government entities and institutions (hospitals, etc) fell until the early 1990s, but has remained stable since that time.

Figure 4 – Average water consumption in the industrial and commercial sectors, kL



By far the most interesting trends have been in the residential sector. Although there has been some drop in average consumption over the longer term, it has risen since the mid 1990s, both for separate dwellings and flats/units. The rise for separate dwellings has been only slight. However, there was a sharper rise in average consumption in flats and units.

4.3 FORECASTS – CONSUMPTION

In this section, forecasts of consumption provided in SWC's *Submission to the Tribunal's Review of Metropolitan Water Agency Prices* are examined.

A number of factors are important for determining the demand outlook for water. Based on a review of the literature, the key factors appear to be:

- Population growth. This is a key driver of overall demand growth, especially as domestic water usage is increasing in importance.
- Household formation patterns. In particular, in the Sydney region there has been a shift towards multi-unit dwellings and flats. The proportion of multi-unit dwellings has increased over the last ten years. In addition, the trend towards less people per household also increases water usage on a per capita basis, although the difference is likely to be small.

- Economic growth, which impacts on water usage at several levels. High economic growth will accelerate other trends, such as the move towards multi-unit dwellings and the purchase of more appliances.
- Price. A previous study reported that demand for water in Sydney is only slightly responsive to changes in both the marginal price and the fixed usage charge.
- Trends in appliance purchases and usage. There has been a move towards multiple toilets and showers in residences, which tends to increase water usage. The installation of automatic sprinkler systems is also likely to increase water usage. Countering this has been the trend towards more water efficient appliances such as dual-flush toilets and more recently front-loading washing machines.

Apart from these long-term factors, there are other factors that may result in short-term variations in demand. The most important variable is climate, particularly soil moisture and rainfall, which can have a significant impact on outdoor water usage. Temperature may also impact on water usage for air-conditioning. Tourist numbers will also impact on both short-term and long-term trends in water usage.

MMA has undertaken an econometric analysis of the key determinants of metered water consumption by customer segment. The analysis was undertaken for residential and commercial segments, using data from 1981 to 2004. Ordinary least squares regression techniques were employed to determine the importance of relevant explanatory variables. Several model specifications were tested, with the final choice depending on which specification provided the highest adjusted R^2 ratio and acceptable estimates for other key diagnostics (such an acceptable Durbin-Watson ratio and significant goodness of fit statistic for whole estimated equation).

The results of the analysis are shown in Table 7. The estimates in the body of the table represent estimated t statistics for the variables in the final specification chosen. The values in parenthesis represent significance levels.

The analysis should be treated as indicative as there were substantial difficulties in developing adequate formulations of the model given the paucity of good data for many variables and the high correlation exhibited between some of the explanatory variables. The results of the analysis were found to be sensitive to even slight changes to the specification of some of the key variables, particularly weather variables.

Table 7 – Key drivers of water demand

Variable	Separate houses	Flats/units	Commercial
Income	1.64 (12%)	3.99 (1%)	1.94 (11%)
Usage charge	-2.36 (3%)	NS	NS
Water restrictions	-2.05 (6%)	-4.94 (1%)	NS
Occupancy rate	5.20 (1%)	NS	NT
Proportion of dual flush toilets	-3.52 (1%)	-1.77 (11%)	NT
Technical efficiency trend	NT	NT	-1.78 (14%)
Evaporation	2.69 (2%)	NS	NS
Temperature	NS	1.72 (12%)	NS
Rainfall	NS	-1.64 (14%)	NS
Demand management (retrofit)	-2.57 (2%)	NS	-2.09 (9%)

Note: NS = not significant; NT = not tested. [Income was represented by real State GSP per capita. Usage charges were represented by published usage charges in real terms. Occupancy were derived from census data and data provided by SWC. Proportion of dual-flush toilets equals the proportion of dual-flush toilets to the total stock of toilets derived from data provided by SWC. Evaporation, temperature and rainfall were represented by the number of days that average daily value was 25% above long-term mean value.]

The results indicate that income was a significant determinant of demand, with demand increasing with increasing income. However, its impact was small, with income elasticities estimated to be less than one for residential customers and slightly greater than one for commercial customers.

Usage charge was a significant explanatory of water demand by separate houses but not for other customer segments. In the case of flats and units, the lack of significance is probably due to the low number of flats that are separately metered. For separate houses, the own price elasticity was estimated to be -0.16, meaning that a 1% increase in price decreases water demand by less than 0.16%.

The imposition of water restrictions and implementation of demand management (DM) programs obviously have a significant impact on water demand.

Weather conditions have an impact on water use in residential dwellings. This supports other data suggesting weather affects outdoor use in separate houses and air-conditioning use in flats and units. The impact of rainfall on consumption by flats and units probably reflects usage behaviour in townhouses, which are included in this property group. However, the significance of this variable is marginal and hence the result should be treated with some caution.

4.3.1 Method and assumptions

SWC forecast water usage on a water release basis, covering all customers segments and unaccounted for water supplies. A baseline demand is forecast, which covers demand in the absence of active demand side management programs. Then the impact from various demand side management programs is deducted to arrive at the final forecast.

The basic method is as follows:

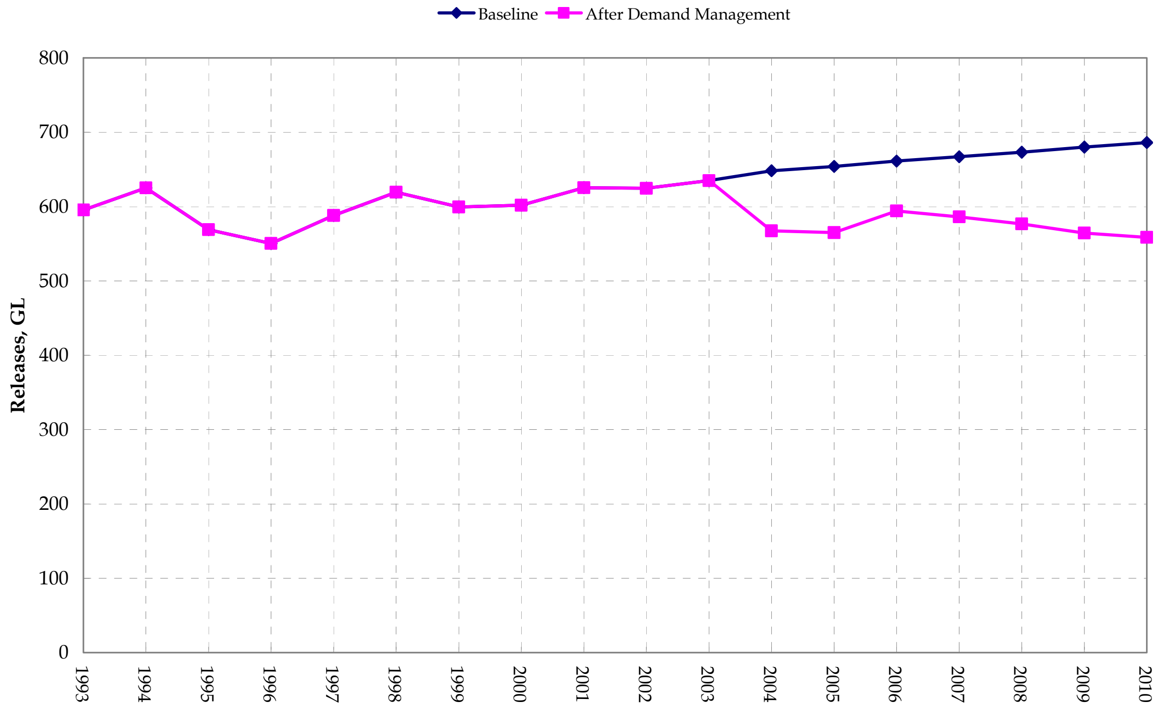
- First, a baseline water demand forecast is developed. For this submission, the baseline forecast was set at 426 LCD. This was agreed to by a number of relevant state government agencies. It is a weather corrected estimate of the average daily consumption and is meant to be representative of current trends in this variable. The estimate of average litres consumed per capita per day covers potable water releases and does not include the reuse of recycled or wastewater.
- The LCD estimate is multiplied by projections of population, which are obtained from DIPNR. The population projections cover the relevant local government areas supplied by SWC. Not all customers in these regions are serviced by the company, so SWC adjusts the population projections to only account for those customers who are serviced by the Sydney Water Corporation.
- The estimated savings in water consumption due to the implementation of a range of demand management initiatives are then deducted from the baseline forecasts to arrive at the final consumption forecasts. The impact of each demand management initiative is estimated through the application of an end-use model. This analysis is described in more detail in the next section.

The forecasting method for baseline consumption is relatively simple, it relies on an historical average after correcting for weather. Estimates of water savings from demand side management involve the use of more sophisticated approaches, with forecasts supported by detailed modelling.

4.3.2 Indicative consumption forecasts – Business as usual

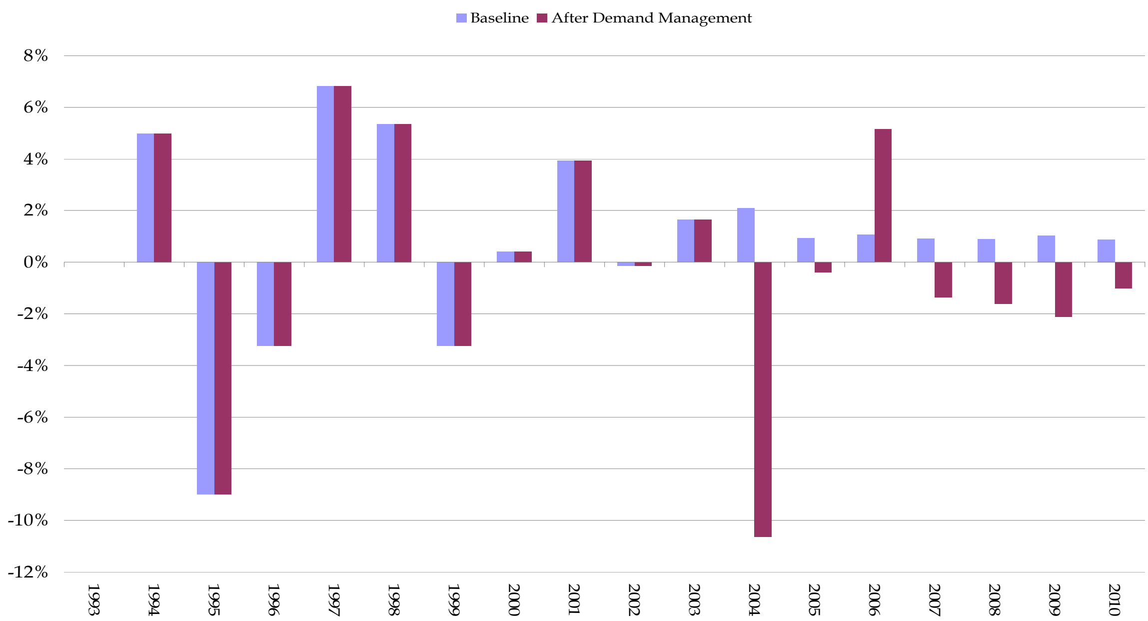
The forecast of baseline water demand provided by SWC is shown in Figure 5. Baseline water consumption is forecast to increase from 648 GL in 2004 to 686 GL in 2010. The average rate of growth over the forecast period is 1% per annum, which is slightly higher than the historical rate of growth since 1993 of 0.8% per annum (see Figure 6). Final consumption, after deducting for water savings, is projected to fall from 563 GL in 2004 to 559 GL in 2010. Clearly demand management is expected to have a large impact, resulting in savings of over 127 GL pa by 2010.

Figure 5 – Baseline and after demand management and water demand forecasts



Source: SWC AIR dated 27 October 2004

Figure 6 – Historical and forecast growth rates in water releases



Source: MMA analysis based on forecasts provided by SWC

The growth rate is comparable with some of the key economic drivers underpinning water demand, as shown in Table 8. The real price increase is expected to augment further, but this is captured as a demand management measure. Price sensitivity is also less than one.

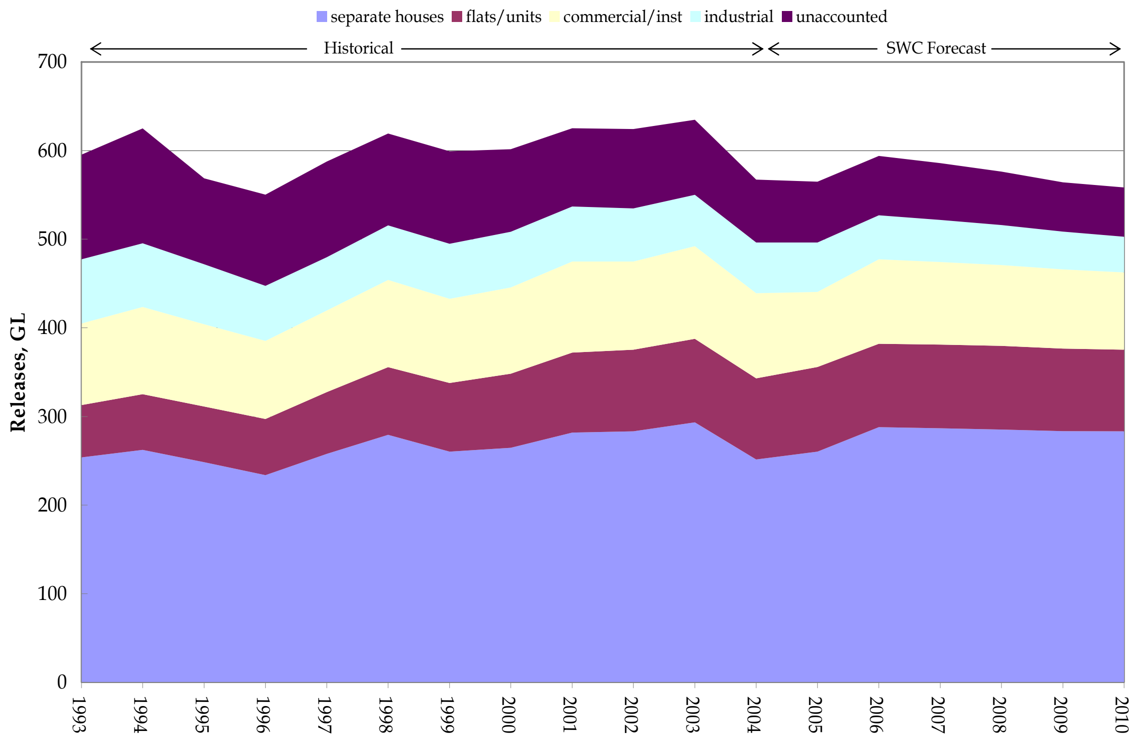
Table 8 – Growth in water demand and growth in key drivers, 2005 to 2010

	Growth rate, % pa
Baseline demand	1.0
Population growth rate	1.0
GSP growth rate	0.7
Real price increase	3.0

Sources: SWC, NSW Treasury, DIPNR

SWC did not provide estimates of the baseline demand by customer segment. Some trends can be discerned, however, by examining forecasts of metered consumption after the impact of the demand side management initiates are deducted (see Figure 7).

Figure 7 – Forecast of consumption by customer segment



A review of the forecasts reveals that industrial demand is forecast to continue falling as a result of water use efficiency improvements and increased usage of recycled water. SWC's largest customer has recently announced approval for further water recycling to reduce water demand in the sector by an additional 7.0 GL. Overall, water demand in this segment is forecast to fall by an average of 5.7% per annum.

In addition, demand from the commercial and institutional sectors is forecast to fall by 1.5% per annum on average. This would reflect the adoption of demand management initiatives for this sector.

Unaccounted for water is forecast to fall by 4.6% per annum due to replacement of bad meters and the leakage reduction program.

Residential demand is forecast to increase, this is mainly due to the removal of water restrictions and population growth. Towards the end of the forecast period, demand for separate houses and medium density dwellings start to decrease as the DM programs begin to impact on demand.

4.3.3 Analysis of forecasts

SWC's forecasts rest on two sets of assumptions. Firstly, that average daily consumption per capita, in the absence of demand management, remains constant at 426 LCD.

Secondly, that existing and new demand management initiatives will be successful in leading to large reductions in water usage. Given that many of these programs will be new, this assumption needs close scrutiny. An analysis of the assumptions behind the demand management programs is provided in the next section.

Information provided in SWC's submission indicated that the estimate of 426 LCD was arrived at by an interdepartmental committee. The figure was derived to be used for planning purposes and to assess the impacts of various options for demand management and supply augmentation.

Support for the estimate is provided by a separate study undertaken by SWC.[4] MMA has reviewed this study and undertaken some statistical analysis to assess the veracity of the assumption. A summary of the results and key conclusions is provided below.

SWC's methodology for computing the baseline forecast involved a combination of seasonal decomposition and regression analysis using monthly data on water releases. The seasonal decomposition component of the analysis normalises the LCD data in order to remove seasonal fluctuations in demand. Regression analysis is then applied to the seasonally adjusted series in order to reveal any LCD trends over time. The analysis was preformed using data from the most recent period in which there were no water restrictions (November 1996 to October 2002).

The procedure was as follows:

- Convert monthly releases by population to get LCD estimates. Population estimates were derived from data provided by DIPNR. A linear trend in population growth was applied across the months in each year.
- Seasonal decomposition methods were applied to monthly water release data. This effectively removed seasonal influences on water consumption.
- Regress using OLS estimators the monthly LCD with a trend variable and the relevant weather variables. The weather variables were specified as temperature variation from monthly average, rainfall variation from monthly average, evaporation variation from monthly average

4 Sydney Water Corporation, 2004, *Recent Trends in Per Capita Demand*, a report prepared by the Strategic Directions Team, Sustainability Division, October.

- The analysis was undertaken with both actual release data and release data adjusted to remove the estimated impacts of the demand management programs implemented from 1999 onwards.

SWC used the following regression equation to model the seasonally adjusted LCD series:

$$LCD_{i,j}^{DM,SA} = Constant + b_1 \times \left(T_{i,j} - \overline{T}_i\right) + b_2 \times \left(R_{i,j} - \overline{R}_i\right) + b_3 \times \left(E_{i,j} - \overline{E}_i\right) + b_4 \times Trend$$

Where:

$LCD^{DM,SA}$ = seasonally adjusted monthly average LCD, corrected for savings from demand management

$\left(T_{i,j} - \overline{T}_i\right)$ = temperature (average of maximum daily temperature) in month i of year j minus the average temperature for month i during the analysis period

$\left(R_{i,j} - \overline{R}_i\right)$ = total rainfall in month i of year j minus the average total rainfall for month i during the analysis period

$\left(E_{i,j} - \overline{E}_i\right)$ = total evaporation in month i of year j minus the average total evaporation for month i during the analysis period

$$Trend_i = \frac{\text{Sequence number month}_i}{12}$$

SWC has defined the trend variable in the manner shown so that its coefficient provides an indication of the annual upward or downward movement in per capita consumption.

MMA repeated this analysis with data provided by SWC. The analysis involved testing different specifications of the weather variables to see if the results of the analysis could be improved. MMA also used different values to SWC to indicate average weather conditions. Instead of calculating average values from data during the analysis period, MMA's analysis used long-term (30 year) averages. The details of MMA's analysis are outlined in Appendix A.

The results for the data corrected for the demand management programs are shown in Table 9.

Table 9 – Regression analysis of deseasonalised DM adjusted LCD

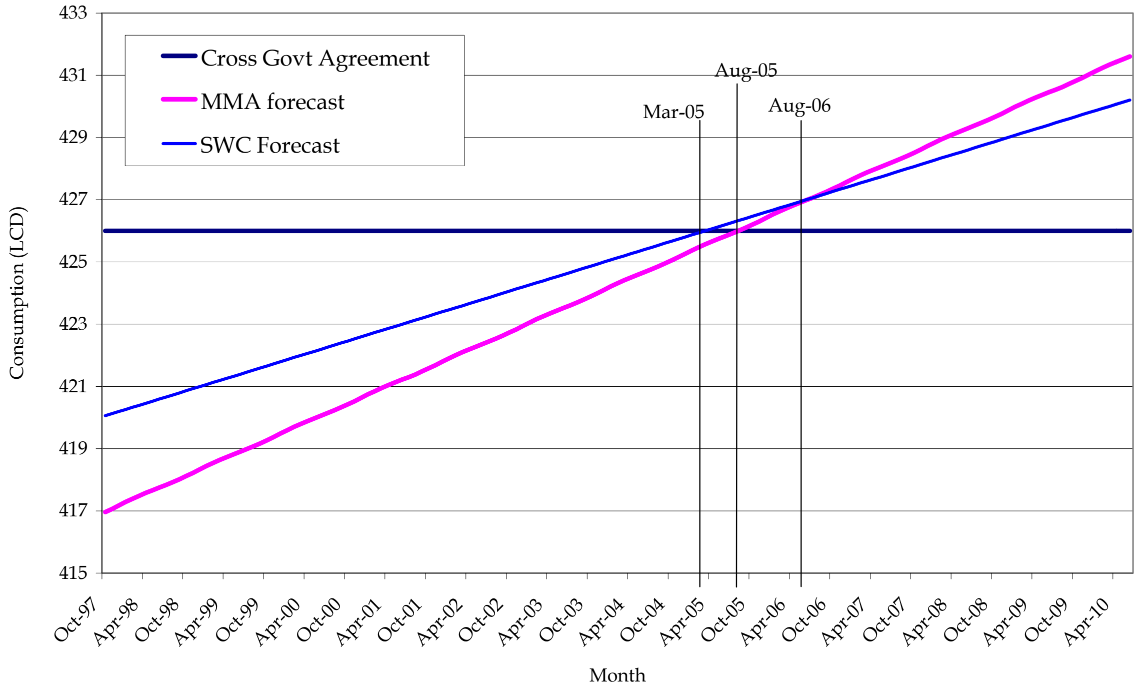
	SWC results	MMA results
Constant	420.134	414.705
Constant p-value	0.000	0.000
Trend coefficient	0.866	1.150
Trend coefficient p-value	0.412	0.285
Temperature coefficient	8.737	7.090
Temperature coefficient p-value	0.000	0.001
Rainfall coefficient	-0.036	-0.045
Rainfall coefficient p-value	0.320	0.189
Evaporation coefficient	0.792	0.834
Evaporation coefficient p-value	0.000	0.000
R^2	0.67	0.67
Adjusted R^2	0.65	0.65

The MMA and SWC models provide identical results in terms of the adjusted R^2 statistic. However, the two models give noticeably different results in terms of the trend coefficient, with SWC's model predicting an annual increase of 0.9 LCD and MMA's model predicting an increase of 1.2 LCD. MMA's model gives a more statistically significant p-value for the trend coefficient, indicating that an increase of 1.2 LCD per annum is more representative than SWC's 0.9 LCD per annum.

The discrepant estimates of LCD lead to slightly different water consumption forecasts out to 2010. The forecasts for LCD are shown in Figure 8. Although MMA's model predicts a greater rate of increase in LCD per annum, the lower value of the constant in the model actually results in the predicted LCD crossing the constant cross-government agreed value of 426 LCD at a slightly later date (approximately five months later, some time in August 2005). Beyond August 2006, MMA's model predicts higher rates of per capita consumption than SWC's model.

More importantly, based on SWC's own analysis, the estimate increases from 425 LCD in 2004 to 426 LCD in 2005 and then gradually rises to just over 430 LCD in 2010. The average over the forecast period is around 428 LCD. MMA's estimate of the average LCD is also slightly higher than the 426 LCD assumption used in SWC forecasts of water demand. However, the difference is not substantial, leading to an underestimation of demand of less than 1%.

Figure 8 – Forecasts of LCD



There are a number of limitations with this analysis that restrict its usefulness as a tool for demand forecasting.

These limitations include the fact that estimating monthly population growth is difficult, which leads to errors in the LCD calculated for each month.

Furthermore, the trends in the LCD mask a large number of other trends, such as reductions in industrial demand and leakage. The estimate of the trend variable is not robust and is likely to change over time as interplay of the underlying trends change. For example, there has been a large decrease in industrial demand over the last 20 years, which would have decreased the impact of other trends on water demand. Further substantial reductions are not likely unless significant water recycling occurs. Thus, the growth in LCD may be faster than indicated by both the SWC and MMA models.

The estimate of the trend in LCD is highly sensitive to the specification of the weather variables. The specification used by SWC was based on analysis undertaken by a weather correction model – the specification was chosen as the one that provided the highest R^2 statistic. Analysis by MMA indicated that even slight changes to this specification resulted in different trend parameters. Thus, some justification for the choice of model specification is required.

Finally, data provided by SWC suggests that the usage rate for new homes is higher than for older homes. The higher consumption appears to be sustained for long periods. Once again, this suggests that the LCD rate will tend to increase over time as the proportion of new homes increase.

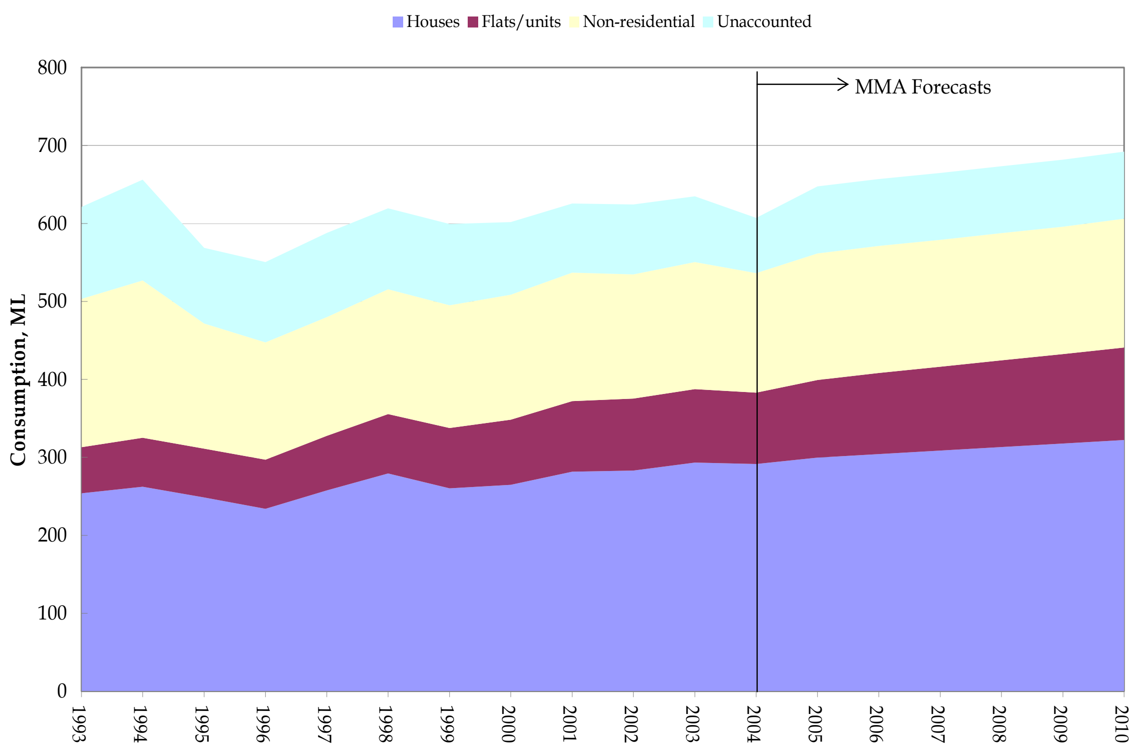
MMA has developed alternative forecasts based on information provided by industrial customers and statistical models of demand for residential customers and commercial customers. The forecasts do not include the impacts of the demand management programs currently being implemented.

The forecasts are based on the following assumptions:

- income growth rates are in line with recent NSW Treasury estimates for GSP growth rates
- SWC's proposed increases in usage charges
- average weather conditions
- unaccounted for water usage as forecast by SWC
- industrial demand forecasts based on survey information provided by customers.

The forecasts for each customer segment are shown in Figure 9. MMA and SWC's baseline forecasts are compared in Figure 10. Based on MMA's model, baseline water releases under the baseline scenario are expected to increase in 2004/05 with a return to normal weather patterns, removal of restrictions and population growth. Thereafter, water consumption is expected to increase slightly in line with growth in population and incomes. This growth would be higher, except for the assumed small increase in real terms in usage charges and the continuing higher proportion of homes with dual-flush toilets.

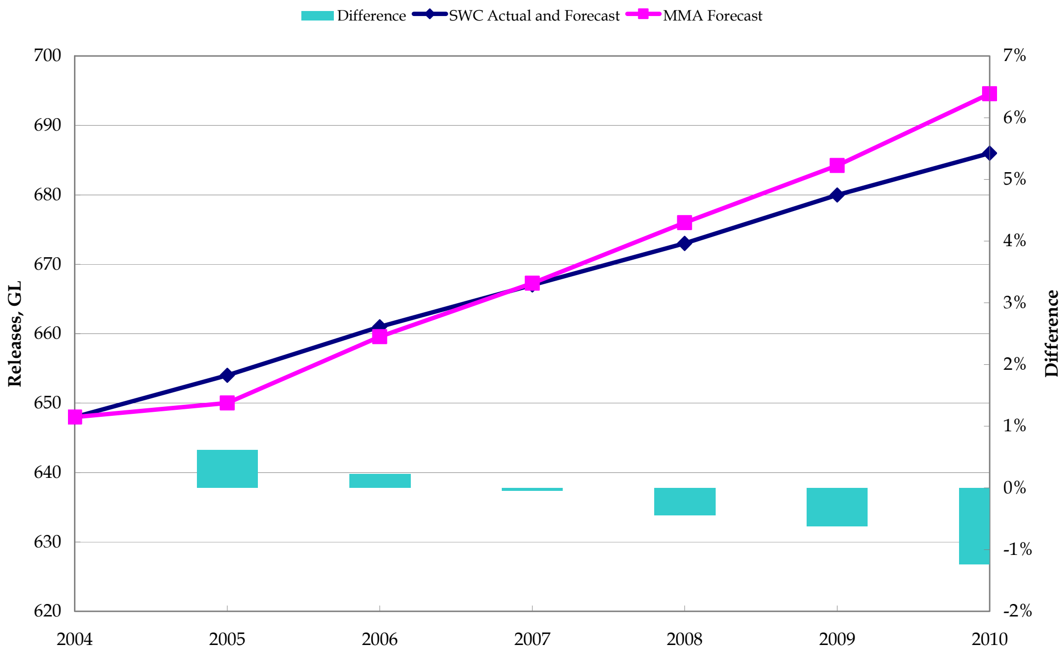
Figure 9 – MMA baseline water consumption forecast, ML



The forecasts should be treated with caution as the analysis was based on indicative models of water demand. Although the models have good predictive capabilities, the impact of underlying structural changes means that parameter estimates can change over time. More analysis is required to firm up the forecasts.

Figure 10 shows a comparison of MMA and SWC's baseline forecasts. MMA's indicative forecast for baseline consumption is some 1% to 2% higher than the baseline forecast produced by SWC in the latter years. If SWC used the rising trend estimate for LCD, the difference in forecasts would have been smaller (less than 1%). Other factors which explain the difference include SWC's use of a slightly lower population growth forecast than the most recent forecasts provided by DIPNR.

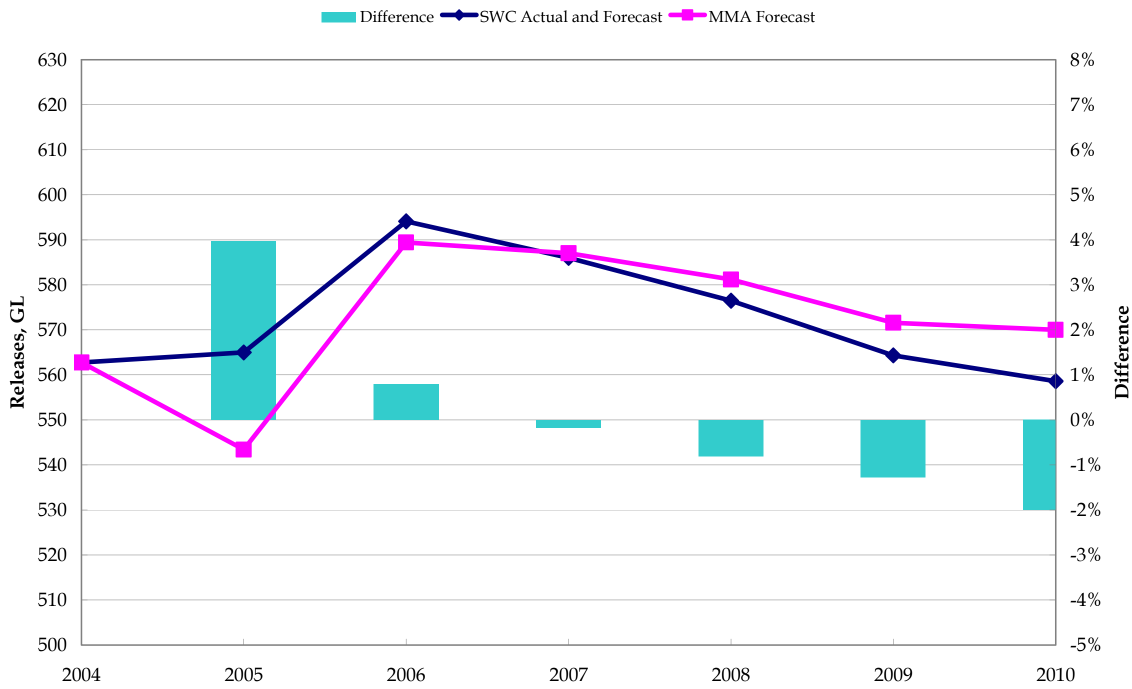
Figure 10 – Comparison of MMA and SWC baseline forecasts, GL



Based on the analysis above, MMA believes the forecasts provided by SWC are reasonable given the data relied upon and the difficulties of building suitable and robust demand models.

The comparison between MMA's and SWC's consumption forecasts is shown in Figure 11. These forecasts are derived from the baseline forecasts by deducting the impact of current and proposed demand management programs and the ongoing impact of water restrictions. The consumption forecasts includes unaccounted for water usage.

Figure 11 – Comparison of MMA and SWC consumption forecasts, GL



4.3.4 Large customers

SWC provided historical water consumption and contact details for its top 20 large customers. These customers represent a number of industries, ranging from mining and steel production to paper and food manufacturing.

MMA interviewed eight large customers. These large customers mainly use water for:

- industrial processes
- dust suppression
- cooling towers.

Based on the information provided by these customers and SWC, it appears that most large customers are either implementing internal water conservation programs or are exploring ways to minimise their water consumption. Interview comments indicated that the major barriers to implementing water conservation measures within these industries are the capital cost of the programs and their financial pay back. For SWC's 20 largest customers it is estimated that total consumption will decrease from 29.6 GL in 2003/04 to approximately 21 GL in 2009/10, which is about a 6% reduction per annum. The drop in water consumption can be explained by the substitution of potable water with recycled water and the implementation of DM programs.

4.4 FORECASTS – DEMAND MANAGEMENT PROGRAMS

SWC has proposed a set of very wide-ranging DM programs covering the period from 2004/05 to 2009/10. MMA has reviewed each of the more important DM programs in some detail in order to comment on the reasonableness of DM savings proposed by SWC.

So that the DM review ties in with the rest of MMA's forecasting, this section has adopted the following conventions:

- Only DM activities from 1 July 2004 are taken into account. MMA has analysed elsewhere the average consumption, by customer sector, over the period. This consumption analysis has taken into account the impact of any DM programs that have already been in place to 30 June 2004. Because of this, the impact of programs implemented prior to 30 June 2004 has been excluded – the program results have already been taken into account in our forecast for the sector prior to new DM programs.
- Only half of the savings from programs which are expected to develop over the course of a year are allocated to that year. The remainder is allocated to the following year. Thus, if 1,000 homes are retrofitted over the course of the year 2004/05, each saving an assumed 20 kL, then during the year 2004/05 only half of the savings, ie 20,000/2=10,000 kL, is recognised. Conversely, where programs are fully in place from the start of a year, for example price increases assumed to take place on 1 July, it is assumed that the full impact of the program is achieved during the year.
- Where double-counting is likely to be an issue, MMA has taken measures to eliminate or reduce this. For example, although recycled water is being used in new homes, this is included under the BASIX program but not the recycled water program.
- MMA has generally assessed the programs as proposed by SWC. This raises the issue that the proposed program may not be undertaken or may be undertaken with different timing or parameters than those proposed. Thus, for example, MMA has assumed the stepped tariff pricing option proposed by SWC is to be implemented. If a different set of prices is to be implemented, possibly relating to the determination by the Tribunal, then the savings need to be re-assessed.
- Significant uncertainty surrounds the likely impact of many of the programs proposed by SWC. Indeed, there are very few examples of programs where savings can be quantified with confidence. Where significant uncertainty exists, this is pointed out in the analysis.
- Materiality has been a consideration in the review. Where programs are very small, or the impact of alternative assumptions is relatively immaterial, MMA has generally not commented, or commented but not made alternative assumptions.
- In the draft report, MMA outlined any areas of significant disagreement with SWC and provided an indicative forecast using alternative MMA assumptions or methodology.
- MMA has met with SWC personnel twice since the draft report was produced. The meetings were to clarify MMA's initial position, receive comments from SWC and debate any issues of disagreement. This final report retains the comments contained in the draft report, but then provides the substance of any subsequent debate and the final judgement taken by MMA. The savings for each DM program in the final report are based on that judgement.

4.4.1 RETROFIT

4.4.1.1 Program description

The residential retrofit programs apply to existing homes. Generally retrofit programs undertake one or more of the following:

- supply and install AAA showerheads
- supply and install 3 litre cistern displacement device
- supply and install tap flow regulators
- fix leaks.

SWC has already undertaken three of these programs, one for free, one with a customer contribution and one targeted. The free program is understood to have retrofitted about 70,000 homes, the contribution program about 100,000 homes and the targeted program a further 63,000 homes over the period 1999/2000 to 2003/04.

SWC plans to implement the following additional program over the period to 2009/10:

- Targeted 53,000 end-users, each with an expected saving of 20.9 kL/HH/a, (kL per household per annum) consistent with savings seen in the recent program.
- Targeted 95,000 "premium" end-users, each with an expected saving of 25 kL/HH/a.
- Retrofit of 25,000 DoH homes, each with an expected saving of 20.9 KL/HH/a.

4.4.1.2 Expected program savings

The Institute of Sustainable Futures (ISF) has estimated a saving of about 20.9 kL/HH/a for the retrofit program. ISF has also found that the 20.9 kL/HH/a has remained approximately constant over the life of the programs.[5]

SWC has assessed that the 20.9 kL per household annual savings is made up of:

- 13.9 kL for AAA showerheads
- 3 kL for the cistern displacement
- 3 kL for tap regulators
- 1 kL for leak repair.

SWC estimates the savings arising from the retrofit of 230,000 houses to the end of 2004 to be about 4,900 ML.

4.4.1.3 MMA initial review

After reviewing the material supplied by SWC, including the evaluation reports from the ISF, MMA considers the savings of 20.9 kL/HH/a to be a reasonable estimate for the

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[5] Institute of Sustainable Futures, 2004, , *Every Drop Counts: residential retrofits, analysis of water savings*. Report to SWC, April.

average savings achieved per retrofit to date. The total savings, and the break-up between components match reasonably well the findings in the Sarac et al study.[6]

Although there has been some concern about the impact of the retrofits declining over time, there has, as yet, been no evidence of this.

MMA considers it reasonable to assume that the result of the targeted additional retrofits will be 20.9 kL/HH/a in line with current averages.

SWC is assuming the same average saving for retrofits of about 25,000 DoH properties. MMA agrees with SWC that this saving is likely to be conservative, given that DoH properties typically consume more water per household than the average property. This is probably because the Government pays for water for tenants of DoH properties.

SWC is assuming a saving of 25 kL/HH/a for premium retrofits. This is on the basis that such retrofits will target likely customers with high savings, for example, focusing on high water using customers and excluding pensioners (who have lower savings on average according to the ISF evaluation).

While the extent of the savings achieved from such retrofits is uncertain, MMA considers the 25 kL/HH/a savings assumed to be reasonable given that the average for parties other than pensioners who were retrofitted was at least 22.6 kL/HH/a[7] and further targeting is expected to allow higher savings.

Although the allocation of savings between appliances is not relevant to the expected savings from the retrofit projects, it is important for understanding and confirming projected savings from other programs such as appliance standards.

As stated in Section 4.4.1.2, SWC has assumed that the average saving of 20.9 kL/HH/a is made up of:

- 13.9 kL/HH/a to AAA showerheads
- 3 kL/HH/a to the toilet flush arrester
- 3 kL/HH/a to tap aerators/regulators
- 1 kL/hh/a to leak reduction.

However, this must be read against the understanding that not all participants in the program received each of these measures. While the uptake of AAA showerheads is understood to have been high, with about 280,000 AAA showerheads provided to over 233,000 participants in the program (over 24% of participants, we understand, receiving two showerheads)[8] this may not have been the case for the other products – either because such fittings were not possible or not requested by the household.

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6 K Sarac, D Day, S White, ISF, *What are we saving anyway? The results of three water demand management programs in NSW*. Source: http://www.isf.uts.edu.au/publications/E20632A.pdf Last accessed: 9 Dec 2004.

7 Institute of Sustainable Futures, 2004, , *Every Drop Counts: residential retrofits, analysis of water savings*. Report to SWC, April.

8 SWC WC&R Implementation Report 2003/04, p 8.

From the information provided above and further information supplied by SWC, we estimate that about 93% of participating households had a AAA showerhead fitted. This indicates that houses which have at least one AAA showerhead fitted save some 15 kL/HH/a, a figure which matches well with the Sarac et al work.

The ISF April 2004 report carries out an analysis on a sample of almost 13,000 retrofit houses, including 219 which had no changes made. This indicates that some 50% of houses had toilet flush arrestors fitted, each with an impact of some 6 kL/HH/a and 90% had tap aerators fitted, each with an estimated impact of 3.3 kL/HH/a. Again, these results are broadly similar to those in the Sarac analysis.

The timing of the savings is of some relevance. SWC expects the full savings to be during the year in which the retrofits take place. In fact, they are likely to be achieved throughout the year as retrofits take place. This means that the impact in the first year is only half that expected, with the rest of the impact carried over to the second year. Thus the impacts of the program to be carried out over the period 2005 to 2010 will not be fully felt within that period, which will slightly reduce the overall impact expected for the period from 2005 to 2010.

However, by the same argument, half the impact of the targeted retrofits carried out in 2004 will be felt in 2005. This needs to be factored into the calculations.

4.4.1.4 Further MMA review following the draft report

SWC has accepted the need for program timing considerations to be taken into account. As this was the only difference of substance between MMA and SWC, MMA has not changed its forecasts from the draft report.

4.4.1.5 Analysis of outcomes

So long as the retrofit program is implemented as proposed, MMA considers the outcomes expected by SWC, which are summarised in Table 10, to be reasonable. We have re-calculated the MMA assessment of savings based on the timing issue discussed in Sections 4.4.1.2 and 4.4.1.3 above.

Table 10 – Expected retrofit savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
Targeted	490	835	1,044	1,148	1,253	1,357
DoH	125	563	1,188	1,688	2,000	2,250
Premium	131	293	376	475	523	523
Total	746	1,690	2,608	3,311	3,775	4,130
Compared with SWC	887	1,889	2,723	3,296	3,651	4,005

The savings expected are approximately in line with those proposed by SWC. We have reasonable confidence (say ±10%) in the savings proposed so long as the program is followed.

4.4.2 BASIX

4.4.2.1 Program description

The Building Sustainability Index (BASIX) program has been introduced by the NSW government to reduce the use of water and energy in new homes. From 1 July 2004 it has been mandatory for development proposals for new single or dual occupancy dwellings in Sydney to meet the current BASIX requirement (which theoretically produce 40% potable water savings and 25% greenhouse emission reductions). New multi-residential proposals in Sydney will be required to meet the requirements from 1 February 2005 and all remaining NSW applications from 1 July 2005.

From 1 October 2005, BASIX requirements will need to be met for proposals for alterations (requiring new construction) to existing homes.

The target set by BASIX is the reduction of water usage by 40% compared to the average of existing homes (not new homes). According to BASIX material, a typical development will meet the target for water conservation if it includes:

- showerheads of AAA rating or more
- tap fittings of AAA rating or more
- dual-flush toilets
- a rainwater tank or use of recycled water for outdoor water use and toilet flushing and/or laundry use.

4.4.2.2 Expected program savings

SWC has calculated the savings from the implementation of BASIX as:

- the number of net new single or multi-residential homes in each year (from residential and demographic forecasts)
- the assumption that BASIX on new homes will reduce potable water usage by 40% in line with BASIX targets
- from a base of an average single residential dwelling using 300 kL/HH/a or of a unit using 171 kL/HH/a
- assuming a three month lag in achieving the savings in Year One for single residential dwellings and a two month lag for multi-residential.
- for alterations and additions SWC has assumed that there are 50,000 major renovations in NSW per year, of which 62% are in the SWC area. Of these:
    - 30% are to bathrooms with a saving of 17.5 kL/HH/a (15 from showers, 2.5 from bathroom taps)
    - 20% are to kitchens with a saving of 5 kL/HH/a (5 from kitchen taps)
    - 10% are to bathrooms and kitchens with a saving of 22.5 kL/HH/a

- 5% are to laundries with a saving of 12.5 kL/HH/a (2.5 laundry taps, 10 washing machines)
- leaks from bathrooms and kitchens are also assumed to be fixed at the rate of 5 kL/HH/a for all kitchen and bathroom renovations
- in total, the savings are calculated by SWC to be 18.65 kL/HH/a for each bathroom, kitchen or laundry renovation
- the savings are assumed to accumulate in the year of building or renovation except in the first year when only half the year is considered applicable.

4.4.2.3 *MMA initial review*

MMA has reviewed the assumptions made by SWC relating to BASIX and has the following concerns and reservations:

- The numbers used for new dwellings should match those in the 2004 end-use model.
- We consider that the number of new dwellings is slightly underestimated because SWC uses a net dwelling number in forecasting. In fact, the number of new houses will be higher as there are some demolitions. We estimate that taking into account demolitions will increase the number of new separate dwellings constructed (and hence the impact of BASIX) by some 5 to 10% for single households (none for multi-residential).
- The savings estimated by SWC are based on 40% of estimated current average usage. However, as we understand it, the current average usage on which BASIX savings are calculated for single residential houses is about 262 kL/HH/a, not the 300 kL/HH/a used by SWC. It is not clear whether the average assumed by BASIX for multi-residential is the same as that assumed by SWC. This means that the savings actually expected by BASIX are 40% of 262 kL/HH/a, ie 105 kL/HH/a, rather than the 120 kL/HH/a assumed by SWC.
- In any case, we consider it unlikely that the savings estimated by BASIX will actually all accrue. An example of this is that BASIX has assumed that the installation of a AAA toilet in new houses will save some 6% of average water usage (15 kL/HH/a). This is because BASIX compares against average current practice across all similar households. However, 6/3 litre toilets (AAA) have already been required for new houses for several years and are the default toilets. Despite this, there is no evidence in the information provided by SWC that the average usage in new separate houses has actually reduced.
- The timing of the expected savings is a further issue. As we understand it, BASIX applies only to planning documents. We expect the lag time between the lodging of planning documents and the completion of homes to be at least 6 to 12 months. Thus, the impact of BASIX on new completions will not even start to be felt until at least six months after BASIX is introduced. Even then, it will only be felt for the proportion of

the time that the completed BASIX houses have actually used water — that is, not all the new houses will be completed in Month One. In addition, the entire SWC reticulation area will not be covered by BASIX until 1 July 2005. Only the Sydney region will be covered until then. This reduces expected savings by some 10%.

- We consider the SWC assessments for BASIX applying to alterations and amendments to be unrealistic in several areas. There is no justification provided for the assumed 50,000 renovations requiring BASIX certification per year in NSW. By comparison, we understand that a Housing Industry Association survey reported only 67,000 such major renovations Australia-wide in 2003.[9] There appears to be no justification for the assumption that improved washing machines will be required or that laundry taps will need to be AAA – neither of these is currently a requirement under BASIX. Also, SWC has assumed savings due to additions that are the same or greater than those found in the retrofits applying to complete houses. This is unlikely to be the case. Finally, there is again the issue of timing. The planning applications for certification of major renovations will not start until October 2005. After this it will take probably three to nine months for the renovations to be acted upon, and the water savings will presumably be spread throughout the year.

4.4.2.4 Further MMA review following the draft report

SWC accepted the two timing considerations outlined by MMA in its draft report that:

- there will be a delay of some time between a BASIX certificate being granted and the completion of a house (and hence savings)
- the results of the program will be phased over a year, not all achieved from the first day.

SWC did object, however, to three main components of the MMA analysis of BASIX. SWC argued that:

- The savings estimated should be from a baseline of 290 kL/HH/a applying to separate houses rather than the 262 kL/HH/a assumed by MMA. Apparently this is the benchmark currently used by BASIX derived from data provided by SWC.
- The full 40% savings should be applied. SWC argued against the MMA position that only 35% savings would be achieved for separate houses as all new homes already had dual-flush toilets as a default. Furthermore, SWC provided data from actual experience with recycled water at Rouse Hill to show that homes with recycled water used between 105 and 130 kL/HH/a of this water over the past three years, some 35% to 40% of potable use.[10]

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9 Source: http://www.propertyinsider.com.au/eac/WebNews.cfm?newswidth=600px&clientid=554&fullstory=183&periodid=41 Home renovations boom across the country. Last accessed: 9 Dec 2004.

10 SWC also provided some evidence that the overall level of water use in homes using recycled water was similar to that in comparable nearby areas.

- The correct number of alterations and additions should be 50,000 per year. This number had apparently been provided by the DIPNR based on information from Victoria.

BASIX personnel have advised MMA that the average use assumed per single house is 290.3 kL (discussions with SWC suggest this is derived from material provided by SWC). It is expected that the water savings will therefore be 40% of 290.3 kL, or about 117 kL per house. The timing of BASIX is expected to be in line with the program currently set out, and all renovations, not just major ones, are expected to be covered by BASIX. The estimate of 50,000 renovations was derived by DIPNR.

SWC is assuming that the savings due to BASIX applying to new houses will be about 117 kL pa and has provided some evidence that the use of recycled water in new housing estates is around or over 100 kL per house. This would mean that, for new houses using recycled water and other BASIX elements (such as AAA showerheads), the savings are likely to exceed 117 kL pa.

However, according to SWC, houses with water recycling are likely to constitute only about 30% of new houses. The remaining 70% are likely to have rainwater tanks. According to SWC modelling, the impact of rainwater tanks is to reduce water usage by some 40 to 60 kL per house. Combined savings, taking into account the above savings and expected uptake of AAA showerheads and taps, but also the comments previously made about dual-flush toilets, are expected to be less than 117 kL pa.

MMA has held discussions with the Housing Industry Association (HIA) to discuss BASIX, the delay between a BASIX certificate being achieved and dwelling completion and also the discrepancy between the number of major renovations assessed by HIA and overall renovations assessed by DIPNR.[11]

The HIA is of the view that there will be great difficulty in multi-residential units being required to meet BASIX by February 2005 and has argued strongly to government that the date should be changed to July 2005. This could then also result in delays in extension of BASIX to alterations and additions and the rest of NSW.

The HIA has expressed the opinion that the delay between development approval and a single house being constructed is, on average, about nine months. For multi-residential dwellings it is extremely variable, but might be expected to average twelve months. Renovations are estimated to have an average completion time of six months.

The HIA's list of major renovations apparently covers those of value over $12,000 and is based largely on analysis of home warranty insurance. This is obviously one source of discrepancy between the DIPNR estimate of coverage and that used in the draft report. HIA was also of the view that the higher number may include a significant proportion which were either very small or where council approvals were not sought.

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[11] S Tennent, Chief economist and W Gersbach, Executive Director Planning and Environment, Housing Industry Association, Personal Communication.

Significant uncertainty still remains about the likely impact of BASIX. On balance, for this final report, MMA has modelled the BASIX assumptions as follows:

- The timing of BASIX is in accordance with current expectations.
- A savings of 102.8 kL/HH/a per new separate house. This is about 35% that of average separate houses, somewhat lower than expected by DIPNR and SWC. MMA's position on this is based on the initial and final reviews as discussed in Sections 4.4.2.3. Savings for multi-residential dwellings are as modelled for the draft report.
- A delay of nine months between BASIX approval and construction of a new separate house, twelve months for a multi-residential dwelling and six months for a renovation. This is an increase over the assumption in the draft report based on advice from the HIA.
- An estimate that 35,000 renovations will require BASIX certificates. This is halfway between the level of alterations and additions estimated by DIPNR and of major renovations estimated in line with HIA numbers.

The remainder has been modelled largely as for the draft report as has been described in Section 4.4.2.3.

4.4.2.5 Analysis of outcomes

MMA's assessment of the expected impact of BASIX based on the above discussion is provided in Table 11 and compared against the combined SWC estimates.

Table 11 –Indicative BASIX program savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
New houses	87	769	2,496	4,733	6,966	8,979
Alterations	0	24	144	337	529	722
Total MMA	87	793	2,640	5,070	7,495	9,701
Total SWC	958	3,313	5,891	7,985	10,073	12,163

The savings estimated by MMA attributable to BASIX are significantly lower than those expected by SWC and have a different time profile. There is reasonable uncertainty about the savings, say ±30%, because of uncertainties about program timing, delay between BASIX certificate, and completion of construction, number of renovations covered and extent of savings.

4.4.3 Appliance rating and labelling

4.4.3.1 Program description

The federal government has introduced the Water Efficiency Labelling and Standards Bill 2004 to require labelling of showerheads, washing machines, dishwashers, taps, urinals and toilets. Minimum performance standards for toilets are also likely to be set.

Minimum performance standards for showerheads, washing machines and dishwashers may follow.

SWC has assumed that the labelling component of the program will be fully introduced in 2005/06 and that the initial impact will only be on showerheads and washing machines. We assume that the impact on toilets is largely immaterial as virtually all toilet sales in the SWC region are already 6/3 litre toilets (AAA rated). It is unclear why the impact of labels on taps has not been assessed.

The setting of compulsory standards is assumed to be introduced in 2008/09.

4.4.3.2 *Expected program savings*

SWC has calculated the savings as a 5% proportion of savings that would be achieved, according to its modelling, if all showerheads and washing machines were required to achieve AAA standards level.

4.4.3.2.1 Showerheads

SWC has assumed in calculating standards program savings for showerheads that:

- The sales of normal and AAA showerheads will be according to its 2003 end-use model (EUM). This assumes that one third of sales are AAA and the rest are normal.
- Only sales to existing homes are impacted. This is appropriate as sales to new homes will presumably be covered by BASIX.
- After standards come into place, all normal showerhead sales will be replaced by AAA showerhead sales.
- The saving from the conversion of a dwelling's showerheads from normal to AAA is estimated at 21 kL/HH/a.
- After mandatory labelling is introduced, but prior to the imposition of standards, it is assumed that 5% of the impact of standards is achieved through labelling alone.

4.4.3.2.2 Washing machines

SWC has assumed that the standard will require all washing machines to be the efficiency equivalent of today's front loaders and that the water saving will be the difference between average usage by a current front loader minus that of a current top loader. In its EUM, SWC has calculated this difference to be about 13 kL/HH/a.

4.4.3.3 *MMA initial review*

4.4.3.3.1 Showerheads

MMA has reviewed the assumptions made by SWC relating to appliance labelling and standards and has the following comments, concerns and reservations:

- SWC has used numbers derived from its 2003 model, rather than the 2004 model.

- The SWC methodology (based on the 2003 model) appears to be understating the number of sales of normal showerheads by some 10%. This is due to an error in calculation of the reduction due to new homes taking showerheads.[12]
- There is no proper consideration of the impact of the 240,000 homes which have already had recent retrofits and of the expected 173,000 which are to be retrofitted over the next five years. This number should be used to update the stock model and thus to amend the number of normal showerheads requiring replacement. This will have a significant impact on the amount of showerheads (all normal) requiring replacement.
- The estimated replacement rate with AAA of 33% in the SWC EUM model may be low as it does not appear to account for recent penetration rates recorded in the latest Australian Bureau of Statistics (ABS) report on water efficient appliance penetrations.
- The impact of the BASIX alterations and additions program needs to be taken into account.
- Based on retrofit experience the estimated savings of 21 kL/HH/a appears too high. SWC has estimated that 13.9 kL/HH/a of the estimated 20.9 kL/HH/a is due to AAA showerheads. Even if this is factored up to take into account average showerheads per household (taking into account that some 24% of the retrofit program took second showerheads) it only results in a saving of about 17 kL/HH/a. However, given that there will be additional expected savings from labelling standards applied to taps, we have, overall, considered the use of the 21 kL/HH/a to be reasonable.
- SWC has assumed that the labelling program will be in place from 1 July 2005. While we consider this to be optimistic, (while the Act may have been passed we consider that the apparatus will take longer to put in place), we have accepted the timing. We also accept SWC's position that standards for these products may well be in place by 1 July 2008, given that there is an increasing pace for water conservation in government.
- We consider the SWC assumption that the impact of labelling will be 5% that of standards to be reasonable.
- There is again a timing issue. Given the likely spread of sales throughout the year, only half the savings from purchases in that year are likely to accrue within that time period.

4.4.3.3.2 Washing machines

MMA considers that there are several inconsistencies in the SWC modelling of this option, for example, 2003 stock numbers were used rather than those for 2004. In addition, the average usages and frequency of use were not those demonstrated in the most recent water survey. However, the differences are not considered material in this option.

12 In its appliance rating and labelling spreadsheet rows 20 and 21.

It is also not clear why SWC has only included sales to existing customers in this option. This, and changes to timing, are the only amendments MMA considers required for this component.

4.4.3.4 Further MMA review following the draft report

SWC did not raise any objections to the MMA analysis in this section.

4.4.3.5 Analysis of outcomes

MMA's indicative assessment of the impact of labelling requirements based on the above discussion is provided in Table 12 and compared against the combined SWC estimations.

Although differences in outcome are not particularly significant at the labelling stage, they become more material when standards are introduced. We consider the savings to be relatively uncertain (say ±25%), mainly because of the timing impacts, stock and efficiency assumptions used and the assumptions made that labelling will have 5% of the impact of standards.

Table 12 –Indicative labelling savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA showers plus taps		34	102	170	238	308
MMA washing machines		36	110	183	256	329
MMA total		70	212	353	494	637
SWC showers		81	164	250	338	427
SWC washing machines		59	119	180	242	305
SWC total		140	282	430	580	731

4.4.4 Appliance standards

4.4.4.1 Program description

As discussed in Section 4.4.3, the federal government's Water Efficiency Labelling and Standards Bill 2004 foreshadows minimum standard requirements for showerheads, washing machines, dishwashers, taps, urinals and toilets. Although no date has been set for the minimum performance standards for showerheads and washing machines, SWC has assumed that such standards will be introduced on 1 July 2008. Given the recent commitment by all governments across Australia to work towards water sustainability, MMA considers this to be a reasonable expectation.

4.4.4.2 Expected program savings

The SWC methodology for calculating savings from adopting mandatory standards for showerheads and washing machines has been discussed in Section 4.4.3. While labelling is expected to result in 5% of the benefits being achieved, the standards themselves are expected to result in the full benefits when implemented.

4.4.4.3 MMA initial review

The same comments made in Section 4.4.3 also apply here. Additionally SWC has assumed that the labelling and standards outcomes can both contribute from 2008/09, whereas this appears to be double-counting.

4.4.4.4 Further MMA review following the draft report

SWC did not raise any objections to the MMA analysis in this section.

4.4.4.5 Analysis of outcomes

MMA's indicative assessment of the impact of standards is provided in Table 13 and compared against the SWC estimations.

Table 13 – Indicative standards savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA showers plus taps					655	1,975
MMA washing machines					692	2,083
MMA total					1,347	4,058
SWC showers					1,755	3,530
SWC washing machines					1,457	2,929
SWC total					3,212	6,459

Program timing again plays a part in the difference. We consider the savings to be relatively uncertain (say ±20%), mainly because of the timing impacts and stock and efficiency assumptions used.

4.4.5 Residential outdoor programs

4.4.5.1 Program description

According to the SWC end-use models, external residential use would have been about 86 GL in 2004/05 prior to DM measures and restrictions, an average of some 63 kL/HH/a and thus making up some 27% of residential use. Garden and lawn watering is estimated by SWC to make up about 85% of external use, car washing 3%, swimming pools about 8% and "hosing down" of hard surfaces, etc about 5%.

There are several components of SWC's outdoor demand management programs. The "Every drop counts" (EDC) outdoor conservation program has been providing advice about efficient garden and outdoor water use since 2000. SWC expects such programs to continue.

As well SWC expects that some restrictions on watering of hard surfaces and cars and watering will become permanent even after the current restrictions are lifted.

4.4.5.2 *Expected program savings*

SWC has assumed that:

- SWC's current outdoor programs are already achieving a saving of 3% of water use in 2004/05 and 2005/06 and this will reduce to 1.5% when some permanent restrictions are assumed to be imposed.
- a permanent mandatory use ordinance will commence in 2005/06 which will reduce use in the garden and lawn by about 5% from modelled restriction-free levels and reduce hosing down by 40% from modelled levels.
- landscape assessments for 40,000 targeted high usage households which are expected to save 15% of garden usage by these households, about 2.5 GL in total by 2010.

4.4.5.3 *MMA review*

There is certainly scope to save significant amounts of water through modifying external water usage. This is amply demonstrated by the impact of the recent mandatory water restrictions. MMA estimates that after these were imposed in October 2003, average water use in the residential sector reduced by some 9-10% overall – or about 35-40% of all external usage.[13]

However, significant uncertainty exists about:

- the extent of permanent restrictions likely to apply over the forecast period and the decay effect of the current restrictions
- the extent of savings likely to be achieved from various programs targeting outdoor usage
- the extent to which savings "decay" – that is, the period over which users return to "normal" practice.

The assumption used by SWC for the demand forecasts is that the current mandatory restrictions will be lifted from 1 January 2005, but that a new level of permanent restrictions will apply from 1 July 2005.

As stated in the beginning of Section 4.4, the MMA demand management analysis does not take into account the effect of demand management activities prior to 2004, but considers only the effect of additional programs. The net effect of the permanent restrictions according to SWC will be to reduce outdoor use for gardens, hosing down and car washing by about 5% from restriction free levels.

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13 Note that the estimates of savings in the draft report were lower than this because information from an earlier version of the AIR had been used.

While the recently released Metropolitan Water Plan, 2004[14] provides no evidence that the Government intends to retain permanent mandatory restrictions, some level of permanent restrictions has been foreshadowed by the Utilities Minister, Mr Sartor. In an interview with *Stateline*, Mr Sartor stated that there will be some permanent restrictions but that they would be "modest"[15] and that hosing of paths would be an obvious restriction.

Given this announcement and expected long-term public concern over water security, MMA considers it reasonable to assume that a level of permanent restrictions will continue to apply over the forecast period, including the banning of hosing down hard surfaces.

As stated previously, MMA has calculated that the impact of the current level of restrictions has been to reduce residential outdoor usage by some 35-40%. The extent and impact of future restrictions are difficult to predict. MMA considers it reasonable to assume that hosing will be banned and that some level of timing restriction on garden watering will be retained. In total, these are expected by SWC to result in a net 5 GL or so annual reduction in outdoor use, of which about 2 GL will be due to a restriction on hosing down.

Although MMA is not convinced that the "hosing hard surfaces" end-use is as high as shown in SWC's end-use model (about 3 kL/HH/a),[16] overall MMA considers the reductions to this end-use proposed by SWC to be reasonable as the SWC assumptions about the adherence to the permanent restrictions on hosing down are considered conservative.

While the additional 3 GL of savings (the difference between the net savings expected by SWC and those attributed to reduction of hosing down) due to permanent water restrictions is uncertain, it is generally accepted that the impact of water restrictions decays over time after they are removed, rather than taking effect immediately. Even with a decay rate of 50%, the average over the period 2006 to 2010 would result in an average of about this incremental amount. MMA modelling has assumed the impact of restricting hosing down plus the minimum of the decayed impact of the restrictions or 2% of garden use (1.7 GL), assumed to be the additional level of restrictions imposed.

MMA, therefore, considers the SWC forecasts with regard to the net impact of mandatory restrictions in this area to be reasonable over the entire period, but conservative in terms of timing.

SWC has included earlier savings from, for example, outdoor education in its assessment. As discussed previously, MMA has used (weather and restriction normalised) 2003/04 as

14 NSW Government, *Meeting the challenges. Securing Sydney's water future. Metropolitan Water Plan 2004*, October 2004.

15 Mr F Sartor, NSW Utilities Minister, interviewed for *Stateline* 22/10/2004. Source: http://www.abc.net.au/stateline/nsw/content/2004/s1226833.htm. Last accessed: 9 Dec 2004.

16 For example, SWC assumes that almost 50% of households hose down while the recent IPART survey suggests the proportion in 2003 was only 10-20% (IPART residential survey held in June to September 2003, Table A1.1).

the base year and has thus not included these savings. MMA has only assessed the net impact of changes to SWC forecasts from 2003/04.

SWC has proposed outdoor audits/landscape assessments for 40,700 high use households which it has assumed consume an estimated 435 kL/HH/a in the garden. The results of such water audits are typically found to have a reasonable outcome (the US EPA has quoted benchmark savings for such conservation measures of the order of 5 – 20%).[17] MMA considers the estimate of 15% saving for the high users to be reasonable, but believes the average garden usage estimate of 435 kL/HH/a is too high and a decay rate of only 5% per annum to be too low, unless substantiated, and has assumed average garden use of 350 kL/HH/a (after taking into account the impact of restrictions) and a decay rate of 20%. Because this is a program which is implemented over the entire year, timing issues are also involved.

4.4.5.4 *Further MMA review following the draft report*

The analysis relating to the level of savings currently achieved has been re-calculated based on more current material. This has resulted in a higher estimated saving from mandatory restrictions. MMA has also increased the proportion of garden savings expected from permanent restrictions to the impact of hosing down of hard surfaces plus 3% of garden usage.

SWC provided evidence in support of its assumption that the average garden usage by the largest users was 435 kL. MMA has accepted this evidence and used 435 kL for its analysis.[18] The remainder of the analysis is unchanged.

4.4.5.5 *Analysis of outcomes*

MMA's indicative assessment of the impact of the residential outdoor program and water restrictions is provided in Table 14 and is compared against that of SWC.

Table 14 –Indicative outdoors savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA restrictions	18,887	11,549	6,840	4,521	4,544	4,567
MMA landscape audit	0	64	531	1,260	1,857	1,913
MMA total	18,887	11,613	7,370	5,781	6,401	6,480
SWC restrictions (incremental to 2003/04)	49	4,907	5,026	5,117	5,207	5,297

17 US EPA Water Conservation Plan Guidelines, Appendix B *Benchmarks used in conservation planning*, Table B-4.

18 Although there was still some uncertainty as to whether all the end-users would actually undertake the audits, whether the whole 435 kL was all garden use and the impact of any permanent restrictions on this average.

FY ending June	2005	2006	2007	2008	2009	2010
SWC landscape audit	0	129	952	1,746	2,514	2,389
SWC total	49	5,036	5,978	6,863	7,721	7,685

We consider the savings to be very uncertain (say ±50%), mainly because of the ambiguity of the decay rate of restrictions and the level and impact of permanent restrictions imposed.

4.4.6 Rainwater tank and other rebates

4.4.6.1 Program description

The NSW government currently provides rebates for rainwater tanks. According to the Water Management Plan, rainwater tank rebates will continue to apply until 2008, but will exclude rebates to new homes to which BASIX applies.

Minor savings are also expected from rebates to primary schools in 2004/05.

4.4.6.2 Expected program savings

SWC has modelled continuing rainwater tank rebates at a level of 300 tanks per month, the average of rebates since October 2003. It has assumed that these do not apply to new homes to which BASIX applies. Each home is estimated by SWC to achieve an average saving of 41 kL/a, based on the sizes and configurations actually taken up and modelled water savings outcomes. It has assumed the program ceases at the end of June 2008.

4.4.6.3 MMA initial review

MMA considers the assumptions made by SWC in this area to be reasonable overall. While the number of rebates taken up is likely to be somewhat less than assumed, based on rebates in the first year of the program and after new houses are excluded, the water savings made per household may be greater than modelled by SWC.

MMA also considers reasonable the assumptions of the 21 ML pa saved by primary schools through rainwater tank rebates in 2004/05.

As in other areas, MMA has generally not included savings considered by SWC to have been made prior to 2003/04, except when timing issues are taken into account. This means the effect of any washing machine rebates for the program which concluded in July 2003 have not been considered.

4.4.6.4 Further MMA review following the draft report

SWC did not raise any objections to the MMA analysis in this section.

4.4.6.5 *Analysis of outcomes*

MMA's indicative assessment of the impact of rebates for rainwater tanks and washing machines on demand over the forecast period is provided in Table 15 and compared with that of SWC.

Table 15 – Rebates savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA rebates	214	372	519	667	740	740
SWC total excluding washing machine rebates	330	477	624	771	771	771

The main cause of the differences is the omission of pre-2004 program effects (apart from those due to timing) from MMA's considerations. We consider the savings to be relatively uncertain (say ±30%), mainly because of inconclusiveness regarding the actual impact of rainwater tanks.

4.4.7 EDC Business Programs

4.4.7.1 *Program description*

The non-residential sector accounts for some 30% of metered usage by SWC customers. SWC has in place a number of activities which are specifically targeting business. The "Every drop counts" business program includes:

- management diagnostics
- water audits and checklists
- water reuse trials
- best practice benchmarks and guidelines
- *Conserver* magazine.

SWC anticipates continuing and expanding the program. According to SWC worksheets, it has spent about $2 M pa over the past three years on the EDC business program and is proposing to spend about the same amount each year over the next six years.

4.4.7.2 *Expected program savings*

According to SWC, by 30 June 2004, 206 customers had formally joined the EDC program. By working with these customers, SWC had identified water savings of 19.2 ML/day (7000 ML/a) with actual implemented savings of 11.8 ML/day (4,300 ML/a).

Over the period 2004/05 to 2009/10, SWC anticipates spending a further $12.7 M on the business EDC program as well as providing a $2.5 M capital grant in 2004/05, and anticipates that business will spend $20.4 M (including the capital grant). As a result of this program, SWC anticipates savings of 1.52 GL/a for each year of the program, or 9.1 GL by about 2010.

SWC has provided a summary of the results of the EDC business program to October 2004. It includes:

- names of the customers
- historic and current usage
- identified water savings
- implemented water savings
- SWC expenditure
- customer expenditure.

MMA has not checked or audited the business program information provided by SWC and assumes the information provided to be correct.[19] Although the information provided is sketchy and in some cases appears inconsistent, overall it shows that the program to date has identified savings of about 7.2 GL of which about 4.5 GL has been implemented. The amount implemented is reasonably consistent with the amount estimated by SWC in its analysis of the program results to date.

4.4.7.3 MMA initial review

SWC appears to have calculated its savings based on a "saving per resource spent by SWC" basis and reducing this slightly compared to current experience. If this approach is correct, then a doubling of program expenditure would appear likely to result in double the savings, meaning additional savings of the order of 9 GL would be achievable by 2010. A capital grant of $2.5 M as a pilot for the demand management fund would be expected to further increase the savings, potentially to almost 11 GL.

However, this approach raises issues about the potential for diminishing returns. Another valid approach that could be taken would be to look at the expected savings for targeted customers based on current experience.

Water savings identified for individual sites by the EDC program range from very low to well over 50%, with a weighted average of about 21%. The results of measures implemented similarly range from 0% to over 50%, but with a weighted average of about 13%.[20]

The non-residential sector as a whole consumed about 160 GL in 2002/03. If the programs are representative, a saving of 13% over the non-residential sector as a whole would be expected to save some 21 GL (including the 4.5 GL already understood to be saved).

Of course it would be impractical to carry out the program on all these customers. If audits were to be carried out on all of the top 600 or so customers, who each consume

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19 In interviewing eight of the largest SWC customers, MMA has identified that most of these large customers are aware of the program and some are already participants.

20 The weighted average is based on the identified or implemented savings divided by the greater of historic or current usage where there is some saving identified

more than 30 ML per year (consuming in total an estimated 80 GL between them), the average 13% implemented saving would result in a total saving of about 10.5 GL – including the 4.3 GL already implemented, an additional saving of some 6.2 GL.

However, we would not expect all of the top 600 customers to be audited. As has been confirmed by SWC, this would not be cost-effective. If only the top 200 customers are audited and the average saving is 13%, then the total saving would be expected to be some 13% of 58 GL = 7.3 GL. This is a relatively small increment on the amount already saved from customers in this group.

The SWC approach assumes that results will largely be in line with expenditure. In support of this SWC states that the program is still relatively immature and many "low hanging fruit" still remain to be picked. As well, the approach will be supported by the government's Metropolitan Water Plan which requires the largest 200 customers to prepare water conservation plans by March 2006 and to implement cost-effective measures by September 2007. This is estimated by the government to achieve a saving of 20% of about 58 GL or 11.5 GL, a saving of perhaps 7.5 GL over current savings from this group. Finally, the program will also benefit from the intention to increase Tier 1 pricing for non-residential customers in line with increases to residential customers (see Section 4.4.11). This will increase the value of avoiding water usage seen by customers undertaking the program.

However, there is also likely to be an element of "diminishing returns" over time. This suggests that as the program becomes more mature, the returns on investment will inevitably reduce.

The range of potential outcomes for the program is, therefore, quite large. Based on current program experience, the additional savings between 2005 and 2010 could plausibly lie between about 4 GL based on the 13% expected implementation on the top 200 customers and 10.7 GL based on the expenditure approach.

Given the uncertainty and the fact that both methods have elements of reasonableness, MMA considers that the outcome is likely to lie between the two extremes and has assumed an additional saving half-way between these extremes of 7.4 GL by 2010, spread evenly over the years. This equates to a saving of 1.2 GL pa. Because the program is on-going at approximately the same level, we have not taken into account any timing impact.

There is also a further impact likely on this program from the Demand Management Fund (DMF). Of the 104 sites where there was documented customer expenditure associated with implemented water savings, 93 had relatively quick payback periods (simplistically calculated as the customers expenditure divided by the assumed annual savings per kL, valued at $2/kL)[21] of less than 2.5 years. However, eleven others had longer payback

21 Thus, for example, if a customer spent $100,000 to make an annual saving of 20,000 kL the payback period was calculated as 100,000/(20,000 x 2) = 2.5 years. The $2/kL value of avoided water use takes into account both water and wastewater savings but does not include any increased operating costs or other non-water savings.

periods, with the longest being 15 years. If the savings per kL is estimated at $1.30/kL (after taking into account additional operating costs as estimated by SWC) the number of sites with payback periods less than 2.5 years is 17. In both cases, however, the savings attributable to such sites (with long payback periods) is estimated to lie between 5% and 10% of total implemented savings.

With the existence of a DMF, some of the customers who implemented savings which achieved only a relatively long payback period may have asked for a payment from the DMF (see Section 4.4.8). This would have moved such customers from the EDC business program to the DMF program. However, not all companies with payback periods greater than 2.5 years would necessarily do this. We have contemplated reducing the savings in the years 2006/07 to 2009/10 by 3% to account for such a move but, given the overall uncertainties, have decided not to do this.

4.4.7.4 Further MMA review following the draft report

SWC has argued that MMA's initial review understated the likely outcomes of the EDC program for business. It has cited the impacts of:

- increasing price paid for water and wastewater (which is not considered separately for business)
- the requirement for the largest users to undertake water audits and also to undertake economic efficiencies
- the timing effect - many of the achievements of work undertaken to date will only bear fruit over the coming years
- significantly more than the assumed top 200 customers being assessed.

SWC has also pointed to a major customer which is expected to reduce potable water use by about 2 GL pa from about 2005.

MMA accepts that there are significant drivers for business to undertake water efficiencies. However, MMA is still concerned that there is also significant potential for diminishing returns. With the same expenditure by SWC as over the past five years a further 200 customers may well be signed up to the program, but the water usage and potentially water savings available from these customers would likely be significantly less than from the first 200.

On balance, MMA has again assumed that the savings from the EDC program will be half-way between that achieved through using the alternative methodologies, but has increased the lower calculation to be on the basis of the largest 400 customers (previously 200) signing up to the program.

4.4.7.5 Analysis of outcomes

MMA's indicative assessment of the impact of the business EDC program over the next six years is provided in Table 16 below and compared against that forecast by SWC.

Table 16 – EDC business savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA EDC business	1,397	2,793	4,190	5,586	6,983	8,379
SWC EDC business	1,520	3,040	4,560	6,080	7,600	9,120

Business EDC is a substantial component of SWC's total DM program. While the results for several businesses are now available to provide guidance, there is still significant uncertainty, (say ±30%) on what the outcomes will be, depending on the methodology of assessment as outlined above.

4.4.8 Demand Management Fund

4.4.8.1 Program description

The DMF was announced by the NSW government in its Metropolitan Strategy. It allocates 30 million dollars for businesses and councils to undertake water saving expenditure that would not have a payback period in the short-term, but would in the medium term. The fund is expected to be allocated to the most efficient schemes available.

SWC has assumed that the capital contribution available from the DMF will be $15 M each year from 2005/06 to 2009/10, with the remainder of the $30 M allocated to other parts of the DM programs. It has assumed that the fund will be fully taken up in each year, but that only one quarter of the water savings impact will be felt in 2005/06.

SWC personnel have confirmed that the fund criteria will be structured to ensure that there is no "gaming" of the system and that the fund will not subtract significantly from other programs, in particular the EDC project which is to be run in conjunction with the DMF.

4.4.8.2 Expected program savings

SWC has carried out a simple calculation to forecast expected savings. It has initially assumed or estimated that the subsidy required from the fund will be $5/annual kL saved. This has meant that the fund will in each full year of operation be expected to save $15 M/$5 = 3 GL. Only one quarter of this is expected to be realised in 2005/06. According to SWC, the subsidy assumption was based on experience.

4.4.8.3 MMA initial review

The DMF is expected to be an efficient means through which to allocate funds for water savings, so long as the pool of available projects is sufficiently large. This may be an issue after the first year or two as less material projects are identified. The real question, however, is what the annual outcome will be in terms of water savings for the fifteen million dollars of capital spent.

SWC has not provided any real justification for its assumed subsidy level which is central to the whole calculation of water savings, apart from saying that it is based on experience gained from projects assessed and providing a couple of worked examples.

The justification provided by SWC for its estimate of subsidy required, and hence savings forecast, is far from adequate to allow any certainty in the calculation of expected savings.

One way to estimate the subsidy required would be to provide the estimated capital expenditures and avoided costs for projects identified by SWC, but not implemented over the past few years (see Section 4.4.7.2), stack these in order of required subsidy/kL saved, draw the line at the fifteen million dollar expenditure and then find the average subsidy required. SWC should be asked to provide such a schedule or an alternative, preferably better, methodology for its assessment.

As well, the cost of the subsidy may well increase over time as the most cost-effective projects are implemented and lower impact producing and more expensive projects are identified.

MMA has used a simple payback calculation to indicatively assess the orders of magnitude of subsidy likely to be required. The outline of the methodology is provided in Exhibit 1.

Exhibit 1 – Indicative example of a subsidy calculation from simple paybacks

- Assume a company identifies a water saving measure that will cost it $1,000,000 and save 100,000 kL each year. Assume that the value of water avoided is $2/kL (taking into account avoided water and wastewater costs and assuming no additional operating costs borne by the company).
- The simple payback period is calculated as $1,000,000/(100,000 x 2) = 5 years. If we use 2.5 years as a measure of the acceptable payback period required for a "non-core" project such as water savings, then the company would justify the expenditure of $500,000 for the measure. If the DMF contributed the remaining $500,000 then the program would proceed. In this example, the subsidy paid by the fund would be $5/annual kL saved.
- If, instead, the capital cost of the project was $900,000 while all else remained the same, giving a payback period of 4.5 years, the subsidy required would be $4/annual kL saved. Alternatively if the cost of the project was $1,100,000 the payback period would be 5.5 years and the subsidy required would $6/annual kL saved.

Using such a methodology and the first example provided in the Exhibit, results in an average subsidy requirement of $5/kL for an average project with a payback period of 5 years, assuming the company will pay the capital up to the required payback of 2.5 years. This is in line with the amount assumed by SWC.

In the absence of other information, MMA is prepared to accept that the initial subsidy required may be $5/kL based on the average program in the DM fund for that year having an average payback period of about five years.

However, over time as the most efficient programs are undertaken and fewer material projects identified, MMA would generally expect that the average subsidy required would increase. If the average payback period required to clear the DM fund in the second year increases by 10% to 5.5 years (using the same example), then the required subsidy increases to $6/avoided kL.

In the absence of any further information, MMA has indicatively assumed that the required subsidy will start at $5/kL, as proposed by SWC, but will increase by $1/kL each year to reflect the increasing difficulty of obtaining incremental savings. The methodology to calculate savings is then the same as that used by SWC.

4.4.8.4 Further MMA review following the draft report

Subsequent to the draft report, SWC has provided further cost and water savings data for 15 projects which were considered candidates to go ahead with a DMF. It is not clear how these projects were selected.

MMA has analysed the information provided for these projects after assuming that the four projects with a payback period of less than 2.5 years would not have access to the fund but would be handled through the EDC program. The analysis showed that the average payback period for the remaining projects was 5.6 years, a little longer than assumed in the Exhibit, with an average subsidy cost of $4.80/kL, a little less than assumed by SWC.

On the basis of this (quite possibly unrepresentative) sample, MMA has seen no reason to change its assumptions from the draft report.

4.4.8.5 Analysis of outcomes

MMA's indicative assessment of the impact of the DMF over the next six years is provided in Table 17 below and compared against that forecast by SWC.

Table 17 – DMF savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA DMF	0	750	3,750	6,250	8,393	10,268
SWC DMF	0	750	3,750	6,750	9,750	12,750

It must be stressed that the levels of savings calculated by both MMA and SWC are largely speculative, with an accuracy of about ±50%.

4.4.9 EDC schools program

This is a small part of the EDC business program, targeting 200 schools over the five-year period 2003/04 to 2007/08. According to SWC estimated average savings observed at the 40 schools which underwent the program in 2003/04 were 7.7 kL per day or 2.8 ML each year. However, as mandatory restrictions were also in place during this year, SWC has assumed that only 40% of the savings are attributable to the program.

This is a minor program and MMA has accepted the savings proposed by SWC, 45 kL/a, except for those derived from 2003/04, the base year.

4.4.10 Pressure Management

4.4.10.1 Program description

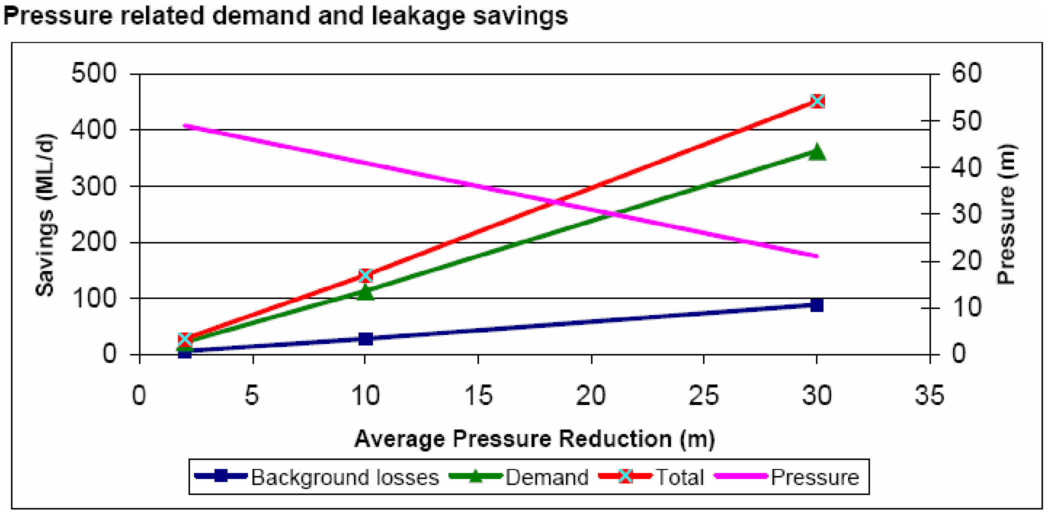
Reducing water pressure in areas where this is feasible, results in a reduction of both leakage and consumer demand. SWC proposes to trial the impact of reducing pressure to parts of the system which have maximum pressures higher than 60 m water. SWC estimates that over 25% of the system has a maximum pressure greater than 80 m water and over 40% has a maximum pressure greater than 60 m. However, water pressure is not static and some areas which have a pressure of 80 m in low demand periods, can drop to the vicinity of the minimum demand pressure during peak summer periods. This, together with significant uncertainty about leakage and demand reductions and potential customer difficulties and complaints, means that trials are essential to ascertain whether, and how best, to proceed.

As we understand it, SWC is considering installing 350 pressure reduction valves (PRVs) with associated system adjustments to reduce maximum pressure to 60 m in some 40% of Sydney's regions. SWC has estimated that the cost of the program will be $50 M and has made a provisional allowance of fifty million dollars over ten years for this program, starting with one million dollars in 2004/05. It has assumed that 60% of the program money will be spent between 2005/06 and 2009/10, and has estimated savings in proportion to capital expenditure.

4.4.10.2 Expected program savings

According to SWC, the impact of pressure reduction to the 40% or so of mainly residential areas suitable for implementation, will be the same as reducing the pressure across the network as a whole from 51 m to 40 m, a reduction of about 20%. SWC has modelled savings from leakage and reduced consumer demand arising from the program using a software program developed in conjunction with the International Water Association and Water Loss Task Force. A graph provided by SWC showing the output from this model is provided in Figure 12.

Figure 12 – Expected savings from reducing network pressure



Source: SWC, Sydney Water's Leakage Performance and Water Savings Improvement Program, page 16.

According to the model, the expected impact of average pressure reduction of 10 m is a reduction of about 20 ML/d in background losses (system leakages) and a further 130 ML/d in reduced demand. However, as this data is UK-based and modelled and has not been confirmed locally, SWC has, conservatively, assumed a saving of 50 ML/d, some 3% of the total annual system use. SWC has assumed that the impact is 50% due to leakage reduction and 50% to demand reduction.

4.4.10.3 MMA initial review

There is no doubt that pressure reduction, if implemented, will have an impact on both leakage and consumer demand. The question is: how much impact?

We have assumed that the program, including the full $50 M expenditure will take place, although there must be significant uncertainties about the project itself, the cost and the phasing. Indeed, given the uncertainties, we would expect that the phasing of capital expenditures is likely to be delayed.

In this section we only consider the savings due to pressure reduction on consumer demand. This is the only section which impacts on SWC's demand for pricing purposes. The proportion due to leakage is considered only for forecasts for SCA.

For the consumer, reduced pressure will result in reduced flow rates. Consumer demand will be affected by a pressure reduction in several ways:

- demand for internal volumetric applications, such as toilets, baths, washing machines, dishwashers will be largely unaffected
- demand for internal "free fill" applications, such as showers, and some tap use will likely be reduced. For households with AAA fittings, the impact is likely to be negligible as these are already flow reduced

- demand for external use, largely garden and lawn watering but also car washing is expected to reduce
- leakage within the property will be reduced.

The extent of the reduction in all of these areas is uncertain and depends on the actual pressure reduction, stock of appliances and fittings and garden needs. Given the importance of garden and lawn watering, actual reductions here are very significant and basing assumptions on actual result experienced in broadly comparable communities is vital.

Theoretically, it can be demonstrated that for free-flow consumption purposes, the reduction in flow rates is proportional to the square root of the reduction in pressure. Thus a reduction in pressure by 20%, will reduce free-flow rates by about 10%.[22] If external free-flow applications make up 25% of household usage then, without any compensation for reduced flow rates,[23] the impact of a 20% reduction in pressure will theoretically be about 2.5% of total residential use.

A study in the USA has found that this theoretical calculation does provides a good indicator for reduction in usage in irrigation (garden watering). The study found that the reduction in total bills from a pressure reduction of 17.6% in single residences (in which watering gardens made up approximately a third of water use) was about 1.9%, while there was no statistical difference when the pressure reduction was only 6%. For houses with large gardens the reduction found was about 4%.[24]

An Australian study conducted in 2002 examined the effect of reducing pressure from an average of 800 kPa to 350 kPa in several suburbs of Melbourne through individual household valves. As a result of complaints during the study, some households had their pressure increased to 500 kPa. Thus the actual pressure reduction was between 45% and 65%.

If free-flow applications including watering gardens make up 30% of household usage, the expected outcome would have been a reduction in usage by between 6% and 10%. Although the analysis was hindered by the impact of restrictions and variable results, the authors concluded that the outcome was a reduction of usage of between 3% and 4%.[25] The fact that this saving is significantly lower than expected is explained, in part, by the fact that many people apparently watered for longer than usual in order to compensate for the reduced water flow.

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22 Note that the same relationship need not apply to leaks.

23 For example longer watering.

24 A Bamezai and D Lessick, 2003, *Is system pressure reduction a valuable water conservation tool? Preliminary evidence from the Irvine Ranch Water District*, 14 February 2003. Source: http://www.iwrd.com/conservation/PressureReduction.pdf. Last accessed: 9 Dec 2004.

25 South East Water and Plumbing Industry Commission, 2004, *Summary of the report on water pressure reduction project* Appendix 1 in the Regulatory Impact Statement, Plumbing (water and energy savings) regulations 2004.

In a comment on this study the Victorian Water Industry Association has noted that analysis by Yarra Valley Water suggests that pressure has an inconsequential effect on indoor use and that for small changes in pressure, say from 65 to 50 metres, the water savings are likely to be negligible.[26]

As the reduction in average pressure on the SWC system is only expected to be some 20%, the impact would be expected to be less than half that experienced in Melbourne – say 1.5 to 2%.

The impact on commercial and institutional usage will be less than on residential. This is due firstly to the fact that there is proportionally less outdoor usage than in the residential sector. According to SWC, only about 21% and 17% respectively of such usage is external. Much of the indoor usage, especially in the commercial sector, is understood to be related to toilet usage which will not be affected by water pressure. Secondly, many if not most, of the commercial and institutional premises would not be suitable for pressure reduction, for example in central business districts. If a large proportion of commercial/institutional premises are not affected at all, the saving could be of the order of only 0.6% of usage.

Industrial usage is expected to be largely unaffected.

In addition, several of SWC's other demand management exercises will also impact on the effect of pressure reduction. As pressure management will have an impact mainly on external sales, anything which will reduce external sales will similarly reduce the impact of pressure management.

The main impacts on external sales will be the:

- effect of mandatory restrictions on external usage
- effect of the outdoor program and rainwater tank on external usage
- effect of price increases.

We have subtracted the estimated impact of the first two from the external usage available for impact by pressure reduction to determine the reduced effect of pressure. We have assumed that 85% of the impact of pressure reduction is due to external use reduction. The timing of outcomes assumed is the same as that assumed by SWC.

4.4.10.4 Further MMA review following the draft report

SWC did not raise any objections to the MMA analysis in this section. However, as a result of changes in other areas, the outcomes here have been slightly amended.

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[26] Victorian Water submission on the Regulatory Impact Statement Plumbing (water and energy savings) Regulations 2004, 14 May 2004.

4.4.10.5 Analysis of outcomes

MMA's indicative assessment of the impact of pressure reduction on customer demand over the next six years is provided in Table 18 below and compared against that forecast by SWC.

Table 18 – Indicative pressure reduction savings, customer demand only, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA pressure reduction	0	132	751	1726	2,696	3,667
SWC pressure reduction*	0	183	1,004	2281	3,559	4,836

* SWC has stated that half the pressure reduction program savings are due to reduction in customer demand and half due to leakage. Only the former is included here.

The levels of savings calculated by both MMA and SWC are largely speculative (accuracy of say ±70%). There is uncertainty about the program implementation, results (for example, whether the results from reducing pressure to 40% of the population by a lot is the same as reducing pressure across the board by 20%), response by consumers and impact on non-residential users.

4.4.11 Price and metering

4.4.11.1 Program description

SWC has put forward three components of a plan to reduce residential demand through changes to metering and pricing. They are:

- A change to ratio utility billing (RUB) for vertical units which have common meters. At the moment, virtually all vertical units have common metering. Generally, water bills which include a usage component are sent by the utility to the Body Corporate which then allocates and passes on the bills to residents on a basis which typically does not relate to water usage or even identify which component of the cost is related to water. The intention of this program is to provide some signal to residents that water usage has a cost.
- Requiring sub-metering to all new apartment blocks. The intention of this program is to send a strong price signal to residents of new apartment blocks.
- Significantly increasing the price of water usage. While SWC has put forward three options in its price submission to the Tribunal, the option modelled for demand management savings is a step tariff with:
  - o a staged increase in the real price of Tier 1 water usage from $1.01/kL in 2004/05 to $1.39/kL in 2008/09
  - o a second tier incremental price of $1.80/kL (held constant in real terms) for users taking more than 100 kL per quarter to be introduced in July 2005

- o the water service charge staying approximately constant in real terms at $78/year
- o the sewer service charge increasing in real terms from $347 in 2003/04 to $384 in 2008/09.

4.4.11.2 Expected program savings

SWC has proposed the savings as shown in Table 19 for the program.

Table 19 – Water savings from pricing and metering proposed by SWC, ML pa

FY ending June	2005	2006	2007	2008	2009	2010
Pricing		7,619	9,039	10,531	12,038	11,436
RUB + metering		2,441	2,429	2,408	2,378	2,348

The savings have been calculated by SWC in the following manner:

- The RUB savings have been calculated by estimating the number of additional properties which would be exposed to a price signal and multiplying these by an assumed 6% saving of average multi-unit household usage.
- The individual metering would be on new units alone, with an assumed 10% saving on these compared to average unit usage.
- Price impact:
  - o Significant price increases would take place as outlined in Section 4.4.11.1. Non-residential users would retain single tier pricing but would also see the same price increase in this tier as residential users.
  - o Price elasticities of demand understood to be based on the Tribunal report into price structures[27] which ranged from -0.01 for low-using houses and flats to -0.3 for high-using dwellings and resulted in a (consumption weighted average) price elasticity of demand of -0.19 for separate houses and -0.11 for multi-units.
  - o These elasticities to apply only to dwellings which received a price signal, either through direct billing and metering or RUB.
  - o Elasticities applied to average (rather than marginal) price increases.
  - o Taking into account other demand management savings by reducing the average usage prior to applying price elasticities.
  - o Applying a decay factor of 5%, so savings are slowly eroded over time.

[27] IPART,2004, *Investigation into price structures to reduce the demand for water in the Sydney Basin*, OP 24, July 2004.

4.4.11.3 MMA initial review

4.4.11.3.1 Metering and RUB

There is general acceptance that properties which are not individually metered, or where price signals are not passed through, consume significantly more than those which do face price signals. The Tribunal in its Household Survey estimated that properties which received individual usage bills used, on average, 19% more than those that did.

In the individual metering program, SWC has proposed that new multi-units be individually metered and that the savings arising from this would be 10% of average multi-unit usage. It is apparently too expensive to retrofit sub-meters to existing units.

MMA accepts that individual metering will have an impact on prices and considers the proposed savings of 10% to be reasonable. Indeed, a comprehensive recent study which examined the impact of sub-metering on units, in the USA found savings of the order of 15% after sub-metering was installed in multi-units.[28]

However, given that the meters are to be applied to new apartments, the impact of BASIX must be taken into account prior to applying these efficiencies. According to SWC, this is expected to reduce average usage in new units by about 40% of 171 kL/unit, meaning that the average new unit will only use about 100 kL. This means that savings from new units would be of the order of 10-12 kL/unit. MMA considers savings of 10 kL per unit which has a meter fitted to be reasonable. As the program is expected to be started in July 2005, only half the savings are expected to be realised in the 2005/06 year.

The likelihood of RUB reducing demand is, however, far from clear. The same US study mentioned above found that utility allocation billing resulted in no significant impact on consumer demand. A conclusion of the study was that no statistically significant impact from RUBs could be reliably expected.[29]

Although the Australian environment for RUBs may well be different to that in the USA, MMA feels that no benefit should be ascribed to RUBs until this is demonstrated.

4.4.11.3.2 Pricing

SWC has modelled for its DM program a stepped tariff pricing regime for households with the first tier price increasing by 37% over four years, an additional step tier priced at $1.80/kL for users consuming more than 100 kL per quarter, no change in the water service fixed charge and an 11% increase in the sewerage fixed charge over four years.

MMA has reviewed the modelling of such a tariff, but makes no comment on whether such a tariff, or the prices assumed by SWC are appropriate. This will, of course, depend on the determination by the Tribunal and can be reviewed after the draft determination.

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28 Aquacraft and the East Bay Municipal Utility District, 2004, *National multiple family submetering and allocation billing program study.*

29 Aquacraft and the East Bay Municipal Utility District, 2004, *National multiple family submetering and allocation billing program study*, Page xxiv.

In its Price Structures report, the Tribunal commented that the price elasticity of demand indicatively applicable to SWC was of the order of -0.13. That is, a 10% increase in price would result in a 1.3% reduction in volume.

The Tribunal commented that while an elasticity of -0.13 was appropriate for the utility as a whole, it was realistic to expect that low usage customers would have lower discretionary usage and hence elasticities lower than this average. On the other hand, high usage customers are likely to have higher elasticities.

SWC has used such an approach to allocate a range of elasticities to different customer sizes. This has been done separately across detached houses and multi-unit dwellings. This has resulted in a consumption weighted average elasticity of -0.19 for separate houses and -0.11 for multi-units. In its calculations, SWC has taken into account that some houses and many units do not currently face any price impact.

However, MMA has not been able to reconcile the outcomes obtained by SWC using a range of elasticities by consumption band, with that obtained by multiplying the weighted average price increase by the assumed elasticity of -0.13.

MMA considers that if the average price methodology is to be used, then the outcome modelled by SWC should quite closely match the (consumption weighted) average price increase for houses and units multiplied by an elasticity of -0.13. SWC has commented that the range of elasticities by consumption band were agreed with the Tribunal. MMA has not confirmed this assertion with the Tribunal and until this issue is resolved, MMA has used the average –0.13 elasticity estimate across all consumption bands.

As has been pointed out in the Tribunal's Price Structures paper, there is much debate about whether the average or marginal price increase should be the basis of price elasticity calculations. SWC has, conservatively, assumed the latter. If the average price elasticity was used, the expected savings by 2010 would be significantly higher, of the order of 18 GL in 2010, rather than the 11 – 12 GL calculated by SWC using a marginal price approach.

A further issue requiring some debate is the correction for "double counting" with other demand management efforts. Here it is important to consider which elements of water use are most likely to be impacted by a response to significant price increases, in other words, which areas are discretionary and which are non-discretionary.

Over the medium to longer term, we would expect that the responses would include a move towards purchasing more efficient appliances – washing machines, showerheads,[30] garden watering, etc. This will engender a faster than expected change to efficient appliances over the next five years.

However, over the short to medium term, the main impact of price increases is likely to be behavioural in discretionary areas: reduction of shower duration, reduction of garden watering, reduction of hosing down gardens and washing cars with hoses.

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30 New toilets are almost all 6/3 litre dual flush in any case.

These are areas that have already been significantly affected by other DM programs instituted by SWC. For example, the reduction of hosing down hard surfaces, which could constitute a significant part of the behavioural response to increased prices, is already accounted for in assumed permanent restrictions. Similarly, the re-assessment of garden usage by large users, which could have formed another part of the response, is already accounted for by the outdoor audit program and, to some extent, by pressure reduction.

SWC has attempted to remove some of the "double counting" by subtracting the results of DM efforts from average usage before applying the elasticity effect. However, it is unclear whether this is the appropriate methodology or whether DM results in key discretionary areas, such as external use, should be subtracted directly from the expected price impacts at the end. The different methodologies are discussed in Exhibit 2.

Exhibit 2 – Different ways of handling interaction between the impacts of DM measures and price

- Assume that hosing of hard surfaces is a discretionary activity, that this constitutes 1% of total water usage, and that the impact of mandatory restrictions will be to remove all of this use. Further, assume that at the same time a price increase of 20% is applied which is expected to have the impact of reducing overall usage by 2.6%.
- The SWC approach handles this by firstly removing the DM activity and then applying the price response. This results in the price response being 2.6% of 99% i.e. 2.57%. Another methodology might be to assume that as the reduction in hosing down constitutes a significant reduction in discretionary usage it should fully reduce the expected impact of price increases (that is, it would reduce the price elasticity). This would result in the expected price response being 2.6% - 1% or 1.6% (which implies a price elasticity of -0.08 instead of -0.13).
- The use of the different methodologies can thus produce very different results. It is clear that neither methodology is entirely correct. A value between the two extremes would again appear appropriate.

There is no obviously correct methodology for calculating how existing DM programs should be taken into account when calculating the price response.

It is MMA's view that the SWC methodology does not adequately take into account the impact that the DM measures will have on determining the price response. However, the full subtraction of DM programs is likely to result in a significant understatement of the impact of the price increases.

MMA has indicatively assessed the impact of using average and marginal pricing methodologies and of reducing the resultant outcomes by various proportions of the indoor and outdoor DM programs.

On balance, MMA considers that, for the step price change with very significant marginal increases, the SWC methodology, as modified by using an overall -0.13% elasticity rather than the elasticities by consumption band used by SWC and without any decay factor, provides an outcome which is reasonable given the significant range of uncertainty.

4.4.11.4 Further MMA review following the draft report

SWC did not raise any objections to the MMA analysis in this section.

4.4.11.5 Analysis of outcomes

MMA's indicative assessment of the impact of sub-metering, RUB and price increases on customer demand over the next six years is provided below and compared against that forecast by SWC in Table 20.

Table 20 – Indicative water savings due to sub-metering and increases in real price

FY ending June	2005	2006	2007	2008	2009	2010
MMA sub-metering	0	61	186	300	387	440
MMA price	0	5,056	6,850	8,742	10,703	10,703
Total metering & price	0	5,117	7,035	9,042	11,090	11,144
SWC metering & RUB	0	2,441	2,429	2,408	2,378	2,348
SWC price	0	7,619	9,039	10,531	12,038	11,436
SWC total	0	10,060	11,468	12,938	14,415	13,784

The price increases envisaged by SWC are likely to have a significant impact on water usage by residential customers. Although the water savings here are speculative (uncertainty of say ±50%) because of different potential applications of price and compensation for other DM programs, MMA considers the general approach taken by SWC to be reasonable. Overall, the major difference between the MMA and SWC analyses are the expectation by MMA that RUB will have no significant impact on demand.

4.4.12 Alternative pricing structure

In the above base case, MMA has assessed the impact of a stepped price tariff as proposed by SWC. MMA has also been asked to assess the impact of the alternative scenario where there is no re-structure of prices, but the average and marginal prices increase in real terms by 7% in 2005/06 and then 3.7% to 3.8% in each of 2006/07, 2007/08 and 2008/09.

MMA has applied a similar analysis to that contained in the analysis of the stepped tier structure. However, in this case, both the marginal and average price changes are the same.

Using the same approach as previously (elasticity applied to average price increases and modified by DM impact on average usage) results in a reduction by 2010 of about 8,800 ML from pricing alone. However, we would expect that in this case the result would be more muted as the impact of very high marginal price increases is not felt. We have, in this case, estimated a saving which is based on the same price elasticity applied to average pricing but with a reduced impact due to the effect of some of the other DM measures being subtracted. The results of this analysis are provided in Table 21.

Table 21 – Alternative pricing, indicative water savings due to sub-metering and increases in real price

FY ending June	2005	2006	2007	2008	2009	2010
MMA Price Impact	0	1,580	3,930	5,838	7,414	7,152
MMA Sub-metering	0	61	186	300	387	440
Total Metering & Price	0	1,580	3,991	6,023	7,714	7,539

The difference between the impacts of the two pricing methodologies is significant, and in the order of 3,600 ML by 2009/10.

4.4.13 Recycled water

4.4.13.1 Program description

SWC has in place plans to increase recycled water usage in order to displace potable or unfiltered water at:

- Bluescope Steel (about 7.3 GL pa)
- Liverpool Golf Course (about 60 ML pa)
- sewage treatment plants (STPs) at Malabar and North Head, (from 0.7 to 2 GL in total)
- growth in residential recycling at Rouse Hill (Stage 2 and 3) and Glenfield.

4.4.13.2 Expected program savings

The potable water savings from using recycled water are estimated by SWC on a project by project basis by SWC.

- The Bluescope Steel project has been much discussed and is expected to be commissioned in early 2005 and operating at full capacity by mid 2005.
- SWC has announced that the North Head STP will have a recycled water plant installed by mid to late 2005. SWC has assumed that the plant will save 2 ML of water per day and that this would reduce potable usage by about 95% of this amount.
- SWC has assumed that the Malabar STP will have a recycled water plant installed by end 2007 to displace 91% of potable water use at the STP.
- Residential recycling based on experience at Rouse Hill.

In total, SWC has assumed that recycled water use will increase from 2 GL in 2003/04 to 12.8 GL in 2009/10.

4.4.13.3 MMA initial review

MMA has not included in its calculations:

- Recycled water used in the year, 2003/04. This is accounted for as part of the base year. Only developments since 2003/04 are taken into account.

- Any use of recycled products in new homes. These are assumed to be taken into account as savings through the BASIX program.

By far the largest recycled water project is that to be undertaken by Bluescope Steel. MMA has spoken to Bluescope and confirmed that the savings of 20 ML/day contemplated by the program are in fact almost certain to proceed and should be in place by mid 2005.

Use of recycled water at the North Head STP is also considered very likely to proceed following the announcement on 29 October 2004 that a recycled water plant will be installed at the STP as part of a suite of projects to improve reliability of the plant.[31] However, the announcement put the saving of potable water at 550 ML pa, rather than the 693 ML pa estimated in the SWC analysis. MMA has used the number provided in the media release until this is clarified. The expected timetable for completion is mid to late 2005, so MMA has assumed that it will not be operating for one quarter of the 2005/06 year.

SWC has also assumed that a further 1,200 ML pa will be displaced at the Malabar STP from 2007/08. SWC has categorised this as "highly certain" water savings based on the production of 1.3 GL of recycled water of which 91% is assumed to displace potable. MMA is seeking confirmation that this project and the timing and recycled water use at the STP are in fact highly certain.

4.4.13.4 Further MMA review following the draft report

Subsequent to the draft report, SWC has confirmed that recycled water use at Rough Head is likely to be in line with the MMA analysis, somewhat less than initially proposed, and that the recycling at Malabar STP is likely to be 0.9 ML/d. The remainder of the expected savings at Malabar are from business customers and are presumably already considered under the business program.

MMA has consequently reduced its expected savings at the Malabar STP.

4.4.13.5 Analysis of outcomes

MMA's assessment of the incremental displacement of potable water by recycled water use is provided in Table 22 and compared with that of SWC. The customer recycling component of savings is provided separately.

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31 SWC Media release, *Improvement works and recycled water plant announced for North Head Sewage Treatment Plant*, 29 Oct 2004.

Table 22 – Reduction of potable water use with recycled water, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA recycling	2,000	7,772	7,951	8,238	8,238	8,238
Of which customer recycling	2,000	7,360	7,360	7,360	7,360	7,360
SWC recycling	4,123	10,337	10,503	11,666	11,666	11,666

The main cause of the differences is the omission by MMA of existing residential usage as either pre-existing or already counted in BASIX, omission of use at STPs and the reduction of assumed usage at Malabar and North Head STP.

4.4.13.6 Accounting for changes at STPs

It appears that some, but not all, the usage at the SWC STPs is included within metered billed usage. From information provided by SWC, we understand that on average about 1,500 ML of STP use has been included within this category over the past three years. This amount should be removed from the metered billed calculation as sales to SWC's own properties are not billed. It should probably be included as metered unbilled sales.

The volume of supply to metered unbilled sales will then reduce as usage of recycled water at North Head STP increases.

According to SWC usage at Malabar STP has not been included within billed metered usage in recent years. We therefore assume that it will have been included within unbilled unmetered. This means that the level of unbilled unmetered usage is expected to reduce over the coming years as seen in Table 23.

Table 23 – Forecasts resulting from reduced usage at STPs and related

FY ending June	2005	2006	2007	2008	2009	2010
Metered unbilled	1,499	1,086.5	949	949	949	949
Unbilled unmetered	2,800	2,800	2,759	2,472	2,472	2,472

MMA has taken the following steps as a result of exclusion of water usage at STPs:

- it has reduced billed customer usage by 1,500 ML in each year of the forecast period
- it has further reduced usage by the amount of customer recycling
- it has increased forecast metered unbilled from 0 to 1,500 ML in 2004/05 and then reduced this by the expected change in North Head STP to 949 ML in 2009/10
- it has reduced the level of forecast unbilled unmetered usage from 2800 ML in 2004/05 due to reduced usage at Malabar STP.

4.4.14 Water efficient measures for dwellings being sold

In its Metropolitan Water Plan, the NSW government announced that from 1 July 2007 a minimum level of water efficiency will be required when a dwelling is sold. The minimum level of efficiency required is for AAA showerheads, tap fittings and flush arrestors – similar to that of the retrofit programs. According to the announcement, those undertaking the sales are liable to take part in the retrofit program in order to minimise costs of compliance.

SWC has not included any water savings from this program as such within its DM program measures, as this option was apparently not considered likely at the time the DM forecasts were analysed.

4.4.14.1 MMA indicative analysis

According to the HIA, sales of homes in NSW in 2002/03 were about 165,000. The HIA did not have numbers for 2003/04, but expected these to be significantly higher as this was a hot year for sales. We have assumed that the sales will be 165,000 for each year of the review.

Of course, not all these sales are liable to have efficiency improvements applicable to SWC. Only about 62% are likely to be in the SWC area. Some 20,000 to 30,000 are already likely to have been covered by sales of new houses or renovated houses being sold already covered by BASIX. A further 15,000 to 20,000 per year may be covered by the retrofits already assessed for the DM program.

However, the remaining 60,000 or so sales, are likely to have largely not been considered by the SWC DM program. For example, if these were to all have savings of half the current retrofit average, they would generate additional savings of about 600 ML per year, only half being credited in the 2007/08 year, the first year of the program.

SWC has raised no objections to this analysis.

4.4.15 Summary

SWC is proposing to undertake a very comprehensive DM program which it expects by 2009/10 to generate water savings of about 82 GL beyond those already generated. The DM savings proposed set out by major project area are provided in Table 24.

Note that the program savings set out here are net of savings achieved up to and inclusive of 2003/04, and also exclude savings from recycled water in new dwellings as these are covered by the BASIX program. Furthermore, they do not include any savings attributable to leakage reduction (including the half of the pressure reduction savings attributed by SWC to leakage reduction). They do, however, include water savings from use of recycled water at SWC's STPs, which is generally considered as part of metered unbilled sales.

Table 24 – Water savings net of results to 2003/04 according to the SWC DM forecasts

FY ending June	2005	2006	2007	2008	2009	2010
SWC						
Retrofits	887	1,889	2,723	3,296	3,651	4,005
BASIX	958	3,313	5,891	7,985	10,073	12,163
Labelling and standards	0	140	282	430	3,791	7,191
Outdoors	49	5,036	5,978	6,863	7,721	7,685
Rebates	168	315	463	610	610	610
Business	1,565	3,880	8,445	13,010	17,530	22,050
Pressure reduction	0	183	1,004	2,281	3,559	4,836
Pricing and metering	0	10,060	11,468	12,938	14,415	13,784
Recycling	2,000	8,053	8,219	9,382	9,382	9,382
Total	5,627	32,868	44,473	56,795	70,731	81,706

SWC expects the major contributors to customer demand reduction to be business savings, the BASIX program for new houses, pricing and recycling.

MMA has reviewed the SWC DM program and, in order to facilitate debate, provided its assessment of key methodological and assumption differences and indicative savings it expects from the programs in its Draft Report. Following further discussion with SWC and the provision of further information by SWC and other parties, MMA's assessment of water savings under the same programs are provided in Table 25. MMA's analysis suggests that the DM programs will generate significant levels of savings, but not quite those proposed by SWC.

Table 25 – Water savings net of results to 2003/04 according to the SWC DM forecasts and indicative MMA estimates

FY ending June	2005	2006	2007	2008	2009	2010
MMA						
Retrofits	746	1,690	2,608	3,311	3,775	4,130
BASIX	87	793	2,640	5,070	7,495	9,701
Labelling and Standards	0	34	102	170	1,586	4,366
Outdoors	18,887	11,613	7,370	5,781	6,401	6,480
Rebates	214	372	519	667	740	740
Business	1,441	3,633	8,074	12,016	15,555	18,827
Pressure Reduction	0	132	751	1,726	2,696	3,667
Pricing and Metering	0	5,117	7,035	9,042	11,090	11,144

FY ending June	2005	2006	2007	2008	2009	2010
Recycling	2,000	7,360	7,360	7,360	7,360	7,360
Sub-Total	23,375	30,745	36,460	45,143	56,699	66,414
Efficiency on sale of dwellings	0	0	0	282	888	1,513
Total	23,375	30,745	36,460	45,425	57,587	67,927

Reductions to use at STPs would add a further 880 ML of savings due to DM programs by 2009/10.

Over the pricing review period, 2005 – 2010, MMA projects savings of about 83% of those proposed by SWC. The differences are spread across the programs. In most cases, MMA expects the programs to achieve somewhat less than expected by SWC, but MMA has also included a new program, efficiency for house sales, and expects significantly higher outdoor savings over the next year or two as a legacy of the recent drought and current mandatory restrictions.

4.4.16 Leakage reduction

4.4.16.1 Context

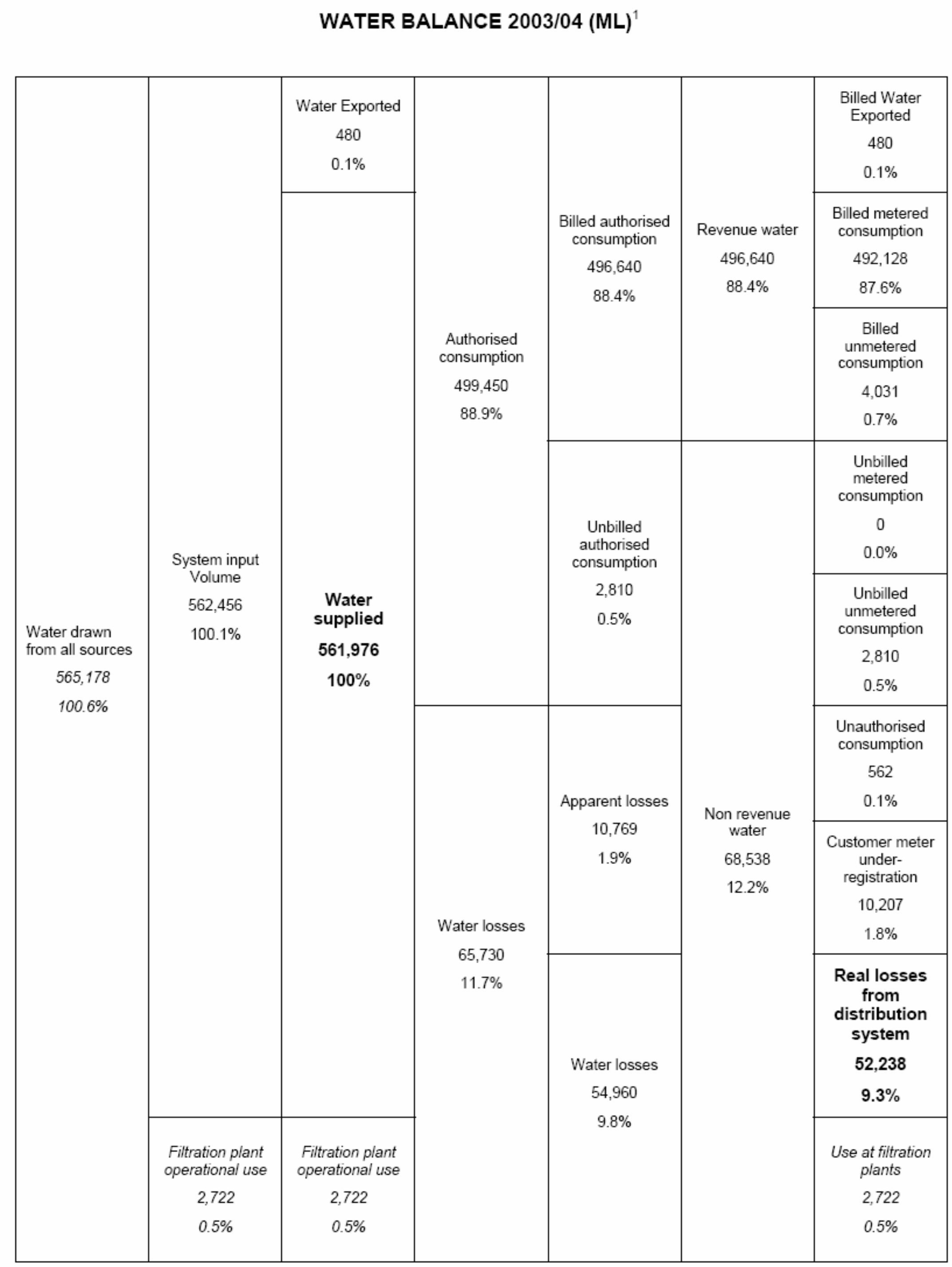
SWC has an active leakage reduction program. While leakage from the SWC system has not been taken into account in the calculation of demand by SWC customers, on which pricing is based, it is important in the calculation of demand for water from the SCA. For this reason MMA has reviewed the water savings attributed by SWC to its leakage reduction program but reported it separately to the review of DM programs impacting directly on demand for water by SWC customers.

4.4.16.2 Calculation of leakage

There is no direct measure of leakage. Instead, leakage is a residual calculated from metered inputs and metered outputs after making assumptions about a range of non-metered usages. The SWC water balance for 2003/04[32] is illustrated in Figure 13 below.

[32] Sourced from the document *Sydney Water's Leakage Performance and Water Savings Improvement Programs* October 2004, provided by SWC.

Figure 13 – SWC water balance for 2003/04, ML



[1] **Notes**

1. All figures other than those italicised are in accordance with IWA and WSAA definitions. Italicised figures are in accordance with SWC reporting requirements.
2. Unbilled metered consumption (SWC properties) included in Billed Metered Consumption.

As can be seen, after some simplification, water supplied in 2003/04 was 562 GL. Billed metered consumption, which we understand includes some consumption by SWC properties (eg STPs), was 492 GL. Estimates of billed and unbilled unmetered consumption was a further 7 GL. The sum of these, the "authorized consumption" was 499 GL.

The difference between water supplied and authorized consumption, after removing use by the filtration plants, is water losses, which was estimated to be about 63 GL.

Losses are then divided into two: apparent losses, which include customer meter under-registration and unauthorized consumption, of about 11 GL and estimated real distribution system losses of 52 GL.

It is these real system losses, including all forms of leakage, that are the subject of SWC's leakage reduction measures. As it is calculated as a balance item, it is subject to some uncertainty. There has been an accounting change in the 2003/04 year to include a component of unauthorized consumption (theft) at 0.1% of supply. This was previously considered part of system losses.

4.4.16.3 Long-term trend in water losses

The longer-term trend in water losses is shown in Figure 14. It is reproduced from SWC's Leakage Performance and Water Savings Improvement Program.

Figure 14 – Longer term trend in water losses

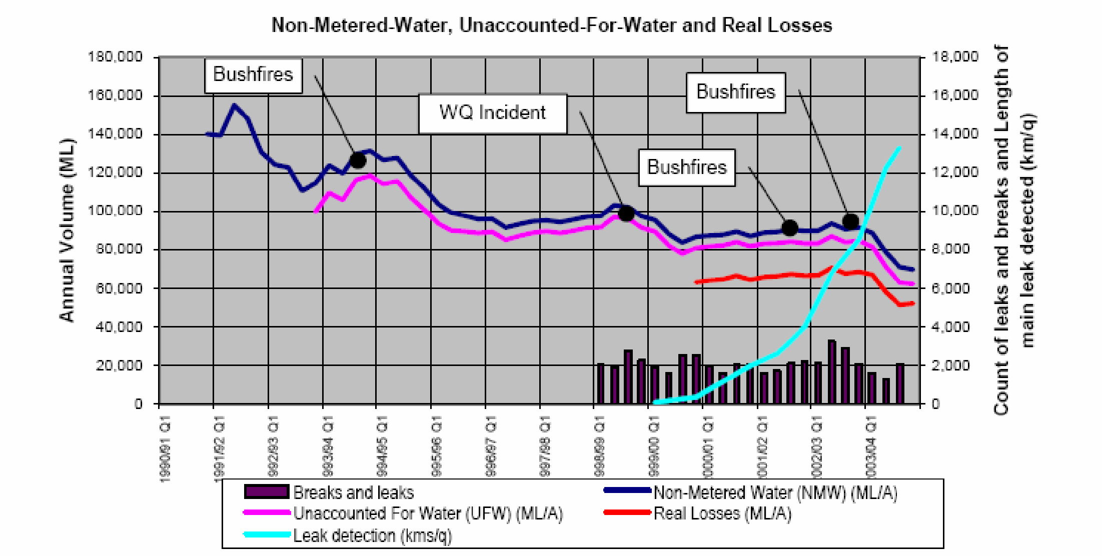


Figure 14 shows that, following a period of reduction in unaccounted for water between 1991 and 1996, associated with improvements in metering and accounting, it remained relatively steady until 2003/04, when it fell quite significantly. Similarly, real losses remained reasonably steady, or rose, until the significant reduction in 2003/04. According to SWC, an underlying fall in leakage between 1999/2000 and 2002/03 due to the leakage reduction program may have been masked by bushfires and record leaks and breaks.

4.4.16.4 Comparison between 2002/03 and 2003/04 losses

In 2002/03, water supplied was 641 GL, authorised consumption was 557 GL and water losses 85 GL. Of the water losses, 16 GL was considered to be due to metering inaccuracy and 69 GL to real losses.

Between 2002/03 and 2003/04, real distribution losses were thus estimated to have reduced from 69 GL to 52 GL, a reduction of some 17 GL.

In light of this very significant reduction in apparent system losses, ActewAGL was commissioned by SWC to conduct a technical audit of SWC's water balance methodology to ascertain whether the reduction in losses was due to changes in methodology or were real.

In its report dated August 2004, ActewAGL[33] concluded that:

> *"The significant reduction in real losses appears to be real and not the result of data problems or the change in water balance methods. The reduction is considered to be largely due to the results of the find and fix program. It appears that the reported sustainable savings to date of 41 ML/d (15,000 GL/yr) from this program may be underestimated. Another factor, which may have contributed significantly to the reduction in real losses, is the reduction in the number of reported breaks and leaks and improved response times. The drought, water restrictions and retrofit program may have all contributed to the reduction in real losses. Further studies to determine this impact are required."*

4.4.16.5 Active leakage reduction program

SWC attributes the significant reduction in leakage to the active leak reduction program which it has undertaken since 2000/2001. While it does not explain the sudden drop between 2002/03 and 2003/04, ActewAGL's audit provides support for this proposal – although it does raise the possibility of other factors, such as the drought and water restrictions playing a part.

SWC's active leakage reduction program began in 1999/2000 as a pilot program and has progressed to the current situation where 7,000 km of mains are scanned for leakage each year. To the end of June 2004, over 15,500 km of mains have been scanned and $7M has been spent on the program. Details of the program and expenditure to date are provided in Table 26. Inspection of the whole of SWC's network is expected to be completed by June 2005.

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33 ActewAGL, 2004, *Technical audit of Sydney Water's waterbalance methodology and results*, August, p ii.

Table 26 – SWC's active leakage reduction program to 2003/04

Year	Length inspected	Original leakage reduction	Revised leakage reduction [34]	Project cost	Original leakage reduction per km	Cost per length of main inspected	Cost per KL of water saved	No of zones inspected
	(km)	(ML/D)	(ML/D)	($)	(kL/km)	($/KM)	($/KL)	
1999/00	350	2.63	2.15	$371,930	7.51	1062.7	141.4	2
2000/01	1,634	12.27	8.34	$1,184,103	7.51	724.7	96.5	7
2001/02	2011	9.96	6.83	$1,232,228	4.95	612.7	123.7	15
2002/03	4410	14.03	12.3	$1,727,085	3.18	391.6	123.1	32
2003/04	7102	13.96	12.2	$2,482,138	1.97	349.5	177.8	52
Project Summary	15,507		41.8 [35]	$6,997,484	2.7	451.2	167.3	108

Source: SWC Document, *Leakage Reduction Project*, October 2004, Appendix A.

The active leakage reduction program is estimated by SWC to have reduced leakage by 42 ML/d or 15,000 ML by the end of 2003/04.

4.4.16.6 Program

Following the first inspection of the entire network by the end of 2004/05, SWC proposes to start again, inspecting and repairing 7,000 km of mains per year, according to priority. Initially, this is in order to reach the target reduction of 60 ML/d (22 GL pa) and then to maintain it at this level against the natural increase of leaks over time. To achieve this, SWC is proposing to spend $2.5 M pa on the project.

As well as the "find and fix" active detection program and the speeding up of response time, which have been the basis of the program so far, SWC is working on using more flowmeters and district metering to enhance the program and allow it to achieve a saving of 60 ML/d by June 2006.

In addition, SWC has in place a program to reduce pressure to parts of the network. This program has been discussed in Section 4.4.10. SWC has allocated half the expected savings from the program to reductions in customer demand (reviewed in Section 4.4.10) and half (ultimately 25 ML/d) to a reduction in leaks. SWC has stated that it has far greater confidence in the modelled estimate of reduced background leaks or losses (about 20 ML/d) than it had in the modelled estimate of reduced consumer demand which it significantly devalued. To the estimated 20 ML/d reduction in background (small)

[34] Leakage reduction is revised by depreciating the leakage reduction gains, reflecting the return of leakage through new faults.

[35] As at the end of 2003/04, the depreciated value of leakage reduction = 41.8 ML/d.

leakage, SWC has added a further 5 ML/d due to reduction in losses from larger meter bursts.

4.4.16.7 MMA initial review

The ActewAGL audit has concluded that the 15 GL pa reduction in leakage between 2002/03 and 2003/04 is real and not due to changes in measurement. It may, indeed, be somewhat underestimated.

The SWC program aims to continue to reduce the leakage by a further 40% through on-going active repair as well as improvements in methodology by June 2006 and then maintain this level of leakage reductions.

MMA has concerns that the dramatic reduction seen in 2003/04 may have been overstated due to the effect of water restrictions and the low level of reported mains breaks and leaks which, according to ActewAGL, was at a level about half that reported over previous years.[36] Also, the continued leakage reduction may not result in further significant falls (from 41 to 60 ML/d) because of diminishing returns as the program moves into the newer, less leaky areas of the network.[37]

Despite these concerns, MMA is encouraged by ActewAGL's conclusion that the savings are real and may be understated, and that improvements to the programs expected by SWC may allow additional reductions to be achieved.

MMA has not reviewed the underlying modelling of background leakage due to water savings, but accepts that SWC has more confidence in it than it does in the modelling of consumer demand reduction due to pressure management.

The SWC forecasts of reductions in leakage, and calculated leakage for the forecast period, are provided in Table 27.

Table 27 – Real losses forecast by SWC and water savings from leakage, ML pa

FY ending June	2004	2005	2006	2007	2008	2009	2010
Real Losses	53,143	51,194	49,660	46,832	43,089	38,368	38,369
Savings (from 2003/04)		1,949	3,483	6,311	10,054	14,775	14,774

If the leakage reductions are as projected by SWC, then SWC will have reduced leakage from about 330 ML/100 km of mains in 2002/03 to about 190 ML/100 km of mains by 2009/10. This would put it in the same ballpark as a number of other Australian water providers with significantly younger networks.

MMA has accepted the SWC forecasts, but considers them to have a high degree of uncertainty (say ±50%) until they are validated with more water balance data from years

36 ActewAGL, 2004, *Technical audit of Sydney Water's waterbalance methodology and results*, p 18.

37 Ibid, p iii.

without restrictions and with normal levels of mains breakage and further results from pressure management trials.

4.4.16.8 Further MMA review following the draft report

Following the draft report MMA was advised that the expected level of further leakage reduction had been increased in the most recent SWC forecasts. Real leakage was now forecast to reduce from 53.1 GL in 2003/04 to 38.4 GL, or 105 ML/d, in 2009/10, a reduction over the period of 14.8 GL. This was said to be due largely to a re-evaluation of the economic level of leakage based on a higher estimated marginal value of water. According to SWC:

> *"Sydney Water has undertaken a study of the leakage/cost relationship or the economic level of leakage. This study indicates an economic level of leakage range from 118.7 ML/d up to 145.3 ML/d at the current marginal cost of water of 18c/kL, compared with Sydney Water's estimated 2003/04 leakage rate of 143 ML/d.*
>
> *Sydney Water does not consider that the current marginal cost of 18c/kL adequately reflects the scarcity value of water that is likely to be identified by IPART as part of its consideration of the wholesale price of water from July 2005. Sydney Water considers that a marginal cost of water of 38c/kL more accurately reflects a shift towards the current scarcity value of water likely to be identified as part of IPART's review.*
>
> *At a marginal cost of water of 38c/kL the identified economic level of leakage ranges from 93.3 ML/day up to 116 ML/day. Sydney Water has used the mid-point of these values or 105ML/d for the purposes of modelling programs of work that would be required to achieve this leakage level and the subsequent investment requirements. This is the basis of Sydney Water's Pricing Submission."*[38]

In its draft report, Atkins commented that:

> "The proposal in the submission is to reduce leakage from 146 to 116 ML/day [39] …Moving to this reduced leakage level over the five year period is a challenge. Achieving these gains will be dependent on a better understanding of methods and costs at an early stage of planning."[40]

MMA has not reviewed the expected leakage reductions in any detail. However, based on the information provided above, there must be some concern that the anticipated level of leakage reduction will not be achieved. While MMA has accepted the SWC position on leakage reduction, the Tribunal may wish to review this component for the SCA after the finalisation of the Atkins report.

4.5 FINAL METERED CONSUMPTION FORECASTS

MMA has forecasts metered consumption using MMA's baseline forecast (as shown in Figure 11) and MMA estimates of the savings from the demand management programs.

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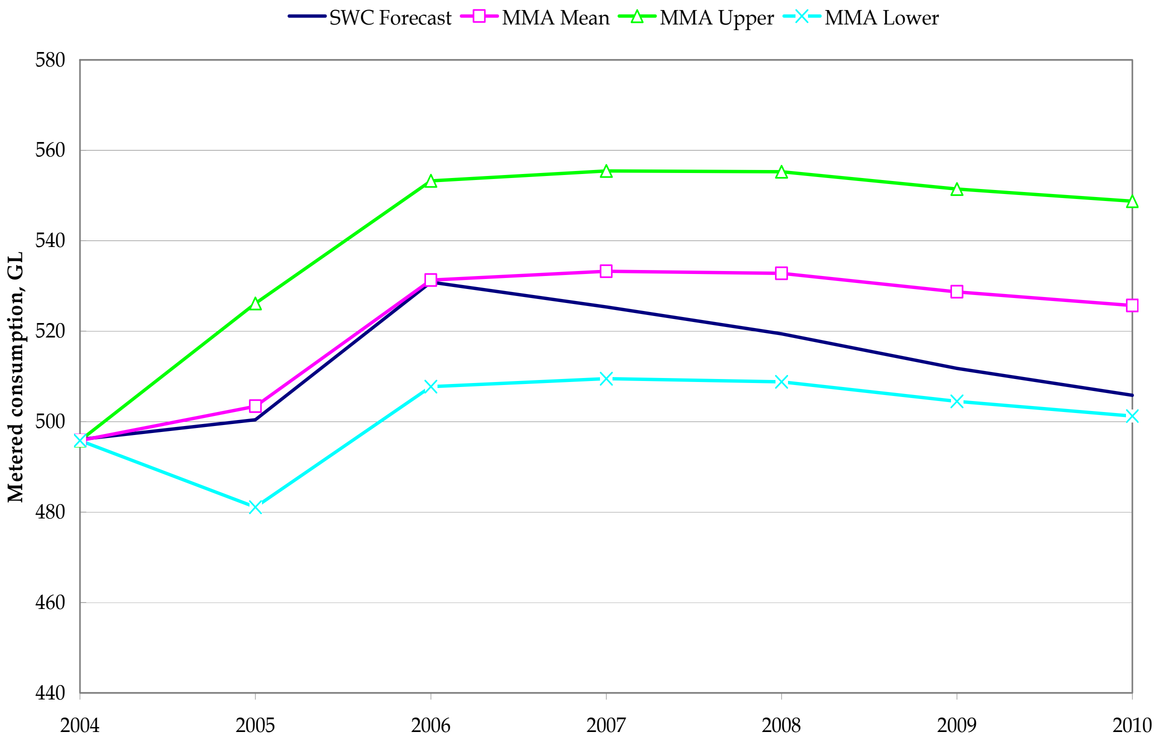
38 M Watts, SWC personal communication, dated 6 Dec 04.

39 According to SWC, Atkins used the upper limit instead of the middle of the range and this should have been 105 ML/d.

40 Atkins Cardno, *IPART Capex, Asset Management and Opex Review*, Sydney Water Corporation, Draft Report, November 2004, Section 3.6.

Upper and lower demand forecasts (based on a 95% confidence interval) were also derived. The MMA forecasts are compared with SWC's metered consumption forecasts in Figure 15. MMA's mean forecast of metered water consumption ranges from 1% higher in 2005 to 4% higher in 2010 than SWC's forecast. However, the SWC's forecast falls within the 95% confidence limits of MMA's forecast.

Figure 15: Metered consumption forecasts



5 HUNTER WATER CORPORATION

5.1 OVERVIEW

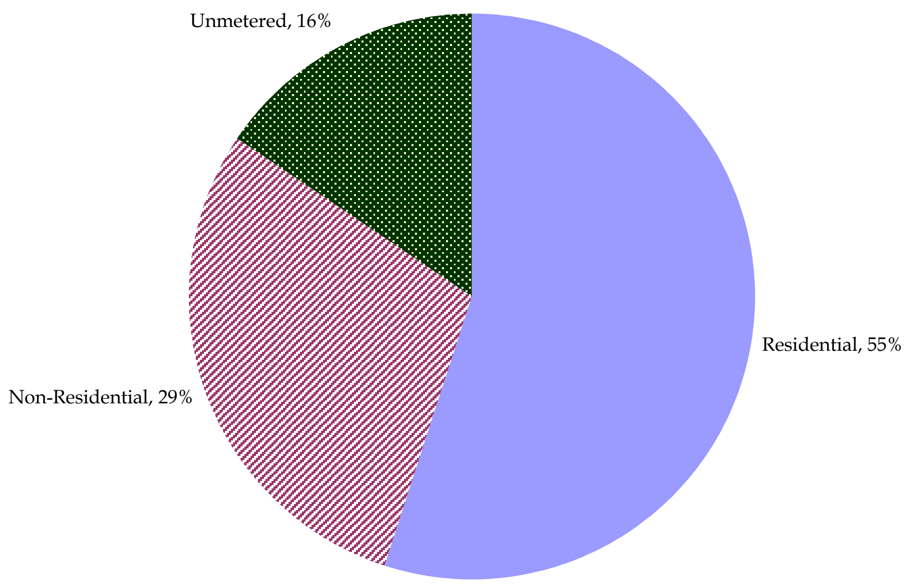
Like other regions in Australia, water demand in the Hunter region has undergone substantial changes over the past decade. The variety of changes makes it difficult to discern key underlying trends.

5.2 CHARACTERISTICS OF WATER DEMAND

Hunter Water Corporation (HWC) services water demand in the local government areas of Cessnock, Lake Macquarie, Maitland, Newcastle and Port Stephens. The region covered has a population of nearly half a million people, as well as a large industrial base located in the principal centre of Newcastle.

Water consumption in the regions is currently about 73 GL to 78 GL pa, depending on climatic conditions. Currently, residential consumption accounts for 55% of total potable water consumption (see Figure 16). Non-residential consumption, covering industrial, commercial and government sectors, accounts for around 29%. The remaining 16% covers unmetered usage such as watering of public land and system leaks (but not reused water).

Figure 16 – Water consumption by customer segment

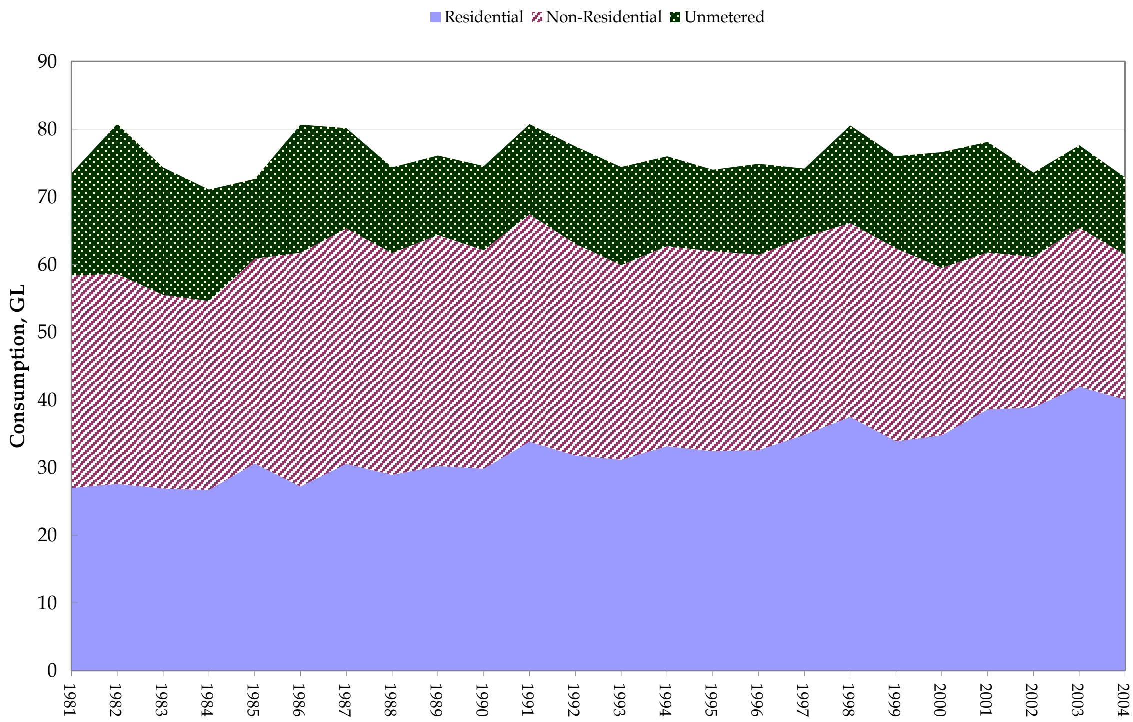


5.3 HISTORICAL TRENDS

Even though overall water consumption has flattened since 1980, several trends are still evident that help to underpin the outlook for water consumption in the Hunter Region.

Firstly, residential water consumption is increasing, whilst consumption in the non-residential sector has fallen (see Figure 17). The fall in the non-residential sector mainly reflects the closure of several large industrial plants over the last five years, as well as improved water use efficiency in the industrial sector as a whole. However, commercial and government use of water has risen steadily and this is not depicted in Figure 17.

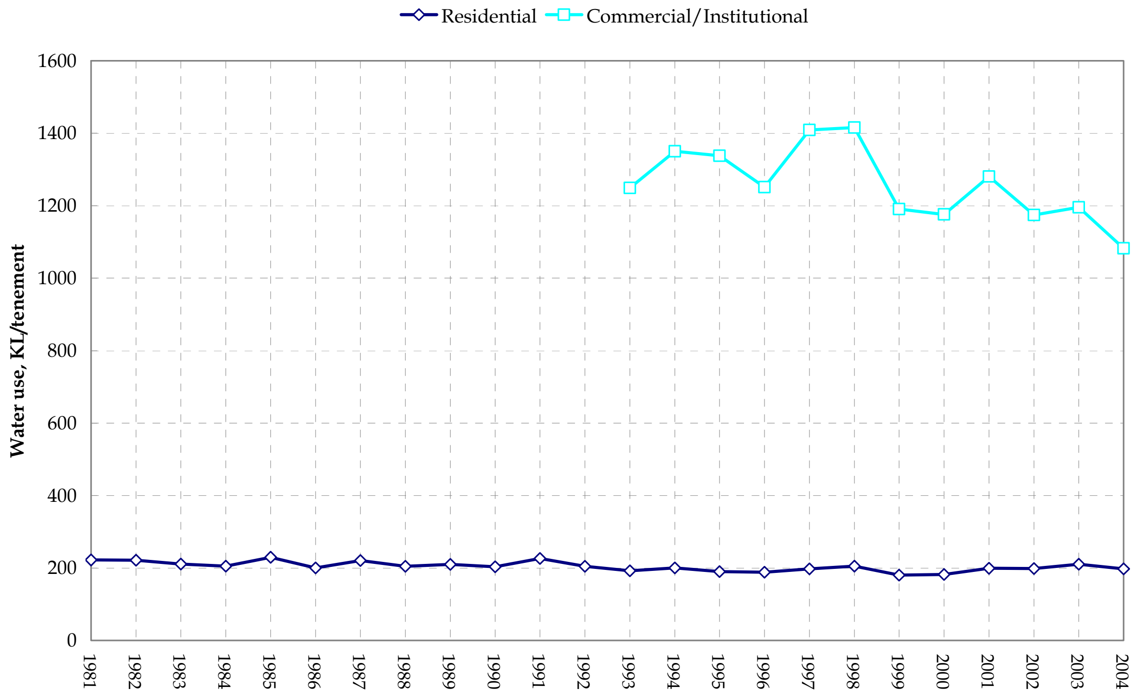
Figure 17 – Trends in water consumption in the Hunter Region



The growth in water usage in the residential sector has largely been driven by population growth. Water usage per residential dwelling has fallen slightly over the period from 1980 to 2004 (see Figure 18). Most of the decrease occurred in the period from 1980 to 1991. A major factor in the drop was the introduction of user pays pricing in 1982. Water consumption per property has remained stable since 1991, despite the implementation of regulations to reduce water usage through the adoption of more efficient appliances such as dual flush toilets. Water usage per tenement in the commercial and government sectors has fallen steadily since 1993, although these sectors comprise only 18% of total water releases.

Water use per industrial customer has also fallen substantially, but this mainly reflects the closure of some of the largest users of water (for example, BHP's steel mill at Newcastle). Excluding these closures, water usage per industrial customer has remained relatively steady, with an average increase of 0.2% per annum.

Figure 18 – Water use per residential and commercial tenement



Several factors may explain historical trends in demand. Residential water consumption has risen on the back of population growth. On a per tenement basis, consumption per house has fluctuated between 200 kL/annum and 238 kL/annum.

MMA has performed an analysis of the key factors impacting on water demand in the Lower Hunter Region. The analysis used ordinary least squares techniques to regress water demand with key explanatory variables affecting water demand. An economic model was developed, regressing water consumption per tenement with income, marginal and average prices, technical trend (for example, uptake of efficient water devices such as dual flush toilets) and weather variables.

The analysis relies on annual metered consumption data by customer segment provided by HWC.

The analysis was conducted for separate houses, flats and units, and commercial sector (small customers segment). The results of the analysis are reported in Table 28.

Table 28 – Factors impacting on water demand – significance of major explanatory variables

Variable/statistic	Separate houses	Flats/units
Income	Significant at 10% level	Significant at 5% level
Price	Significant at 10% level	Not significant
Rainfall	Not significant	Not significant
Temperature	Not significant	Not significant
Evaporation	Significant at 5% level	Significant at 5% level
Occupancy rate	Not significant	Not significant
Restrictions	Not significant	Not significant
Demand management	Not significant	Not significant
Technical change	Significant at 5% level	Significant at 5% level

Note that demand equalled consumption per metered property. For separate houses, income was represented by average weekly earnings, price was represented by the tier 1 usage charge, weather variables were represented by the number of days over summer when the level was greater than 25% above long-term mean values, occupancy rates by the number of days of restrictions and technical change was represented by the adoption of dual-flush toilets. The variables were similar for flats/units, except that price was represented by service charge divided by the water consumption of the average user which was found to be not statistically significant. For small scale commercial customers, income was represented by GSP per capita. Demand management was represented by a dummy variable for the years with an active demand management program.

The analysis indicates that income is a significant determinant of long-term trends in water consumption. However, the analysis indicates that income had a small positive effect on consumption – higher incomes led to slightly higher water consumption. The income elasticity was estimated at 0.23 for separate houses and 0.60 for flats and units. Income was not a significant determinant of demand for commercial users, where it is likely that water is a small component of the total costs for most businesses.

HWC states that the implementation of a usage charge for every litre of water consumed has led to a substantial reduction in water consumption.[41] The introduction of usage charges in 1982 was followed by a consistent decline in water usage per customer of about 20%, compared with pre 1982 levels. The statistical analysis performed by MMA indicates that water consumption is affected by the usage charge, but again by a small amount. For separate houses, the price elasticity of demand is -0.38, indicating that for every 1% increase in the usage charge, water consumption falls by around 0.38%. For flats and

41 HWC, 2002, *Integrated Water Resource Plan*.

units, the usage charge does not significantly impact on water consumption, although this result is probably due to the fact that the bulk of flats and units are not individually metered.

Both DM and the imposition of mandatory restrictions obviously do impact on water demand. However, analysis indicates that the impact is small mainly due to the short amount of time that restrictions were imposed in the period of analysis (from 1988 to 2004) and the fact that active demand management programs did not commence in earnest until April 2004.

Technical developments will also impact on water demand. The adoption of dual-flush toilets has resulted in a large reduction in water use per household. According to data provided by HWC, the amount of water used for toilets was about 18% in 2002. Other data indicated that over 74% of households in the Hunter region had at least one dual-flush toilet. The analyses indicated a significant impact on separate houses, but no impact on flats and units, probably because the bulk of these units are new and have always had dual-flush toilets.

Weather has an important influence on year-to-year variation in water demand. In particular, it was found that the level of evaporation had a significant impact on water use in separate houses. This is probably due to higher garden use with higher evaporation levels. Temperature had an impact on water use in flats and units, with higher temperatures leading to higher water use. It is likely that this is due to the extensive use of evaporative air conditioners in flats and units. The long-term impact of weather will depend on whether there is a persistent warming of temperatures due to the greenhouse effect.

For large scale users, long-term trends in demand are mainly affected by decisions to expand or close plants. Plant closures (especially the BHP steel mill and some coal mines) has seen water demand from this segment diminish substantially by about 10 GL/annum since 1990.

Another factor affecting potable water use for large scale customers is the opportunity to substitute with recycled or bore water. Recycling of wastewater is on the increase, particularly at coal mines, coal processing plant and power stations. As power stations and coal mines are some of the largest customers of HWC, it is important to understand the potential for recycled water use at these sites.

Overall, water use per customer has fallen slightly in the residential sector over the last twenty years. Given the uptake of dual-flush toilets, the imposition of usage charges and the lower number of people per household, a faster rate of decline would have been expected. A survey of consumers in the region also indicated a high level of uptake of water saving devices. Aside from the fact that 74% of households have a dual-flush toilet, about 45% of all households also have a low flow showerhead and just over half used sprinklers for watering gardens.[42]

From the analysis, it appears that two factors may be responsible for maintaining water consumption per household and compensating for the favourable developments:

- Higher incomes lead to higher water usage. It is difficult to discern the reason for this, but analysis indicates that it only has a small impact. Survey data from the Hunter Valley Research Foundation indicates that there are no statistical differences between income groups on the adoption of water saving devices. This would support the notion of an increase in water consumption with income through the greater usage of appliances and the greater number of showers and toilets per household. Higher income houses were found to have a statistically higher number of toilets and showers.
- Data provided by HWC suggest a higher level of usage in new houses compared with older houses. Usage in houses in new suburbs range from 255 kL/annum to 285 kL/annum. In HWC's Integrated Water Resource Plan (IWRP), HWC state that the higher levels of consumption could be due to these being households with families. Families invariably have high water consumption levels, whilst other houses have a higher proportion of households with no children. As the proportion of new households increases, then the average over all households should also increase.

5.4 FORECASTS – CONSUMPTION

In this section, forecasts of consumption provided in HWC's submission to the Tribunal's Review of Metropolitan Water Agency Prices are examined.

5.4.1 Method and assumptions

HWC forecast water usage by the following customer segments:

- separate dwellings
- flats and units
- large non-residential water users
- small non-residential water users.

The method applied was reasonably basic and consisted of the following approach to each customer segment:

- For separate dwellings, the projected number of households was multiplied by 206 kL/annum, with the latter being the estimated average consumption per household after weather correction. HWC stated that this average consumption per household was derived from the average consumption over the period from 1989 to 2001.

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42 Hunter Valley Research Foundation, 2002, *Hunter Water Corporation Water Demand Management Survey 2002*, Maryville, May.

- For flats and units, the projected number of flats and units was multiplied by 131 kL/annum, with the latter being the assumed average consumption per household after weather correction. HWC stated that this average consumption per household was derived from the average consumption over the period from 1982.
- For large non-residential customers, usage is forecast for each individual customer. This is based on a "detailed review of individual customer intentions". Usage is assumed to be similar to 2003/04 levels for most customers, with growth coming from the net impact of the addition of three customers and the removal of two customers. Also, three new customers are added, namely Mandalong mine expansion (0.24 GL/annum from 2005 onwards), Protech Steel (0.70 GL/annum from 2007/08) and Wyong/Gosford (2.19 GL/annum from 2005/06 onwards). The impact of the closure of two sites (Pasminco and Pelton Colliery) has been deducted.
- For small non-residential users, a small growth trend is projected of about 0.63% per annum. No explanation is given to support the use of this growth rate, but it appears to be linked to population growth.

The above assumptions are summarised in Table 29.

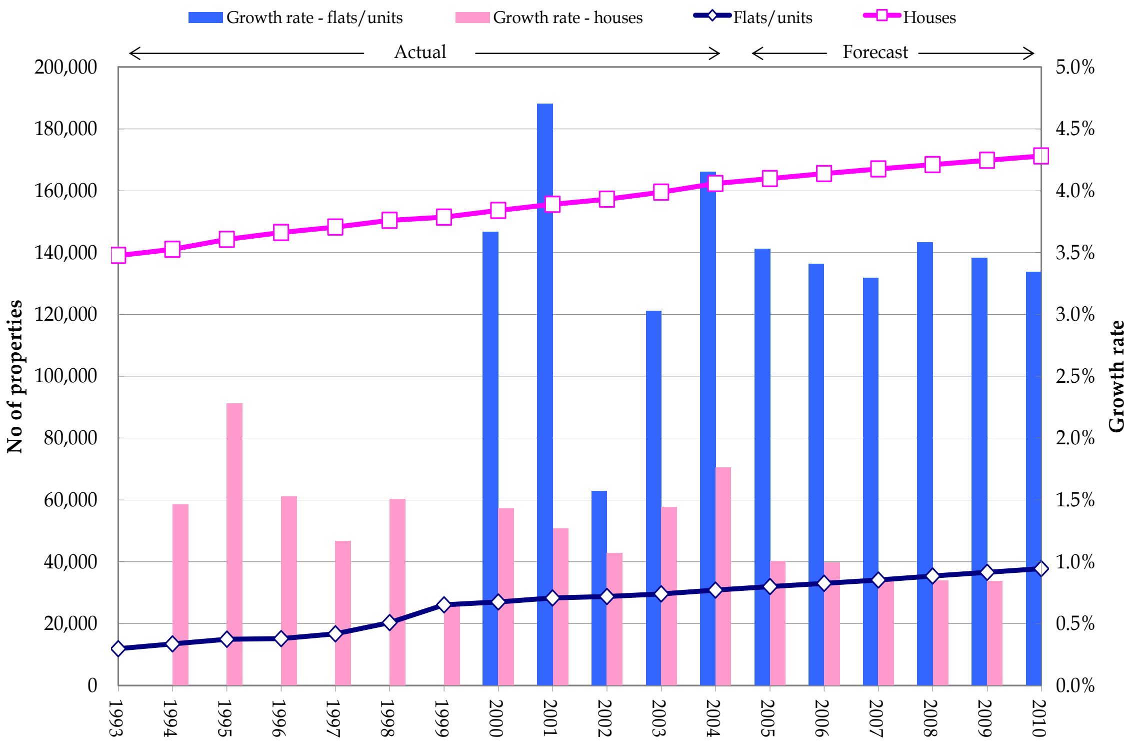
Table 29 – Assumptions used in developing consumption forecasts by customer sector

Sector	Average Consumption per Entity (kL/annum)	Weather Correction	Comments
Separate Dwelling	206	Yes	Average consumption based on data from 1989 - 2001
Flats & Units	131	Yes	Average consumption based on data from 1982 - 2001
Large Non-residential	Based on 2003/04 individual consumptions		Adjusting for new businesses and closures
Small Non-residential	Growth rate of 0.63%/annum		Appears to be linked to population growth

The basis for projecting the number of new houses, flats and units is not clear. For flats and units, it appears to be based on an assumption that the number of new properties is 1,090 each year from 2004/05 to 2006/07 and 1,223 properties, thereafter. Similarly, for separate dwellings, the assumption appears to be 1,631 new homes in each of 2004/05 and 2005/06 and 1,419 new homes each year, thereafter. Figure 19 shows growth in connected properties. These projections appear to be in line with statements made by HWC that the population is expected to continue to increase, but at a slightly decreasing rate (although this would be slightly compensated for by the projected decrease in household occupancy rates).

The analysis assumes implicitly that there is no or little impact from the various DM measures currently being adopted. HWC is currently implementing a retrofit program, which it believes will reduce water use per retrofitted house of around 20 kL/annum. BASIX is also due to be implemented within the time frame of the current price review, but its impact on water consumption is uncertain at this stage.

Figure 19 – Growth in number of connected properties



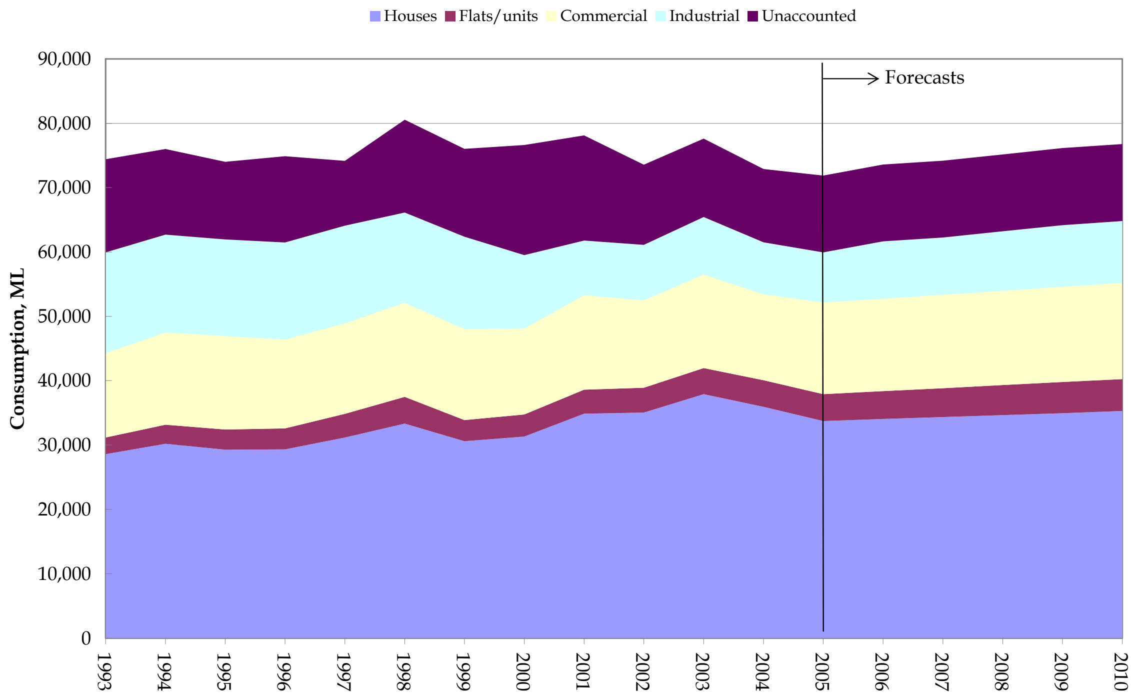
5.4.2 Indicative consumption forecasts – business as usual

HWC's forecasts of water consumption for the review period are shown in Figure 20. The forecasts provided in the AIR reflect an assumption of business as usual with minimal (or zero) impact from DM programs including BASIX. The key features of the forecasts are:

- Growth rates for residential customers are expected to be smaller than the growth rate implied for the period from 1993 to 2004.
- The growth rate for non-residential customers is expected to be lower than historical growth rates, mainly due to the closure of a number of large water consuming plants.
- Water consumption is expected to increase for all customer segments, with the largest increase occurring in flats/units and industrial customers.
- There is a large fall in water demand in 2005, reflecting the assumption of a return to normal weather conditions resulting in lower consumption in separate homes. This presumably reflects lower outdoor water usage.

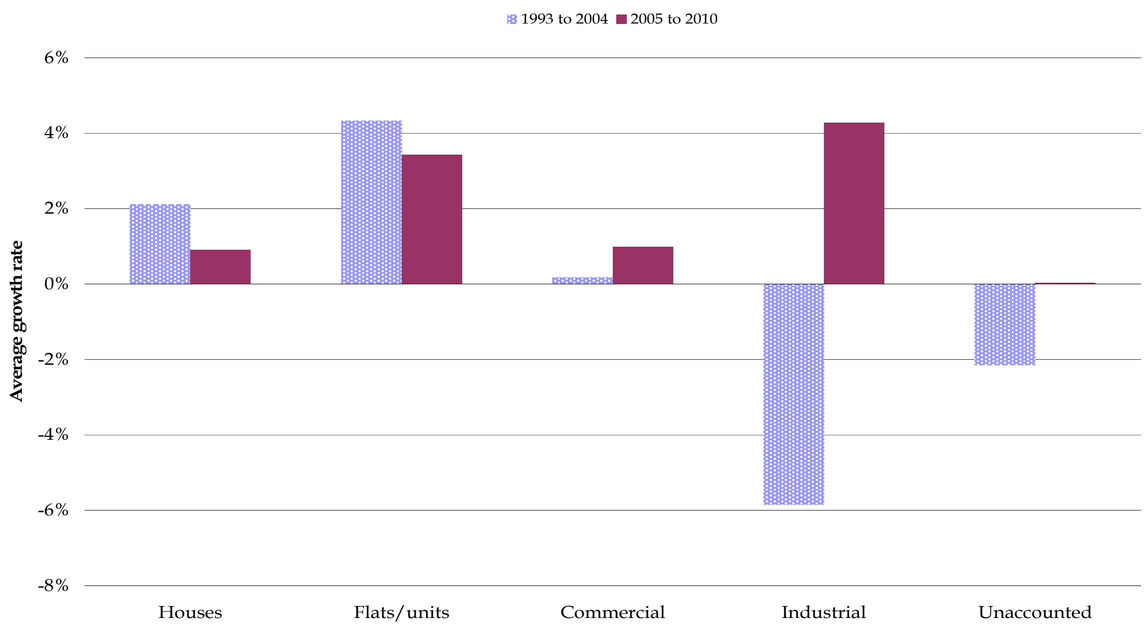
- The increase in industrial demand reflects the forecast of a number of new plants being built, more than compensating for the closure of two plants. Consumption at all other industrial plants is assumed to remain constant.

Figure 20 – HWC forecast of water consumption



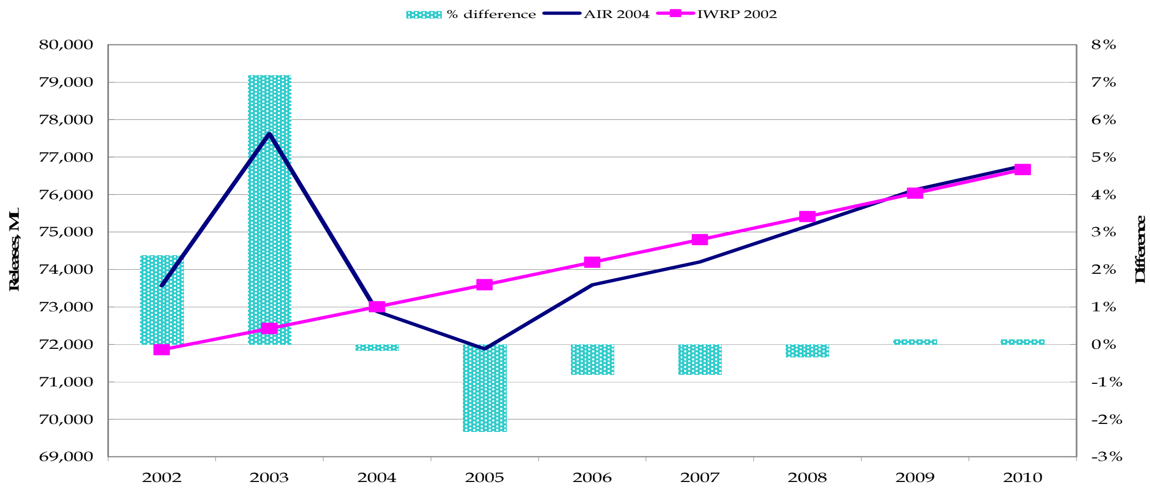
A comparison in the rates of growth in demand between the periods 1993 to 2004 and 2005 to 2010 for the different sectors is shown in Figure 21.

Figure 21 – Rates of growth in demand



The forecasts provided in the AIR are generally lower than those provided in the IWRP published in 2002 (see Figure 22) for two reasons. Firstly, a lower level of leakage is assumed in the AIR forecasts, reflecting the impact of recent leakage reduction programs. Secondly, the AIR forecasts include the impact of the closure of two key industrial users (the Pasminco plant and Pelton colliery) in 2004. The AIR forecasts also assume the addition of three loads, which result in slightly higher forecasts than those in the IWRP in 2009 and 2010.

Figure 22 – Comparison of HWC demand forecasts



Notes: (1) A positive percentage difference implies the AIR forecast is higher than the forecast in the IWRP. (2) Data for 2002 to 2004 years in the AIR forecasts are actual releases for those years.

5.4.3 Analysis of forecasts

HWC's forecasts rest on two key assumptions:

- that demand per residential tenement remains constant
- that demand for non-residential users is largely driven by plant closures, the expansion of existing plants and opening of new plants.

The estimate of demand per residential tenement is based on long-term average consumption per tenement from 1982 to 2004. An estimate of 206 kL/annum for houses and 131 kL/annum for flats/units is assumed.

MMA's analysis indicates that the assumption of 206 kL/annum, as contained in the AIR, is different from the assumption stated in HWC's response to questions asked by MMA and in their IWRP reports. In both cases, an estimate of 210 kL/annum is quoted. The average over the period from 1993 to 2004 has been 214 kL/annum.

In addition, a constant demand per tenement assumes that historical trends continue. However, the observed values for the use per tenement reflect the outcome of two trends. Firstly, the adoption of water saving devices, for example dual-flush toilets and low flow showerheads. The adoption of these devices would tend to put downward pressure on water use per tenement. The fact that the use has remained relatively constant implies that there is a second counter trend, which statistical analysis indicates is probably driven by rising incomes.

It is difficult to discern what is causing the counter trend, but some suggestions include increased cistern leakage (with a growing proportion of households having more than one toilet) and the longer time spent in showers (in households with more than one shower, with the number of these households increasing over time). It is possible that, in the absence of further demand measures, water usage per tenement could increase as the latter trend becomes more dominant. This will be countered to some extent by the successful implementation of the current set of DM initiatives.

Even analysis by HWC indicates that water use per separate dwelling is higher for new dwellings. Data provided by HWC in response to a question by MMA indicates that design demands for new connections for urban houses are assumed to be:

- 285 kL/annum in Maitland and Cessnock
- 270 kL/annum in Port Stephens
- 255 kL/annum in Newcastle and Lake Macquarie.

All of these are significantly greater than the overall average of 206 kL/annum. This trend has been evident for houses built after 1990. It is consistent with data on water consumption for new homes recorded for Sydney. As the proportion of new homes increase, relative to older homes, this would lead to an upward trend in the average consumption level.

The level of 131 kL/annum for flats and units appears to be based on five years of data. MMA found that data on the number of flats and units appeared to be inconsistent across different information sources. Even the AIR has the number of flats and units increasing substantially from 1997 to 1999 (from 16,751 in 1997 to 26,096 in 1999). Historical data for the number of units/flats in the period before 1996 from a previous report indicate a different set of numbers to those used in the AIR.[43] Data on connected properties provided by HWC also indicates a higher level of units.[44] MMA understands that the difference may relate to changes in the estimate of non-metered properties. Regardless of the source of difference, it means that obtaining a reliable estimate of water consumption per flat/unit is difficult.

The impact of DM programs and the proposed changes to pricing structures (with modest increase in real terms of 3% per annum for usage charges) have not been incorporated. MMA agrees with HWC that both factors will lead to only small reductions in the average use per tenement. Each price increase is only small, leading to a reduction in demand of about 1% per annum, based on elasticity estimates derived by MMA.

MMA applied seasonal decomposition and ordinary least squares regression analysis to historical metered consumption per property (disaggregated into houses and flats/units), in order to test HWC's assumption of constant consumption rates.

43 HWC, 1997, *Demand Projections for Hunter Water Corporation*, November.

44 HWC spreadsheet *Properties Water Connected 93-02 for MMA 18 Oct 191004.*

Total metered consumption per billing cycle[45] was used in conjunction with the number of connected properties in each billing cycle.[46] The number of connected properties was provided by HWC on an annual basis. MMA estimated the number of connected properties in each billing cycle by linearly interpolating between the observed values at the end of each financial year.

Water restrictions were imposed in the Hunter region from 7 December, 1994 to 7 January, 1995. In order to gain a picture of consumption per property in the absence of water restrictions, the analysis was therefore performed using all available data after this period.

The regression equation was defined as follows:

$$\text{Consumption per property} = \text{Constant} + \text{b} \times \text{Annual trend}$$

The main results from the analysis are summarised in Table 30.

Table 30 – Regression analysis of consumption per residential dwelling per billing cycle

	Statistic	Houses	Flats/units
Constant	**Constant**	68.858	50.806
	p-value	0.000	0.000
Annual Trend	**Coefficient**	1.181	-0.398
	p-value	0.004	0.023
Overall model	**R^2**	0.296	0.198
	Adjusted R^2	0.266	0.165

The p-value and positive sign of the trend coefficient for houses in Table 30 indicate that there is potentially a statistically significant upward trend in annual consumption per house. The approximate magnitude of this annual increase is 1.2kL/house. The adjusted R^2 value of 0.266 indicates that this simple regression model is able to describe 27% of the observed variation in consumption per house.

In contrast to houses, the regression results for flats and units indicate a statistically significant downward trend in annual consumption per property of approximately 0.4 kL/tenement.

MMA also performed regression analysis of weather corrected consumption per property in an attempt to improve the R^2 statistic of each model (see Appendix B). The results showed that the inclusion of weather variables did not improve the performance of the models and none of the weather variables were found to be statistically significant. The

45 Spreadsheet data supplied to MMA by HWC, November 11, 2004: *cycle_data 111104.xls*.

46 Spreadsheet data supplied to MMA by HWC, *Properties Water Connected 93-02 for MMA 18 Oct 191004.xls*.

poor performance of the weather corrected models may have been due to the nature of the available data (only 3 data points were available for each year) and the definition of the weather variables. In weather corrected models, the best results are generally obtained by modelling time series data on a daily or weekly basis as relationships can be masked when longer time intervals are used.[47] Unfortunately, the time interval between HWC's meter readings precludes analysis on a daily or weekly basis.

The above findings indicate that HWC's assumption of constant consumption per residential tenement may require further investigation. The analysis performed above is not definitive, but does indicate that water consumption per residential customer may not be constant.

However, there may be issues with the use of a constant per tenement usage which lead to underestimating the true level of demand. MMA believes that the use of plausible higher estimates would lead to a demand forecast some 2% to 5% higher than forecast by HWC.

HWC provided historical water consumption and contact details for its top 20 large customers. These customers represent a number of industries ranging across aluminium smelting, steel production, electricity generation, hospitals and education. HWC have assumed that annual consumption for these customers will remain equal to recent levels, except for two customers who have recently closed their plant.

MMA was able to interview five large customers. The main usage of water by these large customers is for:

- industry processes
- dust suppression
- cooling towers.

Based on the information provided by these customers and HWC, it appears that most large customers are either implementing internal water conservation programs or are exploring ways to minimise their water consumption. Interview comments indicated that the major barriers to implementing water consumption measures within these industries are the capital cost of the programs and their financial payback. For HWC's 20 largest customers it is estimated that the total consumption would decline slightly from 10.4 GL in 2003/04 to approximately 10.1 GL in 2009/10, which is less than a 0.5% reduction per annum. The drop in water consumption could be explained by the substitution of potable water with recycled water and the implementation of DM programs.

HWC is, however, expecting three new large customers to commence consumption over the next five years, amounting to a total of over 2 GL per annum. The new customers include:

- an expansion of the Mandalong mine

[47] Committee on USGS Water Resources Research, 2004, *Estimating water use in the United States: A New Paradigm for the National Water-Use Information Program* , National Academy Press, Washington D.C, p.103.

- a new steel mill (Protech Steel)
- a contract to supply Wyong and Gosford with potable water.

Some of these sales are not firm and the timing in particular is uncertain. Centennial Coal, the owner of the Mandalong mine, has stated that the Mandalong mine is due to open in January 2005, and is likely to have a targeted production level of about 4 Mtpa supported by long-term contracts with local power stations. The commencement and level of mining is consistent with assumptions used by HWC.

Data in the Wyong and Gosford AIR support the level of water to be supplied by HWC of about 2.19 GL/annum. However, if rainfall increases substantially over the review period and storage levels recover, then these sales may not proceed. Conversely, a continuation of the dry spell may require more water to be sold to these water agencies.

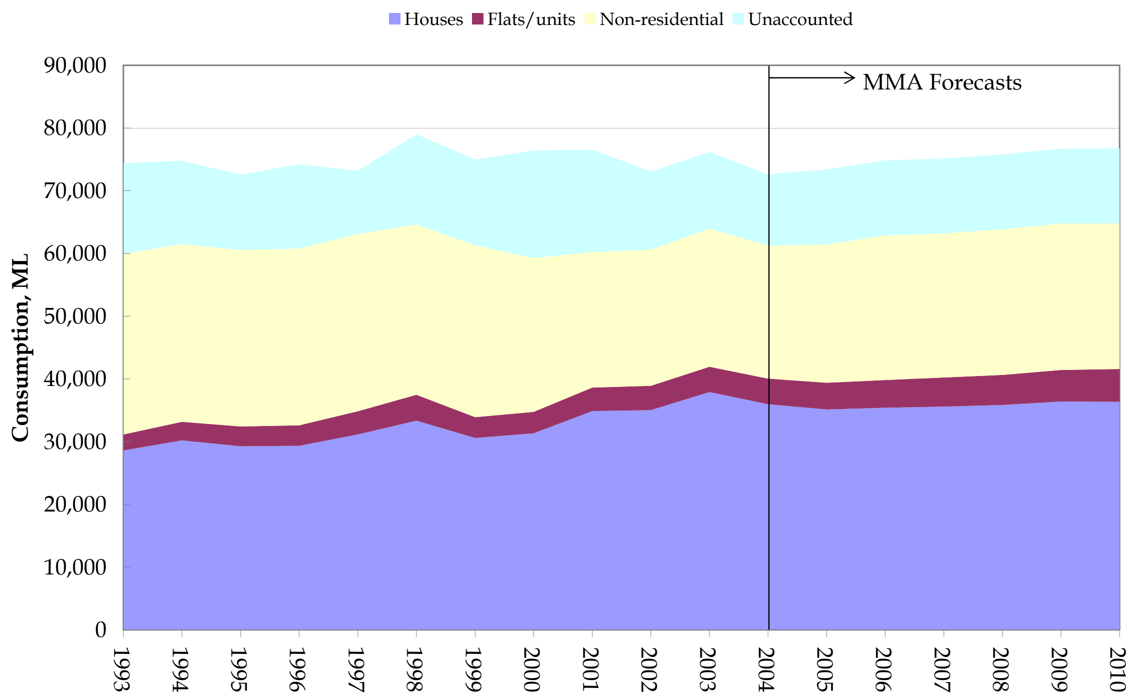
MMA has developed alternative forecasts based on information provided by industrial customers and statistical models of demand for residential customers and small non-residential customers. The forecasts do not include the impacts of the DM programs currently being investigated.

The forecasts are based on the following assumptions:

- income growth rates in line with recent NSW Treasury estimates for GSP growth rates
- HWC's proposed increases in usage charges
- average weather conditions
- unaccounted for water usage as forecast by HWC.

MMA's forecasts for each customer segment are shown in Figure 23.

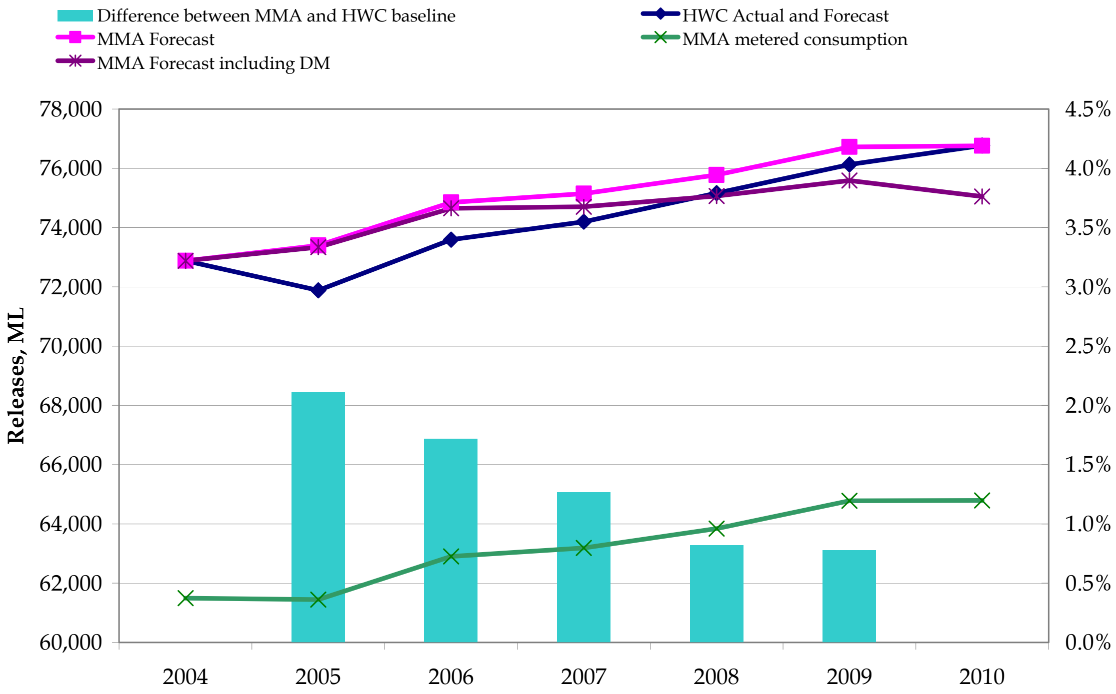
Figure 23 – MMA baseline water demand forecasts for HWC, ML



MMA's baseline forecasts are slightly higher than the forecasts provided by HWC, the difference is between 0.0% to 2.1%. The higher forecast is mainly due to higher consumption in the separate housing segment as a result of smaller growth rates in incomes, a small increase in real prices and continuing penetration of water efficient appliances. Consumption in medium density dwellings is expected to grow strongly, as is industrial demand.

MMA and HWC's forecasts are compared in Figure 24. Based on MMA's model, water releases under the baseline scenario are expected to fall in 2004/05, with a return to normal weather patterns. Thereafter, water consumption is expected to increase slightly in line with growth in population and incomes.

Figure 24 – Comparison of MMA and HWC forecasts, ML



Based on this analysis, the forecasts provided by HWC appear to be reasonable. Caution should be exercised, however, because MMA's forecasts are only preliminary and accounting for demand management would tend to reduce the forecasts.

5.5 FORECASTS – DEMAND MANAGEMENT PROGRAMS

HWC's DM programs are very modest compared to those proposed or undertaken by SWC. This is understandable given the context. HWC has:

- projected demand which falls well within sustainable yield expectations
- water storages which are over 85% full at 1 December 2004 and, consequently, no water restrictions in place
- average residential consumption which is low by the standard of major Australian utilities

- economic supply augmentation possibilities.

Because of this, extensive DM programs generally do not, for HWC, fulfil the requirement of minimising the economic, social and environmental cost of the provision of water-related services.

HWC's DM program involves:

- retrofits under the "Refit" program
- retrofits of some DoH houses
- rainwater tank rebates
- analysis of the impact of a residential campaign focusing on outdoor use
- contribution to a cleaner production program for business
- support for efficiency rating of water products
- seeking markets for recycled water
- water loss minimisation through leakage reduction in mains, services and valve replacements
- some enabling programs including indoor metering to help facilitate understanding of end-uses
- research into water sensitive urban design.

HWC, as well as other utilities across NSW, will benefit from general DM efforts such as BASIX and labelling and standards for water efficient products.

The HWC IWRP 2003/04 Annual Report has identified water savings of about 500 ML in 2003/04, mostly in the area of water loss minimisation. According to HWC, it is committed to a range of DM activities aimed at annual ongoing savings of about 1,000 ML of water. As we understand it, HWC has not included any savings from DM programs in its demand forecasting.

The major HWC generated DM programs expected over the next few years are the REFIT programs and rebates for rainwater tanks. In addition, HWC continues to promote reuse to major clients, but new reuse customers are proving difficult to find.

5.5.1 MMA review of programs

DM programs are expected to play only a minor part in reducing HWC's demand over the pricing period. MMA has limited its review of DM projects to:

- DM projects undertaken by HWC where there is a reasonable amount of certainty and information available about the program
- DM projects which are not originated by HWC but will nevertheless play a part in reducing demand.

As for SWC, MMA has restricted its analysis to:

- savings from DM programs from 1 July 2004 only
- savings which relate only to consumer demand. Water savings due to reduction in leakage, etc are not considered here.
- programs which are expected to generate material savings.

5.5.2 REFITS

5.5.2.1 Program description and estimated savings

The REFIT retrofit program applies to existing homes and is to be undertaken in conjunction with EnergyAustralia and Newcastle City Council.[48] Retrofit programs are likely to include:

- supply and install AAA showerheads
- water and energy audits
- trigger nozzle for garden hoses
- two compact fluorescent lights

The subsidised cost to residents is $39. The program is available to all households within the Lower Hunter Valley.

HWC expects to undertake 5,000 of these REFITs each year from 2004/05 and expects a saving of 30 kL/HH/a. This is a program saving of 150 ML per year.

5.5.2.2 MMA review

MMA has used the HWC estimates of expected number of program participants, but does not consider the estimate of saving per participant reliable.

Savings from the SWC retrofit programs have been evaluated by the ISF which has estimated a saving of about 20.9 kL/HH/a for the program. This includes savings from AAA showerheads, cistern displacement, tap regulators/aerators and leak repair.

While the HWC program does have the AAA showerhead, the largest contributor to water savings in retrofit programs, it does not have the cistern displacement device, tap fittings or leak repair. Instead of these, it provides a water audit and a trigger nozzle for garden hoses.

It is not clear how the HWC estimate of 30 kL/HH/a savings was derived. The retrofit of a AAA showerhead is expected to save about 15 kL/HH/a. Indeed, this saving may be higher than expected for HWC as, according to a survey done for HWC,[49] 45% of

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48 Newcastle City Council, who are project managers on behalf of all parties including Cessnock, Lake Macquarie and Prot Stephens Councils.

49 Hunter Valley Research Foundation, 2002, *Hunter Water Corporation Water Demand Management Survey 2002*, May.

households already have water efficient showerheads, a number significantly higher than the average for NSW.

In the absence of better information, MMA has estimated savings from this program based on a saving of 18 kL/HH/a.

The savings estimated are provided in Table 31 and compared against the savings derived from using HWC's estimated average savings of 30 kL per retrofit per year.

Table 31 – Indicative retrofit savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA REFIT	45	135	225	315	405	495
HWC REFIT estimate	75	225	375	525	675	825

Note that we do not understand HWC to have explicitly used the water savings from the program in its demand forecasting.

5.5.3 REFITS to Department of Housing dwellings

5.5.3.1 Program description and estimated savings

A REFIT retrofit program for DoH dwellings has been agreed on with the Department of Housing. This program is expected to supply and install:

- one AAA showerheads
- one tap aerator
- one cistern weight
- water and energy audits
- two compact fluorescent lights.

Between May and June 2004, 236 homes had the full kit installed and 64 had a part kit installed. The reason for the part kit installations was the unsuitability of the AAA showerheads in dwellings with gravity-feed hot water systems.

According to the IWRP, the results of the initial retrofits are to be analysed from September 2004 and the DoH is considering extending the project to another suburb. The IWRP estimates that 7 ML of water savings will have been made from this project to date.

HWC expects to spend $50,000 on the project in 2004/05 and then to review it after the results are analysed.

5.5.3.2 MMA review

HWC has estimated that the DoH dwellings use some 20% to 30% more water than similar non-DoH properties in the Hunter Valley. There is, therefore, scope for significant savings per DoH house retrofitted.

MMA understands that there were 300 participants in 2003/04 and that the expenditure budgeted for 2004/05 is 2.5 times that budgeted for 2003/04. After that, the program will be re-evaluated. There are 11,000 DoH dwellings in the HWC.

In the absence of further program targets and budgeted expenditures, MMA has assumed that the number of DoH dwellings retrofitted will be 750 in 2004/05 and then 300 in each of the remaining years.

Savings from the DoH program are expected to be about that seen in Sydney, that is, 21 kL per home. While DoH homes use more water than non-DoH homes and a water audit is provided this must be balanced against only about 80% having AAA showerheads retrofitted, the provision of only 1 AAA showerhead and aerator and apparently no leak repair.

MMA estimates of water savings from this program are provided in Table 32.

Table 32 – Indicative DoH retrofit savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
MMA DoH REFIT	11	22	28	35	41	47

Note that we understand that HWC has not explicitly used the water savings from the program in its demand forecasting. HWC has stated that it believes the DoH refits to end 2003/04 will have saved 7 ML, an (annualised) amount similar to that estimated by MMA.

5.5.4 Rainwater tank rebates

5.5.4.1 Program description

In June 2004, HWC announced a rebate program for rainwater tanks that are connected to household plumbing. The program is to be run as a trial from 1 July 2004 for a period of two years and then reviewed.

No information has been provided on expected uptake of the rebates or savings.

5.5.4.2 MMA review

The uptake of rainwater tanks is likely to be severely constrained by the requirement that they must connect to internal plumbing. According to SWC's 2003/04 Water Conservation and Recycling Implementation Report, SWC provided almost 4,000 rebates for tanks during that year, but only 224 were for tanks with internal plumbing.

Assuming the uptake is in proportion to dwelling numbers, this results in an expected uptake of tanks with internal plumbing of only about 30 per year. The savings from such a program are largely immaterial.

5.5.5 Other HWC programs

The results and budgets for other programs undertaken by HWC are too uncertain to include as there is insufficient data on water savings demand.

5.5.6 BASIX

5.5.6.1 Program description

The BASIX program has been introduced by the NSW government to reduce the use of water and energy in new homes. From 1 July 2005 it will be mandatory for development proposals for new single or dual occupancy dwellings in the Hunter Valley to meet the current BASIX requirement (which theoretically produce 40% potable water saving and 25% greenhouse emission reductions). From 1 October 2005, BASIX requirements will need to be met for proposals for alterations (requiring new construction) to existing homes.

The target set by BASIX is the reduction of water usage by 40% compared to the average of existing homes (not new homes). According to BASIX material, a typical development will meet the target for water conservation if it includes:

- showerheads of AAA rating or more
- tap fittings of AAA rating or more
- dual-flush toilets
- a rainwater tank or use of recycled water for outdoor water use and toilet flushing and/or laundry use.

HWC has not explicitly included any demand reductions resulting from savings due to this program.

5.5.6.2 Expected program savings

HWC has made no estimate of the impact of BASIX. It has, however, provided a rationale as to why it believes the expected 40% of savings from BASIX will not be achieved and has estimated savings of 30% to 40% below that of non-BASIX houses.

5.5.6.3 MMA review

MMA has assumed that BASIX will impact on planning for all new dwellings in the HWC area from 1 July 2005.

MMA has assumed:

- the number of net new dwellings forecast by HWC with new houses being 7.5% greater than this.
- savings of 30% from the HWC average usage (210 per separate house and 132 per unit)
- a delay of six months from planning to construction and timing taken into account in calculations.

MMA has calculated the savings from the implementation of BASIX on alterations and additions in the HWC area as a proportion of that for SWC.

MMA's indicative assessment of the impact of BASIX on HWC based on the above discussion is provided in Table 33.

Table 33 – Indicative BASIX program savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
BASIX	0	40	161	319	477	635

Note that we understand that HWC has not explicitly used the water savings from the program in its demand forecasting.

5.5.7 Appliance rating and labelling and standards

5.5.7.1 Program description

The federal government has introduced the Water Efficiency Labelling and Standards Bill 2004 which requires labelling of showerheads, washing machines, dishwashers, taps, urinals and toilets. Minimum performance standards for toilets are also likely to be set. Minimum performance standards for showerheads, washing machines and dishwashers may follow.

HWC has not explicitly included any demand reductions resulting from savings due to this program.

5.5.7.2 MMA review

MMA has assumed that the savings calculated for SWC under these programs are also attributable to HWC. However, they are in proportion to both residential customer numbers and take into account lower average usage per customer in the HWC region. We assume this is half related to indoor usage differences, as shown in Table 34.

Table 34 – Indicative labelling and standards program savings, ML pa cumulative

FY ending June	2005	2006	2007	2008	2009	2010
Labelling and standards	0	8	25	41	213	543

Note that we understand that HWC has not explicitly used the water savings from the program in its demand forecasting.

5.5.8 Price changes

5.5.8.1 Program description

HWC is assuming that there will only be a small real increase in pricing of water. It has not included any impacts from this in its forecasting and MMA considers that this to be appropriate. However, we have included the impact of the proposed price changes in our forecasts of baseline water demand as shown in Figure 23.

5.5.9 Recycled water

HWC has in place a program for recycling water by both industry and agriculture. Between 2002 and 2004, the volume of water recycled was between 3,000 and 4,000 ML, although it is not clear whether this recycled water displaced potable water. Much of this was for industrial use at Eraring Power Station, Macquarie Coal Preparation and Rhonnda Colliery.

In 2003/04 the amount recycled was about 3,000 ML. This is less than in previous years because one of the major industrial users stopped using recycled water.

In terms of demand forecasting, the main issue is whether increased or reduced recycling from baseline levels will play a role in decreasing or increasing the demand for potable water. We understand that the industrial end-user which has stopped using recycled water has moved to an alternative process/source. Thus the reduction in recycled water use will not result in an increase in demand for potable water.

Although, HWC continues to look for new markets for its recycled water, these are proving difficult to find. The main problem is the distribution of recycled water to potential customers as most are not located near the source.

The Kurri Hunter Institute is the only potential large new end-user identified at this time. Although the Institute apparently has the potential to re-use up to 100 ML of water, only a limited amount is currently being recycled.

We have not included any material change in the level of recycled water substituting for potable water over the forecast period.

5.5.10 Summary

Because HWC finds itself in a very different situation to most other utilities in NSW, the DM program proposed by HWC is relatively modest. HWC has not explicitly allowed for the impact of any DM programs in its demand forecasting.

The REFIT program for both DoH dwellings and other homes is the only HWC program likely to change demand in any significant way over the pricing period, with an expected impact of about 500 ML per annum by 2009/10.

DM programs external to HWC, BASIX and water efficient labelling and standards, are expected to play a larger role in reducing demand over the pricing period. BASIX should come into operation in HWC's areas from 1 July 2005 and MMA is assuming that standards for showerheads, toilets and tap fittings will apply from 2008/09.

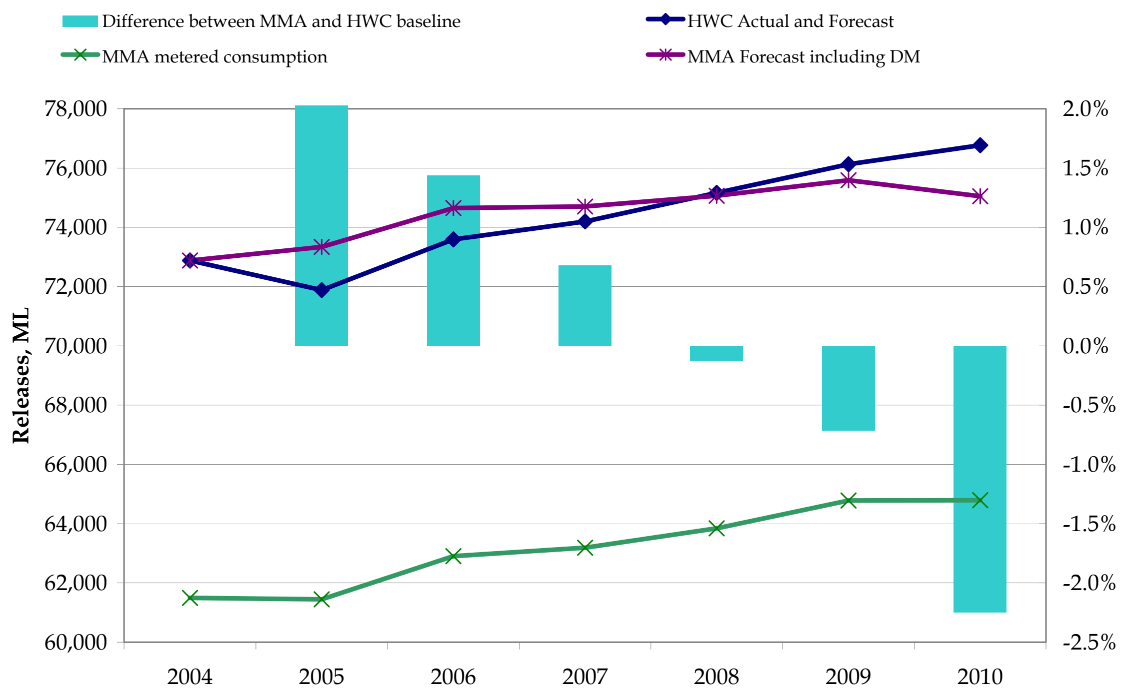
MMA's assessment of the impact of these DM programs is provided in Table 35.

Table 35 – MMA assessment of water savings from HWC and other DM programs, ML

FY ending June	2005	2006	2007	2008	2009	2010
REFIT	45	135	225	315	405	495
DoH REFIT	11	22	28	35	41	47
BASIX	0	40	161	319	477	635
Labelling and standards	0	8	25	41	213	543
Total	56	205	439	710	1,136	1,721

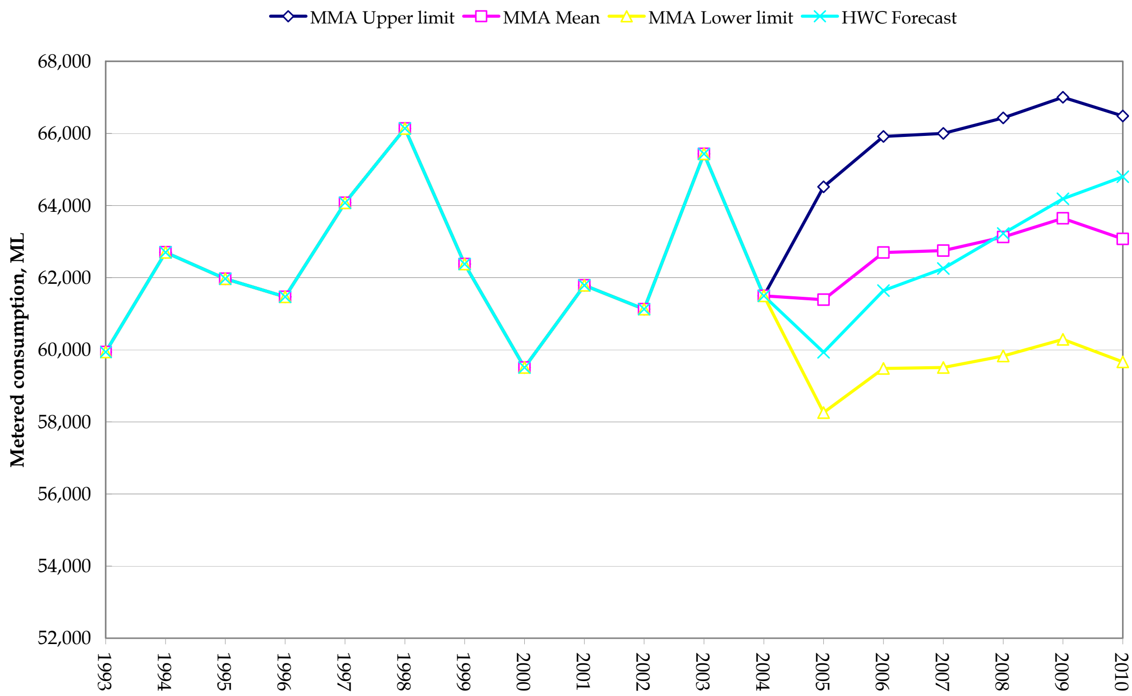
Including the impact of DM programs, the final consumption forecasts by MMA are slightly lower than HWC's final consumption forecasts in the final years of the projection period (see Figure 25). The difference (MMA forecast minus HWC forecasts), varies from +2.0% in 2004/05 to -2.2% in 2009/10.

Figure 25 – MMA water demand forecasts after DM impact deducted



Based on the 95% confidence interval, MMA's upper and lower bound to metered consumption forecasts is compared with HWC's metered consumption forecast in Figure 26. MMA forecast is higher than SWC's (by less than 2%) in the earlier years but lower than HWC's forecasts in the latter years (by less than 3%). HWC's forecast, however, is within the 95% confidence interval of MMA's forecast approach.

Figure 26: Metered consumption forecasts for the Hunter region.



6 GOSFORD CITY COUNCIL AND WYONG SHIRE COUNCIL

Gosford City Council (GCC) is responsible for the operation, maintenance and capital works activities associated with the water supply catchment, water harvesting, treatment and distribution to consumers in the Gosford local government area. [50]

Wyong Shire Council (WSC) performs the same functions for consumers in the Wyong area. The major components of each council's water business is administered and overseen by a joint authority, the Gosford Wyong Councils' Water Authority (GWCWA) Board.[51]

6.1 HISTORICAL TRENDS

6.1.1 GCC

In the 2003/04 financial year GCC supplied a total of 17 GL of water[52] to a population of just under 158,000.[54, 56]

The Gosford are has seen sustained population growth over the past decade. GCC, however, states that this growth has slowed over the last five years and is expected to continue at a rate of approximately 1.1% over the next regulatory period. According to GCC, this slow-down in population growth is inevitable because of a decreasing availability of vacant land.

Figure 27 shows historic and forecast population and population growth rates in the Gosford area calculated from various sources.

Demographer/DIPNR data was calculated by subtracting the estimated population in Wyong (as estimated by a demographer employed by WSC)[53] from the latest DIPNR estimates for the combined population in the Gosford/Wyong regions[54] and taking 96% of the resulting value. Department of Public Works data taken as 96% of the values estimated in a recent study by Dr. Peter Coombes. 96% of the demographer/DIPNR and Department of Public Works data was used because GCC has advised MMA that approximately 4% of the population in the Gosford area is not supplied with water by the council. GCC submission growth rates were taken from GCC's *Review of Water Consumption Forecasts for NSW Metropolitan Water Agencies*.**Error! Bookmark not defined.**

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50 GCC, 2004, *Review of Water Consumption Forecasts for NSW Metropolitan Water Agencies*, September

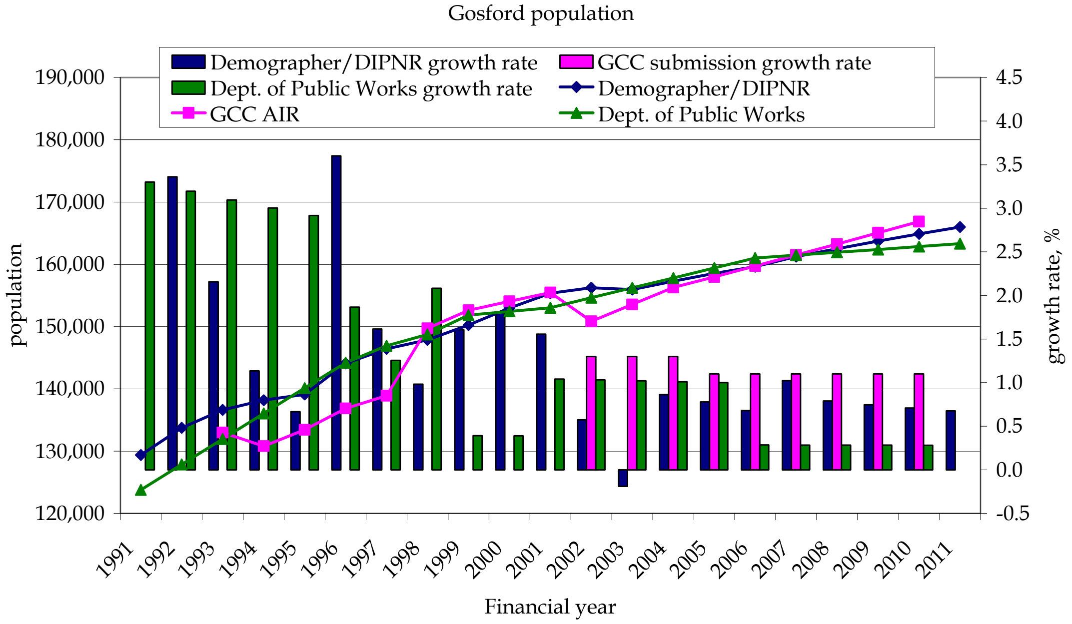
51 WSC, 2004, *Review of Water Consumption Forecasts for NSW Metropolitan Water Agencies*, August

52 GCC, 2004, *Gosford Council 2004 AIR.SIR 10 Nov 2004 - Version 9 101104.xls*

53 Data forwarded to MMA by WSC, *Central Coast: Regional Profile & Social Atlas – Appendix B: Population Projections Wyong Shire.*

54 Data forwarded to MMA by DIPNR, *DIPNR population projections.xls.* Data forwarded to MMA by DIPNR, *DIPNR Historical Water authority population estimates.xls.*

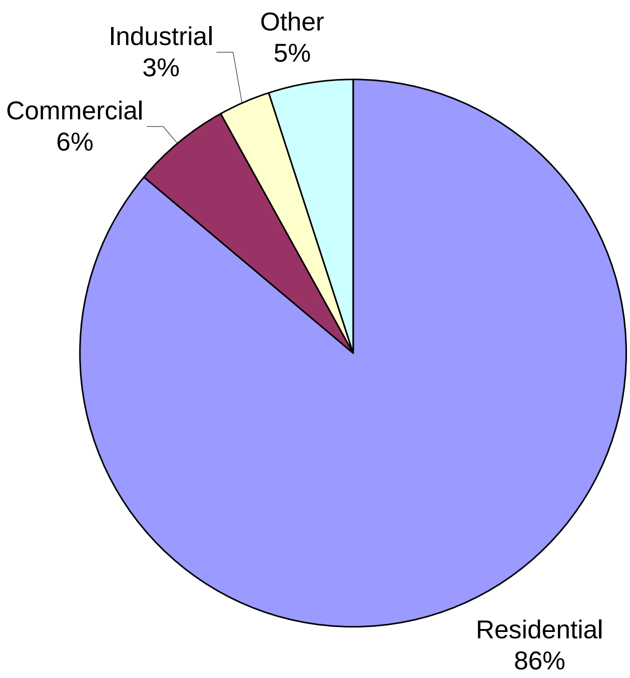
Figure 27 – Gosford population and growth rates – historic and forecast



It is evident from Figure 27 that population estimates for GCC's area of operations differ slightly depending on the data source. A comparison of the forecast growth rates indicates that GCC's forecast growth of 1.1% over the next regulatory period (2005-2010) appears to be slightly overestimated, with demographer/DIPNR and Department of Public Works data predicting lower values. However, the blue and green historic growth rates in Figure 27 do support GCC's statement that there has been a slowing of growth in recent years. Given the population decline observed in GCC's 2002 AIR data and based on verbal advice from GCC, MMA believes the demographer/DIPNR data is the most reliable source.

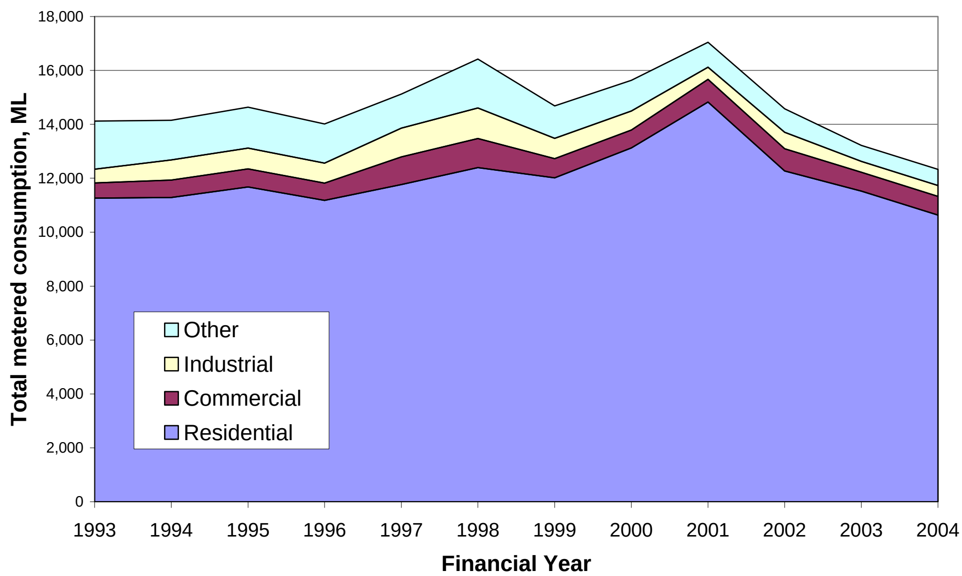
Residential consumption is by far the most significant segment of GCC's water demand, with consumption in this category accounting for 86% of metered consumption in the 2003/04 financial year, as shown in Figure 28.

Figure 28 – GCC 2004 metered consumption by customer segment



Historically, residential consumption has always been the largest component of metered demand in GCC's supply area. As shown in Figure 29, the relative importance of this segment has increased in recent years.

Figure 29 – GCC historic metered consumption by customer segment, ML

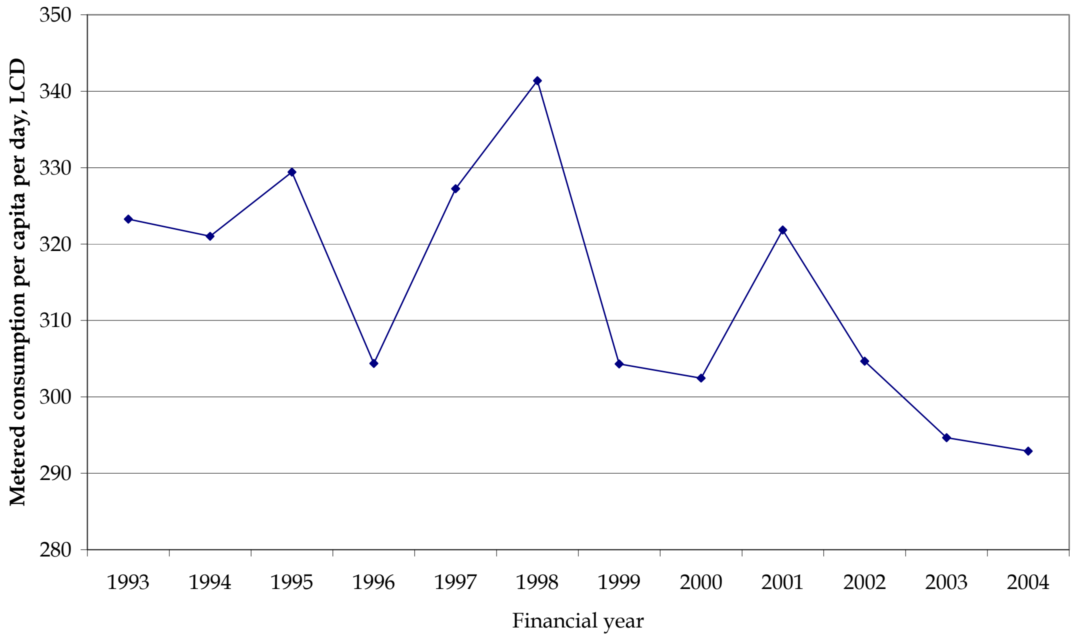


It is also evident from Figure 29 that there has been a decline in total metered consumption in the non-residential sector. Statements by GCC indicate that there has been a decline in industrial activity in the area. The reduction could also be due to improvements in technology which have reduced water consumption. The fall in the other category is mainly due to lower usage of water on public lands.

Total metered consumption peaked in the 2001 financial year. The fall in total demand after this peak could be attributable to the introduction of water restrictions in February 2002, which impacted sharply on residential water usage.

Figure 30 shows that consumption in LCD averaged between 300 and 341 before restrictions were imposed in 2002. It is evident that the increase in total metered water consumption prior to the introduction of water restrictions in 2002 was principally driven by population growth, since per capita consumption prior to 2002 appears to display a constant or possibly slightly decreasing trend.

Figure 30 – GCC total metered consumption per capita per day, LCD



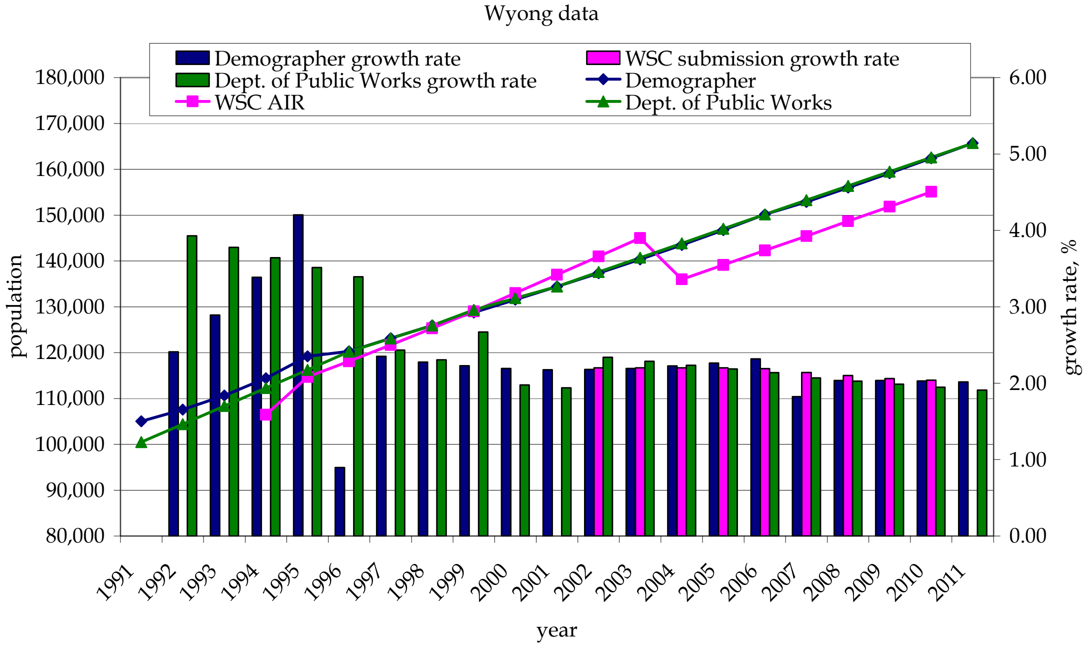
6.1.2 WSC

In the financial year 2003/04, WSC supplied approximately 14 GL of water[55] to a population of around 144,000 people.

In contrast to GCC, WSC states that sustained population growth of 2.2% has occurred over the past decade and is expected to continue over the duration of the Tribunal's determination period because significant reserves of vacant land are available for residential and non-residential development. Figure 31 shows WSC's historic and forecast population and population growth rates as indicated in the council's 2004 AIR and submission to the Tribunal. They are also contrasted with data from other sources.

55 WSC, 2004, *Wyong Council 2004 Annual and Special Information Return 141004.xls.*

Figure 31 – WSC population and population growth rates – historic and forecast



Note: Demographer data was taken from estimates by a demographer employed by WSC[56]. Department of Public Works data was taken from a recent study by Dr. Peter Coombes. WSC submission growth rates were taken from WSC's *Review of Water Consumption Forecasts for NSW Metropolitan Water Agencies*.

The data in Figure 31 supports WSC's assertion that there has been sustained population growth over the past decade. WSC's forecast growth rates also seem to be supported by data from the demographer and Department of Public Works, with all three sources predicting very similar values over the determination period. Based on advice from WSC, MMA believes the population data provided by the demographer is the most dependable source.[57]

As with GCC, residential consumption is the most substantial component of WSC's metered water demand, with demand in this sector accounting for 74% of metered consumption in the 2003/04 financial year (see Figure 32). However, unlike GCC, commercial demand accounts for a sizeable portion of WSC's consumption with 23% of total metered consumption attributable to commercial uses in 2003/04.

56 Data forwarded to MMA by WSC, *Central Coast: Regional Profile & Social Atlas – Appendix B: Population Projections Wyong Shire.*

57 Information forwarded to MMA by WSC, *Clarification and further questions for Wyong City Council 221004.doc.*

Figure 32 – WSC 2004 metered consumption by customer segment

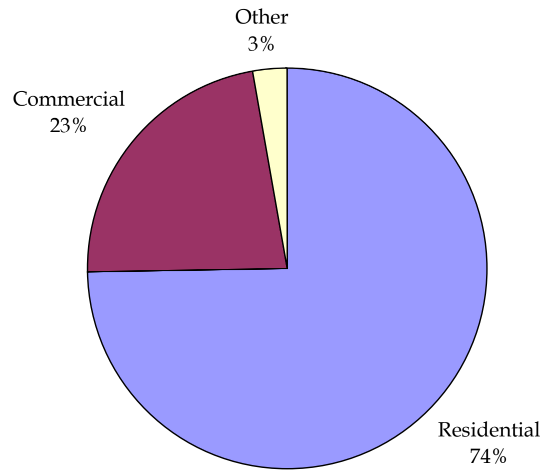
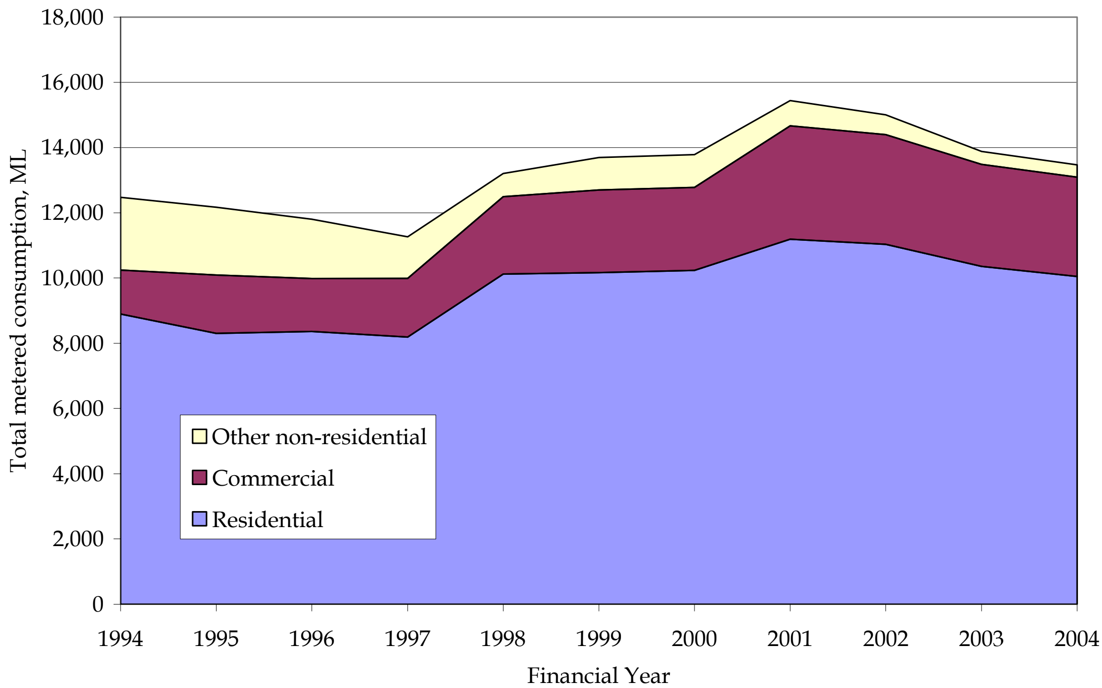


Figure 33 indicates that the relative importance of residential and non-residential consumption has remained fairly constant over the past decade. However, within the non-residential sector, commercial usage has increased in comparative importance. The increasing importance of commercial usage has been accompanied by decreasing usage in the "other" non-residential category, which mainly includes industrial customers (for example, coal mines and power stations).

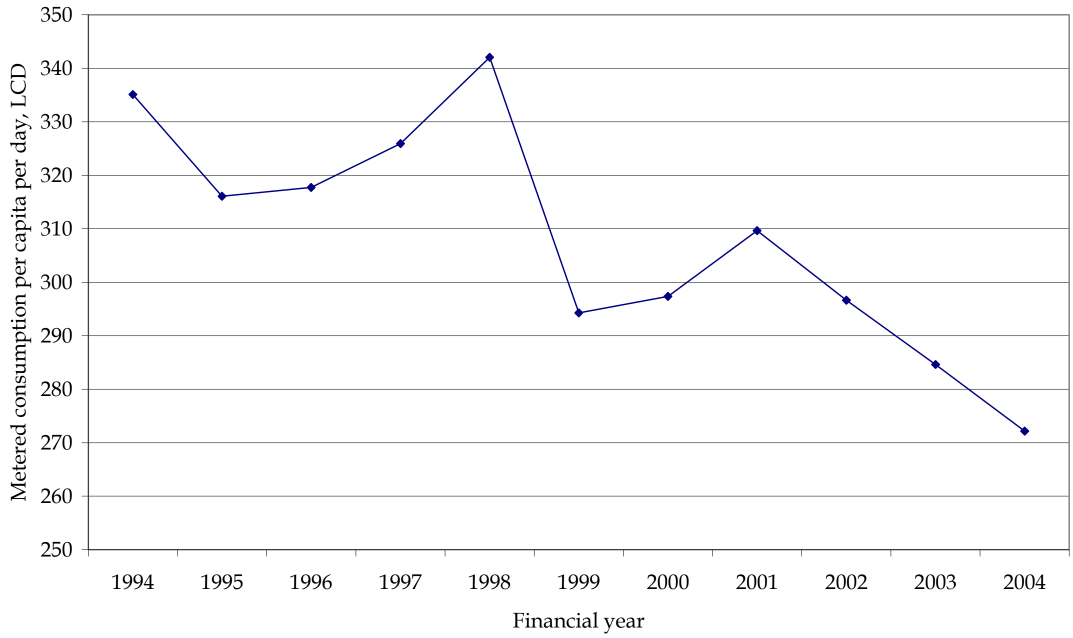
Figure 33 – WSC historic metered consumption by customer segment, ML



The timing of water restrictions in both GCC and WSC's areas is determined by the joint water authority. Hence, as for GCC, Level 1 water restrictions were implemented in the Wyong area in February 2002. This explains the fall in total metered demand from 2002 onwards.

Figure 34 shows the trend in metered consumption per capita per day (LCD) since 1994. There is no clearly observable upward trend in per capita metered consumption, therefore population growth is likely to have been the key driver causing increasing total metered consumption prior to 2001.

Figure 34 – WSC historic metered consumption per capita, LCD



6.2 REVIEW OF GCC AND WSC FORECASTS

6.2.1 Methods and assumptions

GCC and WSC use the same methodology for estimating future water demand. There are three components to the forecasting technique.

Firstly, the trend in unrestricted total water releases is estimated based on historical release data prior to the introduction of water restrictions and expected population growth rates. GCC has used historic data from 1997 and WSC has used data from 1996.

Next, projections of metered consumption are obtained by assuming a constant value for the percentage of unaccounted for water (14.2% for GCC and 7.4% for WSC). This method for estimating metered consumption is used because of irregularities encountered in meter readings and billing cycles.

Finally, estimated savings from water restrictions are subtracted from the unrestricted metered consumption forecast in order to arrive at the final estimate of future metered consumption.

Both GCC and WSC use 30 June 2002 as the starting point for demand projections. They state that this was the last year before the imposition of water restrictions.[58] However, Level 1 water restrictions commenced in February 2002, which clearly falls within the 2002 financial year.

Both agencies have calculated three different forecasts based on high, medium and low restriction scenarios. Details of the assumptions associated with each restriction regime are provided in Appendix C . For the purposes of the Tribunal's pricing submission, both agencies have used the medium restriction scenario.

6.2.2 GCC's forecast

The results of the first two components of GCC's forecast (forecast water releases and metered demand in the absence of water restrictions) are contained in Table 36.

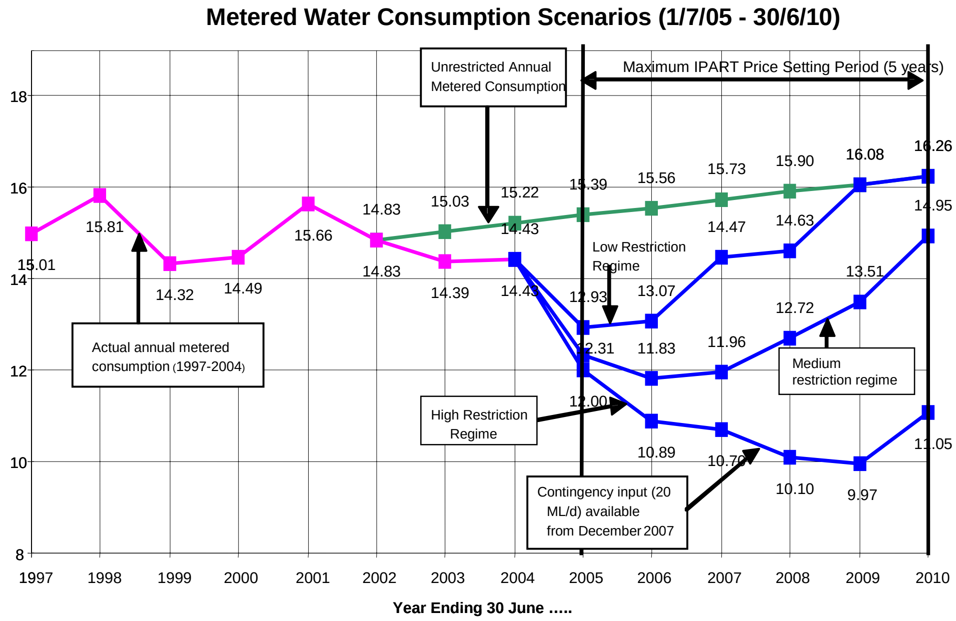
Table 36 – GCC forecasts in the absence of water restrictions

Year Ending	Estimated population growth rate (%)	Unrestricted annual demand (ML)	Metered unrestricted annual demand (ML)**
June 30 2002	1.3	17,289	14,834
June 30 2003	1.3	17,514	15,027
June 30 2004	1.3	17,741	15,222
June 30 2005	1.1	17,937	15,390
June 30 2006	1.1	18,134	15,559
June 30 2007	1.1	18,333	15,730
June 30 2008	1.1	18,535	15,903
June 30 2009	1.1	18,739	16,078
June 30 2010	1.1	18,945	16,255

Figure 35 shows GCC's final metered consumption forecast under each of the water restriction regimes.

[58] GCC, 2004, *Review of Water Consumption Forecasts for NSW Metropolitan Water Agencies*, September. WSC, 2004, *Review of Water Consumption Forecasts for NSW Metropolitan Water Agencies*, August.

Figure 35 – GCC forecasts for metered water demand



6.2.3 WSC's Forecast

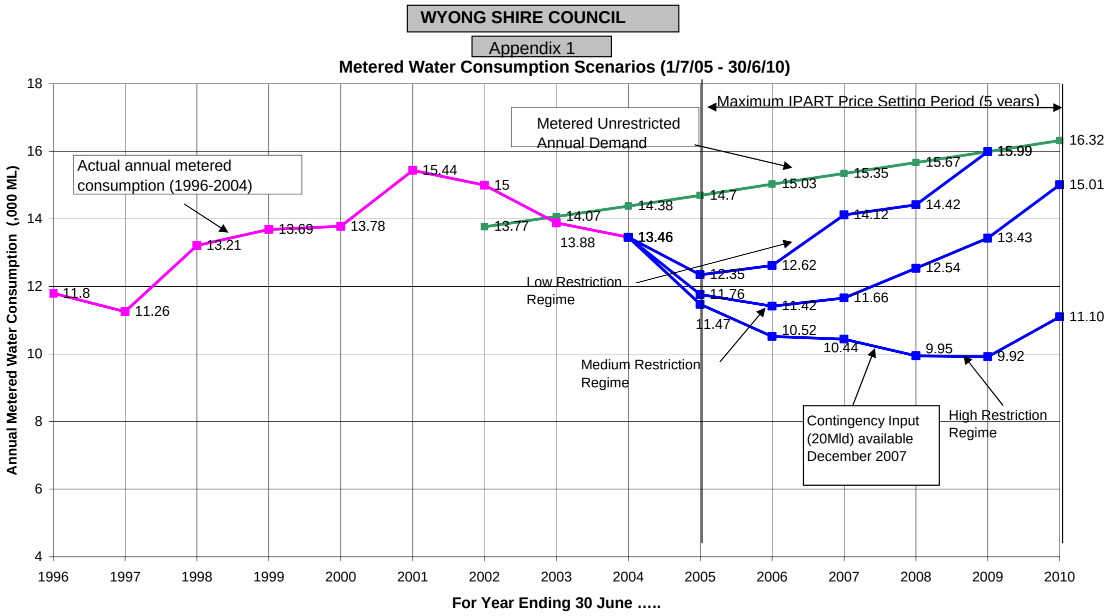
The results of the first two components of WSC's forecast (forecast water releases and metered demand in the absence of water restrictions) are contained in Table 37. [51]

Table 37 – WSC forecasts in the absence of water restrictions

Year ending	Estimated population growth rate (%)	Unrestricted annual demand (ML)	Metered unrestricted annual demand (ML)
June 30 2002	2.2	14,871	13,770
June 30 2003	2.2	15,198	14,073
June 30 2004	2.2	15,532	14,382
June 30 2005	2.20	15,880	14,704
June 30 2006	2.19	16,227	15,026
June 30 2007	2.14	16,575	15,348
June 30 2008	2.10	16,923	15,670
June 30 2009	2.06	17,271	15,993
June 30 2010	2.04	17,624	16,320

Figure 36 shows WSC's final metered consumption forecast under each of the water restriction regimes.[51]

Figure 36 – WSC forecasts for metered water demand, ML



6.3 MMA ANALYSIS

This section examines the robustness of the GCC and WSC forecasts. Whenever possible, MMA has produced an alternative forecast in cases where the assumptions used in the GCC/WSC forecasts are questionable.

In MMA's forecasts, the 2001 financial year is used as the base year since Level 1 water restrictions commenced on 24 February 2002 and therefore 2001 is the last full year before restrictions. By taking 2002 as their base year, GCC and WSC have included the impact of water restrictions in the base year.

6.3.1 Forecast water releases in the absence of demand management

GCC has stated that the data in its 2004 AIR shows that average metered usage per customer has been steady in the five years up to 2002.[59] The same assumption of constant per capita consumption is implicit in WSC's forecasts (see Table 37).

6.3.1.1 GCC historic trends in per capita consumption

If we limit our analysis of historical GCC data to the 1997 to 2002 financial years as per GCC's analysis, it does appear that historic metered consumption per capita has been fairly steady (see Figure 30). However, it is highly unlikely that five years' worth of annual data provides an adequate indication of historic consumption trends. Looking at

59 GCC, 2004, *Response to information request from MM Associates Pty Ltd for review of water consumption forecasts*, October 1.

the data from 1993 to 2001, it appears that there may actually have been a downward trend in metered consumption per capita.

In order to test this hypothesis, ordinary least squares regression analysis of metered consumption per capita was performed using the annual metered sales data in GCC's AIR and population figures based on demographer/DIPNR data. The regression equation for this analysis can be specified as follows:

$$\text{Metered consumption per capita} = \text{Constant} + b \times \text{annual trend}$$

The main results are summarised in Table 38.

Table 38 – Regression analysis of annual metered consumption per capita (1993 – 2001)

Variable	Statistic	Value
Constant	**Constant**	325.71
	T statistic	32.69
	p-value	6.48E-09
Trend coefficient	**Coefficient**	-1.25
	T statistic	-0.70
	p-value	0.50
Overall Model	**Observations**	9
	R^2	0.066
	Adjusted R^2	-0.067

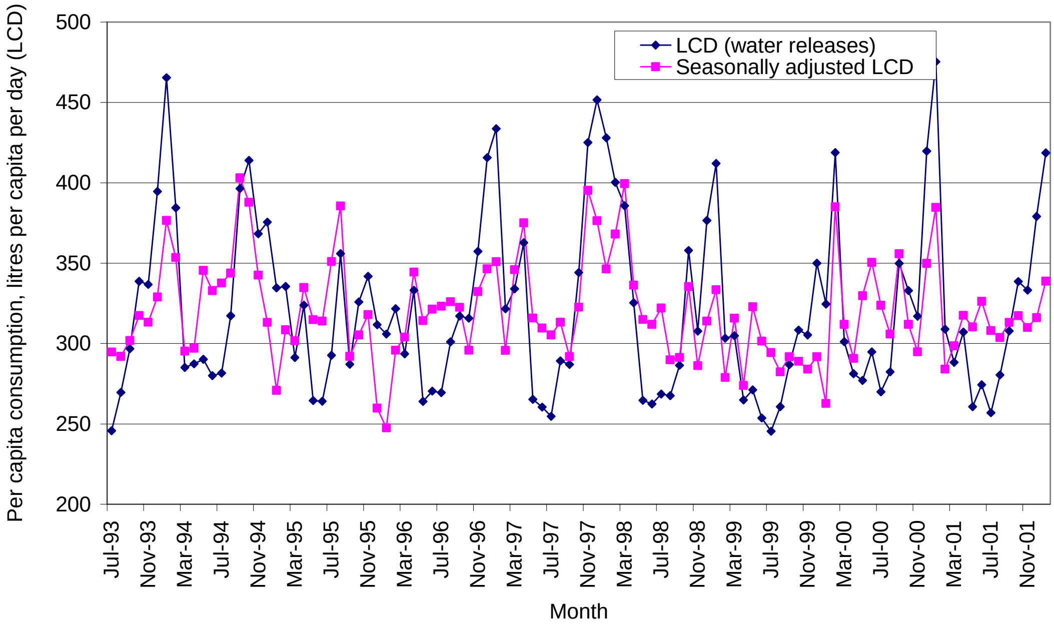
It is clear that regression analysis of annual metered consumption with only nine data points does not produce any clear trend.

As a second check of GCC's statement that historic consumption per capita has been constant, MMA performed a regression analysis on monthly water releases per capita using water release data in the 2004 AIR and demographer/DIPNR population data. Given that both agencies use water releases per capita to derive metered consumption per capita, it is highly pertinent to analyse water release data.

Since monthly data displays seasonal variation over a twelve month period, it is necessary to perform a seasonal adjustment on the data before proceeding to regression analysis. MMA performed a seasonal adjustment on the observed per capita data using the ratio to moving average method. Using this method, a "seasonal index" is calculated for each calendar month and the observed monthly data is divided by the applicable seasonal index in order to compute seasonally adjusted data. All available data points in the period prior to the implementation of water restrictions were included in the analysis (July 1993 to January 2002).

Figure 37 shows the observed and seasonally adjusted data.

Figure 37 – Historic water releases prior to the introduction of water restrictions, LCD



Regression results from the seasonally adjusted data are summarised in Table 39.

Table 39 – Regression analysis of seasonally adjusted monthly water releases per capita

Variable	Statistic	Value
Constant	**Constant**	326.22
	T	52.45
	p-value	4.35E-75
Trend coefficient	**Coefficient**	-1.38
	T	-1.11
	p-value	0.269
Overall model	**Observations**	103
	R^2	0.012
	Adjusted R^2	0.002

Note that for monthly data, the trend variable is redefined so that its coefficient provides an indication of the annual trend in per capita consumption.

$$\text{Trend} = \frac{\text{Observation number}}{12}$$

This definition of the trend variable is based on the method used by SWC.[60]

The negative sign of the trend coefficient indicates that there may be a decreasing trend in per capita consumption, however the trend coefficient is not statistically significant at conventional levels. Furthermore, the adjusted R^2 value indicates that the model uses is only able to describe 0.2% of the variation in LCD.

In an effort to improve the model fit to the observed data, MMA performed the analysis again, this time including three new variables. The new variables were chosen to represent the impact of any departures from long-term average climatic conditions and were defined as follows:

$\left(T_{i,j} - \overline{T}_i\right)$ = temperature (average of maximum daily temperature) in month i of year j minus the long-term (30 year) average temperature for month i

$\left(R_{i,j} - \overline{R}_i\right)$ = total rainfall in month i of year j minus the long-term (30 year) average total rainfall for month i

$\left(E_{i,j} - \overline{E}_i\right)$ = total evaporation in month i of year j minus the long-term (30 year) average total evaporation for month i

All weather data has been taken from the Peats Ridge weather station, being the closest station to Gosford with 30 years worth of historical data for all three weather variables.

The new regression equation including weather variables is defined as follows:

$$LCD_{i,j}^{SA} = a + b_1 \times \left(T_{i,j} - \overline{T}_i\right) + b_2 \times \left(R_{i,j} - \overline{R}_i\right) + b_3 \times \left(E_{i,j} - \overline{E}_i\right) + b_4 \times Trend_i$$

where

$LCD_{i,j}^{SA}$ = seasonally adjusted per capita water releases in month i of year j

$$Trend_i = \frac{Observation_i}{12}$$

The choice of weather variables has again been based on similar regression analysis performed by SWC.[60] The results of the regression analysis with the three weather variables are summarised in Table 40.

[60] SWC, 2004, *Recent trends in per capita demand*, October.

Table 40 – Regression analysis of seasonally adjusted per capita consumption including weather variables

Variable	Statistic	Value
Constant	**Constant**	321.51
	T	86.07
	p-value	3.85E-94
Trend coefficient	**Coefficient**	0.29
	T	0.36
	p-value	0.72
Temperature coefficient	**Coefficient**	8.87
	T	4.89
	p-value	3.99E-06
Rainfall Coefficient	**Coefficient**	-0.06
	T	-2.29
	p-value	0.02
Evaporation Coefficient	**Coefficient**	0.99
	T	5.87
	p-value	6.03E-08
Overall Model	**Observations**	103
	R^2	0.68
	Adjusted R^2	0.67

It is clear that the regression model is drastically improved when weather variables are included in the analysis. The new adjusted R^2 statistic indicates that the model is able to account for approximately 67% of the variation in seasonally adjusted water consumption per capita. The p-values also indicate that all the weather variables in the model are statistically significant. However, the p-value of the trend coefficient (0.72) is quite high, indicating that there is no statistically significant upward or downward trend in per capita consumption.

The regression results in Table 40 indicate that GCC's assumption of constant per capita demand is reasonable, however future demand forecasts can be improved by applying a weather correction to historical data.

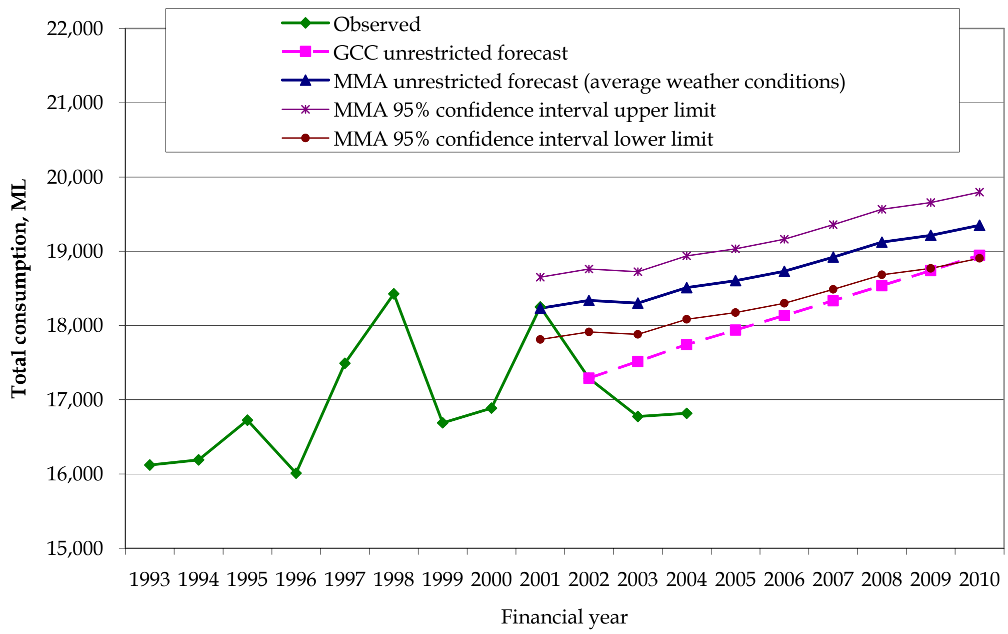
MMA's seasonally adjusted monthly forecasts of per capita consumption under average climate conditions were converted back to non-seasonally adjusted estimates and multiplied by forecast population levels (as forecast by demographer/DIPNR data), in order to arrive at forecast total annual demand, as shown in Table 41.

Table 41 – GCC and MMA forecasts for unrestricted total annual demand

Year ending	GCC's estimated population growth rate (%)	GCC's forecast unrestricted annual demand (ML)	Population (demographer / DIPNR estimate)	MMA's forecast LCD under average weather conditions	MMA's forecast unrestricted annual demand under average climate conditions (ML)
June 30 2001	-	-	155,361	322	18,232
June 30 2002	1.3	17,289	156,252	322	18,337
June 30 2003	1.3	17,514	155,956	322	18,302
June 30 2004	1.3	17,741	157,301	322	18,510
June 30 2005	1.1	17,937	158,526	322	18,603
June 30 2006	1.1	18,134	159,604	322	18,730
June 30 2007	1.1	18,333	161,236	322	18,921
June 30 2008	1.1	18,535	162,510	322	19,123
June 30 2009	1.1	18,739	163,723	322	19,213
June 30 2010	1.1	18,945	164,883	322	19,349

Figure 38 shows that MMA's weather corrected prediction results in consistently higher forecasts for total annual demand when compared with GCC's forecast. GCC's forecast does not fall within the 95% confidence interval for MMA's forecast until towards the end of the determination period.

Figure 38 – Comparison of GCC and MMA forecasts for total unrestricted annual demand, ML



The difference between the MMA and GCC forecasts appears to be quite large and warrants further explanation. The slopes of the two forecast lines are quite similar, so the difference primarily results from the different starting points of the forecasts. MMA's starting point is in 2001. The value used in this year is slightly higher than the observed value, because it represents the expected consumption under average climate conditions. GCC's decision to use 2002 as the base year for forecasting has had a considerable impact on the council's forecasts. If the 2001 base year had been used instead, the GCC forecast would be almost identical to MMA's forecast. The inclusion of a weather correction in MMA's forecast means that it is not as sensitive to the choice of base year as GCC's model.

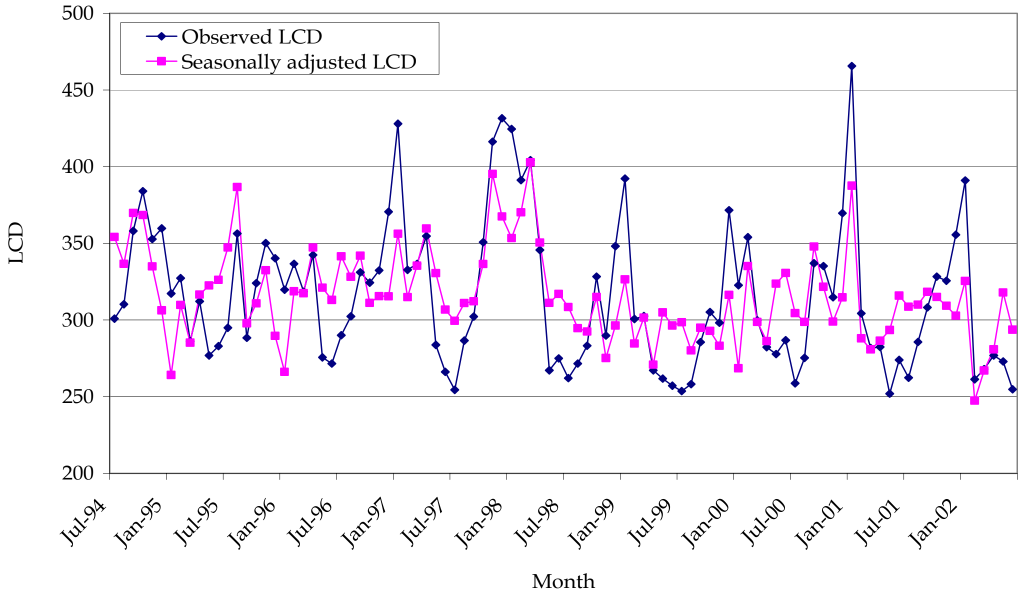
6.3.1.2 WSC historic trends in per capita consumption

MMA has assessed WSC's assumption of constant per capita demand using the same techniques as for GCC.

Figure 39 shows that, it is apparent that over the period considered in WSC's analysis (1996 to 2002), there is no clear trend in per capita consumption. However, if we consider the entire historical period over which unrestricted AIR data is available (1994 to 2001), it is possible that there is a decreasing trend in metered consumption per capita.

As with GCC's data, a regression analysis of seasonally adjusted monthly water release data (converted to per capita daily consumption) was performed in order to gain a better picture of any trends over time. This is shown in Figure 39.

Figure 39 – WSC per capita consumption prior to the introduction of water restrictions, LCD



In contrast to GCC, the results in Table 42 indicate that there is a statistically significant downward trend in per capita consumption in the Wyong area.

Table 42 – Regression analysis of seasonally adjusted WSC monthly water release data prior to the introduction of water restrictions

Variable	Statistic	Value
Constant	**Constant**	331.33
	t	55.58
	p-value	6.77E-71
Trend coefficient	**Coefficient**	-3.49
	t	-2.59
	p-value	0.01
Overall model	**Observations**	91
	R^2	0.07
	Adjusted R^2	0.06

After applying the same weather correction as was used for GCC, the regression results shown in Table 43 were obtained.

Table 43 – WSC regression analysis of seasonally adjusted per capita consumption including weather variables

Variable	Statistic	Value
Constant	**Constant**	330.19
	t	89.44
	p-value	1.22E-86
Trend coefficient	**Coefficient**	-2.51
	t	-2.73
	p-value	0.007
Temperature coefficient	**Coefficient**	9.15
	t	5.09
	p-value	2.05E-06
Rainfall coefficient	**Coefficient**	-0.05
	t	-1.68
	p-value	0.096
Evaporation coefficient	**Coefficient**	0.75
	t	4.41
	p-value	2.96E-05
Overall model	**Observations**	91
	R^2	0.68
	Adjusted R^2	0.66

In the case of WSC, the inclusion of a weather correction also drastically improves the regression model and leads to the conclusion that there is a highly statistically significant downward trend in per capita consumption. The regression results indicate an annual decrease of approximately 2.5 LCD in the seasonally adjusted data. This result is significantly different to what was seen for GCC, where there was no statistically significant trend in per capita consumption.

WSC has advised MMA that the perceived downward trend in per capita consumption should be treated with caution. There were a number of closures of industrial sites during the analysis period and this would have tended to decrease per capita consumption during the historical period. However, further declines in industrial load may not apply in the future so that using a downward trend may not be applicable in the future. As a result, MMA has performed a regression analysis of WSC's data again, this time taking out the trend variable so that the regression only accounts for departures from average climatic conditions. The results are presented in Table 44.

Table 44 – WSC regression results without the trend variable

Variable	Statistic	Value
Constant	**Constant**	321.59
	t	160.68
	p-value	2.1E-109
Temperature coefficient	**Coefficient**	7.29
	t	4.23
	p-value	5.72E-05
Rainfall coefficient	**Coefficient**	-0.04
	t	-1.54
	p-value	0.128
Evaporation coefficient	**Coefficient**	0.96
	t	6.12
	p-value	2.62E-08
Overall model	**Observations**	91
	R^2	0.65
	Adjusted R^2	0.64

A comparison of Table 43 and Table 44 shows that removing the trend variable only has a minor impact on the overall model performance in terms of the adjusted R^2 statistic (0.64 instead of 0.66).

MMA has used the model with a trend included as the basis for forecasting water consumption. This is based on the fact that it is possible that there may be further industrial and/or commercial closures over the Tribunal's determination period. In addition, even in the absence of water restrictions, consumption by WSC's main commercial and industrial customers is likely to decrease as a result of water audits and greater awareness of the need for water efficiency. This is discussed further in Section 6.3.3.

However, future water consumption with no downward trend in consumption are also derived to show the impact of assuming a declining trend in the LCD (see Figure 40).

The WSC and MMA forecasts for unrestricted total annual demand are provided in Table 45.

Table 45 – WSC and MMA forecasts for unrestricted total annual demand

Year Ending	WSC's estimated population growth rate (%)	WSC's forecast unrestricted annual demand (ML)	Population (WSC demographer estimate)	MMA's forecast LCD under average weather conditions	MMA's forecast unrestricted annual demand under average climate conditions (ML)
June 30 2001	-	-	134,424	313	15,364
June 30 2002	2.2	14,871	137,353	311	15,573
June 30 2003	2.2	15,198	140,367	308	15,786
June 30 2004	2.2	15,532	143,492	306	16,050
June 30 2005	2.2	15,880	146,742	303	16,235
June 30 2006	2.19	16,227	150,146	301	16,474
June 30 2007	2.14	16,575	152,886	298	16,635
June 30 2008	2.10	16,923	155,999	296	16,877
June 30 2009	2.06	17,271	159,175	293	17,028
June 30 2010	2.04	17,624	162,407	291	17,226

Figure 40 – Comparison of WSC and MMA forecasts for total unrestricted annual demand

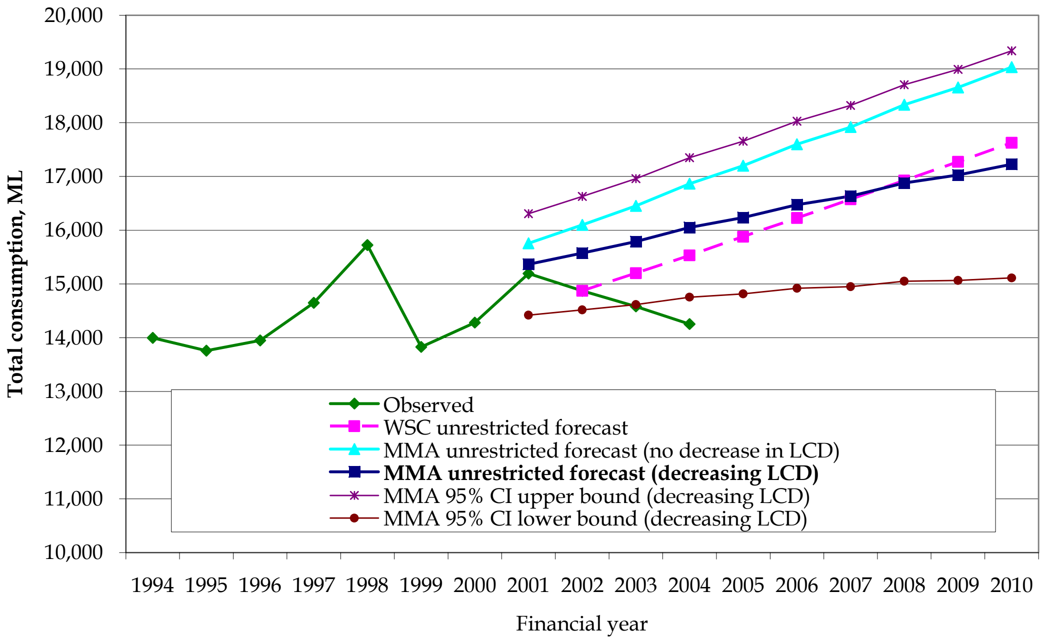


Figure 40 shows that MMA's weather corrected model, which allows for a decreasing trend in per capita consumption, predicts a lower total consumption than WSC's model from 2007 onwards. WSC's forecast falls within the 95% confidence interval for MMA's forecast throughout the determination period.

If MMA was to adopt the same assumption as WSC of constant per capita demand, the weather corrected forecast would be significantly higher than WSC's estimates throughout the determination period (represented by the light blue line in Figure 40).

As in the case of GCC, WSC's decision to use 2002 as the base year has had a noticeable impact on the final forecasts.

6.3.2 Forecast metered consumption in the absence of water restrictions

GCC converts forecast total consumption to forecast metered consumption by subtracting a constant rate of 14.2%, representing unaccounted for water, from total consumption which is total releases as discussed in Section 6.3.1. In WSC's, case the figure is 7.4% Using this methodology, unaccounted for water in both the GCC and WSC forecasts consists of leakages and authorised unmetered consumption such as use in council parks and facilities. The joint water authority has chosen to adopt this method because of difficulties in obtaining accurate metered consumption data due to an irregular meter reading cycle.

GCC's estimate of 14.2% for unaccounted for water is based on the average unaccounted for water calculated from total water releases and approximate total metered consumption in the eight years from 1997 to 2004. This is shown in Table 46.

Table 46 – Data used by GCC to estimate unaccounted for water

Year ending	Metered consumption (ML)	Total consumption (ML)	Unaccounted for water* %	Smoothed metered consumption (ML) total less 14.2% UAW
June 30 1997	15,124	17,490	13.5	15,006
June 30 1998	16,428	18,426	10.8	15,810
June 30 1999	14,689	16,689	12.0	14,319
June 30 2000	15,634	16,888	7.4	14,490
June 30 2001	17,051	18,250	6.6	15,659
June 30 2002	14,583	17,289	15.6	14,834
June 30 2003	13,226	16,774	21.2	14,392
June 30 2004	12,332	16,817	26.7	14,429
			Average 14.2	

WSC's estimate of 7.4% for unaccounted for water is based on the average unaccounted for water calculated from total water releases and approximate total metered consumption in the nine years from 1996 to 2004. This is shown in Table 47.

Table 47 – Data used by WSC to estimate unaccounted for water

Year Ending	Metered Consumption (ML)	Total Consumption (Releases) ML)	Unaccounted for Water %
June 30 1996	11,803	13,950	15.4
June 30 1997	11,261	14,648	23.1
June 30 1998	13,209	15,722	16.0
June 30 1999	13,692	13,827	1.0
June 30 2000	13,779	14,279	3.5
June 30 2001	15,440	15,192	-1.6
June 30 2002	15,000	14,871	-0.9
June 30 2003	13,880	14,583	4.8
June 30 2004	13,467	14,254	5.5
			Average 7.4%

The data in Table 46 and Table 47 clearly shows that the calculated unaccounted for water has varied significantly in each year. There are roughly three meter readings in each financial year, however, irregular meter reading intervals mean that there can be slightly more than, or slightly less than, three readings in any given year. As a result, the figures for observed annual metered demand are not very accurate, which leads to inaccuracies in the calculated unaccounted for water.

Given the data accuracy problems experienced by both GCC and WSC, it is very difficult for MMA to assess their assumptions regarding constant levels of unaccounted for water. As previously stated, unaccounted for water in the joint water authority forecasts represents leakages and authorised unmetered consumption. Assuming a constant rate therefore involves certain assumptions about these two components of unmetered consumption. For example, leakage rates may or may not be constant depending on a number of factors such as pipeline age and maintenance practises. Drier soils may have led to an increase in the frequency of cracking of older pipes in recent years. Similarly, any changes in leakage rates may or may not be accompanied by changes in authorised unmetered consumption rates. For example, watering of parks and gardens (classified as unmetered consumption) may have increased during the last three years.

Overall, GCC's figure of 14.2% seems quite reasonable when contrasted with the average leakage rates observed by other water agencies around the world. According to information in SWC's Water Conservation & Recycling Implementation Report, worldwide leakage rates can vary from 4% of total demand in extremely well maintained systems, to 60% in very poorly maintained systems.[61] In the same report, SWC's also states

61 SWC, 2003, *Water Conservation & Recycling Implementation Report 2002-2003.*

that a leakage rate of 10.7% of demand corresponds with leakage rates in the lower third of countries around the world. This tends to indicate that GCC's estimate of 14.2% for total unaccounted for water is not unrealistic, however this does of course depend on the contribution of authorised unmetered consumption to overall unaccounted for water in the Gosford area. GCC has advised MMA verbally that watering of council parks and gardens typically consumes a constant level of around 1 GL per annum, which represented approximately 6% of total annual demand in 2003/04. This corresponds with a leakage rate of around 8.2%, which seems quite reasonable.

In contrast to GCC, WSC's estimate of 7.4% for unaccounted for water seems to be quite low. Given that the most efficient water agencies in the world can still expect to see leakage rates of at least 4%, it appears unusual that the combined leakage and unmetered consumption rates in Wyong could be as low as 7.4%. WSC has advised MMA that the low rate of leakage is due to the very young age of the system. Most of Wyong has only been developed over the last two decades and hence a large part of the piping system is relatively new. If this is taken into account, a rate of 7.4% for unaccounted for water may be feasible.

MMA's forecasts for unrestricted metered consumption have been based on the same assumptions used by GCC and WSC for unaccounted for water. The forecasts are presented in Table 48 and Table 49.

Table 48 – MMA's forecast for GCC's unrestricted metered consumption, ML

Financial year	Unrestricted total demand, (ML)	Unaccounted for water, (ML)	Unrestricted metered demand, (ML)
2001	18,232	2,589	15,643
2002	18,337	2,604	15,733
2003	18,302	2,599	15,703
2004	18,510	2,628	15,882
2005	18,603	2,642	15,962
2006	18,730	2,660	16,070
2007	18,921	2,687	16,235
2008	19,123	2,715	16,408
2009	19,213	2,728	16,485
2010	19,349	2,748	16,602

Table 49 – MMA's forecast for WSC's unrestricted metered consumption, ML

Financial year	Unrestricted total demand, (ML)	Unaccounted for water, (ML)	Unrestricted metered demand, (ML)
2001	15,364	1,137	14,227
2002	15,573	1,152	14,421
2003	15,786	1,168	14,618
2004	16,050	1,188	14,863
2005	16,235	1,201	15,034
2006	16,474	1,219	15,255
2007	16,635	1,231	15,404
2008	16,877	1,249	15,628
2009	17,028	1,260	15,768
2010	17,226	1,275	15,951

6.3.3 Large customers

Both GCC and WSC provided historical water consumption and contact details for its top 20 large customers. These customers represent a number of industries ranging from electricity production and food manufacturing to building construction and large commercial corporations.

MMA was only able to interview six large customers from both councils. The main usage of water by these large customers is for:

- manufacturing processes
- cleaning
- cooling towers.

Based on the information provided by these customers and both councils, it appears that large customers are either implementing internal water conservation programs or are exploring ways to minimise their water consumption. Two of the six customers interviewed indicated that they had recently undertaken water audits and that they would be implementing some of the recommendations to conserve water usage.

For GCC’s 20 largest customers, it is estimated that the total consumption over the next five years will be at the same level as their average consumption over the last three years, that is approximately 1,320 ML/a. Similarly, for WSC, the estimated consumption is approximately 2,000 ML/a.

6.4 FORECASTS – GCC AND WSC DEMAND MANAGEMENT PROGRAMS

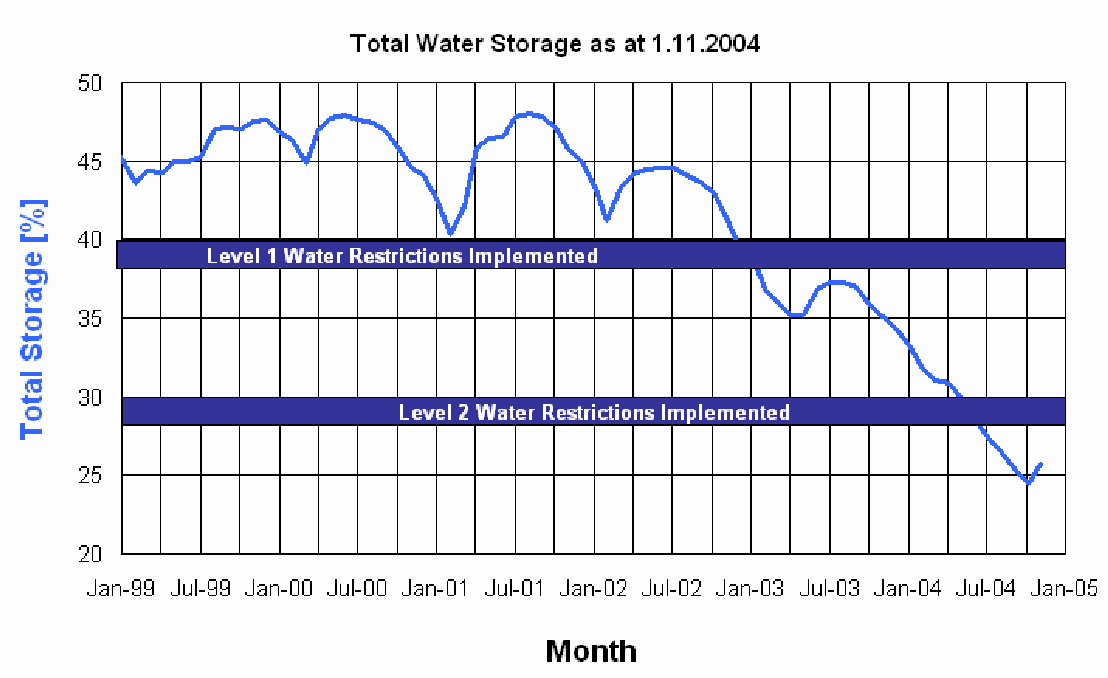
6.4.1 Context

The DM activities of GCC and WSC are considered together as the councils have a long-standing agreement to construct, operate, maintain and share the costs of a joint water supply system and thus have a common supply perspective and approach to DM. This is done through the Gosford-Wyong Councils' Central Water Authority (GWCWA).

The Central Coast region covered by the councils is currently in the grips of a severe drought. As a result, the total water storage available for the councils has reduced steadily from about 45% three years ago, to 25% in October 2004.

The storage situation is shown in Figure 41.

Figure 41 – Water storage for the Central Coast councils



Source: GWCWA, http://www.gwcwater.nsw.gov.au/status_current.htm. Last accessed: 9 Dec 04.

The councils have developed a three-pronged response to the dire situations. It comprises:

- increasingly severe water restrictions
- exploring alternative supply options including supply from HWC and consideration of a desalination plant
- a proposal for significant price increases.

The councils have also developed the outline of a conventional DM program, however, this is not yet fully articulated and is also considered to be subordinate to the targets set for the mandatory restrictions.

6.4.2 Water restrictions

GCC and WSC use identical methods to estimate the impact of future water restrictions and these assumptions are based on the recommendations of the GWCWA.

The GWCWA estimates future savings from water restrictions based on the assumed savings achieved at each water restriction level and the likely timing and level of future restrictions. As previously mentioned, three forecasts based on low, medium and high restrictions scenarios are produced. Details of the three restriction scenarios are available in Appendix C . In their submissions to the Tribunal, the medium restriction scenario is used.

The Councils have in place guidelines for instituting mandatory restrictions. These are shown in Table 50.

Table 50 – Guidelines for the imposition of water restrictions in GCC and WSC

	Trigger, when total storage level is:	Restriction off when total storage is:	Targeted reduction from normal usage
None	>=40%		
Level 1	<=40%	>=47%	8%
Level 2	<=30%	>=40%	16%
Level 3	<=22%	>=30%	24%
Level 4	<=17%	>=22%	32%
Level 5	<=12%	>=17%	38%

Source: GCC and WSC. Note that during March and April 2% is subtracted from triggers and during September and October 2% is added to triggers.

Table 50 also provides the targeted impacts of each level of restriction. Level 1 is targeted to reduce average load by 8%, Level 2 by 16% and so on. These target levels are discussed further in Section 6.4.3.

Details about the key components of the different levels of restrictions are provided in Table 51.

Table 51 – Restriction requirements, abridged version

	Level 2A	Level 3	Level 4	Level 5
Garden sage	Hand held hose half hour/day, alternate days, fixed times. No fixed hoses, sprinklers	Cans or non potable (NP)	NP	NP
Swimming pools existing and new	Emptying, refilling, topping allowed. Filling new allowed	Not from town water	Not from town water	Not from town water
Hosing hard surfaces	No	No	No	No
Sports grounds	Restricted times and hours	NP	NP	NP
Bowling greens, etc	Restricted times and hours	Permit only	Permit only	Permit only
Nurseries, etc	Restricted times and hours	Permit only	Permit only	Permit only
Washing vehicles	Bucket not hose	Bucket not hose	Banned	Banned
Washing boats	10 minute limit	Banned	Banned	Banned
Maximum residential use	Unrestricted, voluntary target 190 l/person/day	Unrestricted, voluntary target 170 l/person/day	Unrestricted, voluntary target 140 l/person/day	Restricted. Penalties for > 130 l/person/day
Commercial and industrial reduction targets (sector as a whole)	< 5%	10%. Larger consuming businesses to be audited or prepare a water management plan	10%	20%
Government reduction target	10%	15%	20%	25%

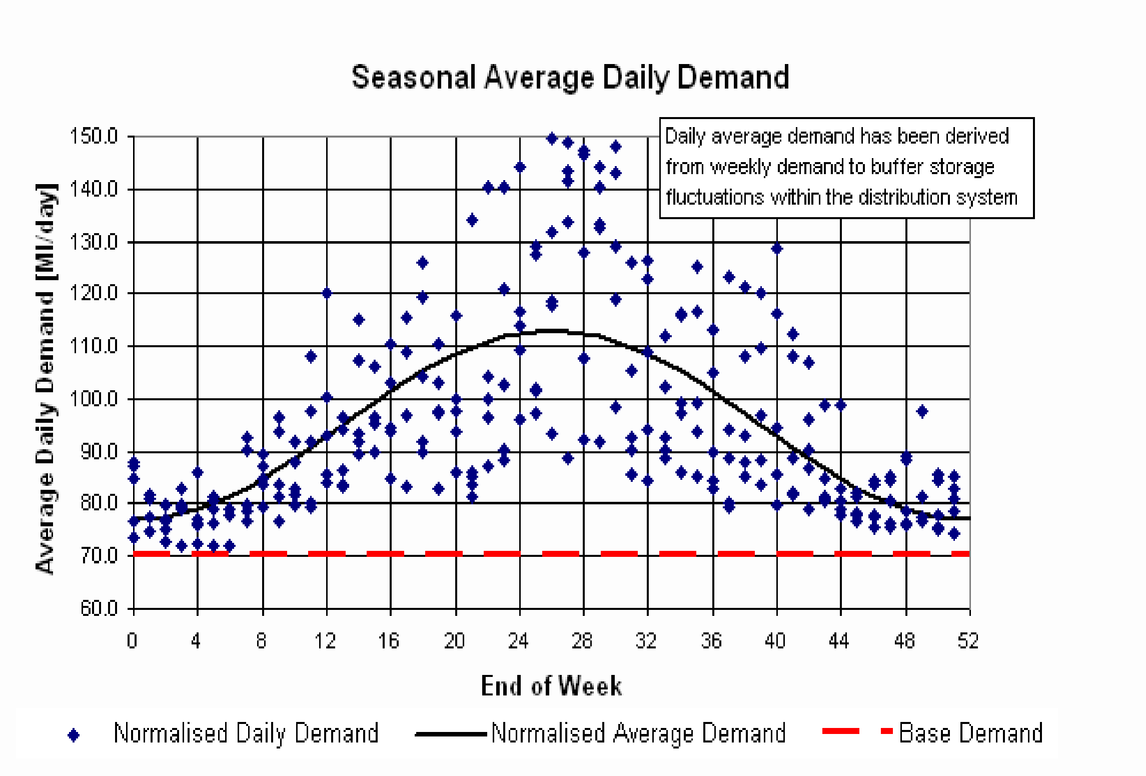
Source: GCC and WSC. Note that this is an abridged version with details omitted.

As expected, the degree of restriction becomes increasingly onerous as the storage level approaches critical levels.

6.4.3 Basis of the targets

While the basis of the target reductions for each level is unclear, MMA believes it has been based on an analysis of weekly usage which separated out the seasonal from the base load. A reproduction of the seasonal average daily demand produced is provided in Figure 42.

Figure 42 – Normalised daily demand over a year, ML/d



Source: GWCWA, Technical advisory group summary advice Annexure E

The average demand derived from the above analysis was about 95 ML/d. The lowest daily values, the base values, were about 72 ML/d. The base value divided by the average value gave a value of 76%. From this it appears to have been deduced that totally removing external usage through restrictions would result in a reduction in total load by about 24%. This would be achieved through increasingly stringent Level 1, 2 and 3 restrictions. It is unclear how the target reductions for Levels 4 and 5 were calculated, however, it is clear that significant reduction in internal residential use and industrial, commercial and government use would be required.

6.4.4 Application of restrictions, results and forecast restriction requirements

Level 1 restrictions were introduced in February 2002 and were in place until May 2004. According to analysis by GWCWA, they achieved a seasonally adjusted average demand reduction of 11%.

Level 2 restrictions were introduced in May 2004 and were in place until August 1 2004. According to analysis by GWCWA, they achieved a seasonally adjusted average demand increase of 3%.

Level 2A restrictions were introduced on 1 August 2004. Preliminary analysis by MMA suggests that they have achieved a seasonally adjusted demand reduction of between 10% and 20%.

The councils have expressed the opinion that Level 3 restrictions will need to be imposed by the end of 2004. The medium demand forecast case put forward by the councils then assumes that Level 3 restrictions will remain in place until December 2007, with Level 2A restrictions for another 1.5 years and then Level 1 restrictions until the end of June 2010.

6.4.5 Price increases

Both councils have proposed very significant real price increases to apply over the period 2004/05 to 2008/09, with no further real increases in 2009/10. The scale of the price increases for the end-users is provided in Table 52.

Both councils have sought pricing which would result in bills for an average residential customer (with a usage of about 183 kL for WSC and 187 kL for GCC per annum) increasing in real terms by about 25% to 30% over the period. This assumes the average usage does not change.

WSC and GCC have both argued that in fact the average bill will not increase by anywhere near this level as the restrictions will result in average usage falling significantly. According to MMA's analysis, even if the average usage fell by 25%, the average end-user would still face bill increases in the order of 15% in real terms.

Table 52 – Average bill increases proposed for various sized end-users between 2005 and 2010

Gosford	250 kL	230 kL	187 kL	120 kL
Average real price increase	35%	33%	30%	23%
Marginal real price increase	99%	99%	99%	99%
Wyong	**250 kL**	**230 kL**	**183 kL**	**120 kL**
Average real price increase	30%	28%	24%	18%
Marginal real price increase	91%	91%	91%	91%

Source: AIR and SIR

6.4.6 Other DM programs

The councils have mentioned a range of other DM programs which are either being implemented or under consideration.

They include:

- retrofits
- audits and water plans for large users
- increasing use of bore and groundwater
- reducing use at fish tables
- recycling
- rebates for rainwater tanks, etc
- reduced water use for irrigation.

The councils have also had analysis carried out of the levels of retrofits and additional rebates required to achieve significant internal demand reductions.

6.4.7 MMA analysis

The councils have an overriding imperative to reduce water usage. This will be achieved mainly through mandatory restrictions of increasing stringency, together with a significant price increase aided by DM programs as required. However, the real driver is the restrictions. If they do not achieve the required savings then the water restrictions will get tougher. The approach taken by the councils is summed up in the quote from a meeting between representatives of the councils and MMA, "We have no choice but to make the restrictions work". MMA accepts this to be the case.

MMA's understanding of the rationale behind the targets for the different levels of restrictions has been provided in Section 6.4.3. Level 1, 2 and 3 restricting obviously aim for the external market.

The councils have provided information which suggests that the average external residential usage on the Central Coast is about 28% of total usage. This is reasonably consistent with findings in Sydney. Given that residential customers make up 75% of end-use in WSC and over 85% in GCC, and that external use typically also makes up some 10 – 20% of demand from commercial and institutional end-users, it appears reasonable to assume that eliminating all external use would reduce demand by between 15% and 25%. Although results to date have been variable, MMA considers a figure of about 20% to be realistic and achievable with enforced Level 3 restrictions.

Price is also likely to have an impact. Given an elasticity of -0.13, the reduction in residential demand due to price increases alone would in the absence of other measures, be expected to lie between about 4% (average price) and 12% (marginal approach). Even though the elasticity may be muted by the mandatory restrictions, there is still expected to be some impact on internal usage – especially when the councils are going out of their way to facilitate this.

Overall, MMA considers that the combination of the price increases proposed and Level 3 restrictions and facilitation by councils may well achieve the 24% targeted by GCC and

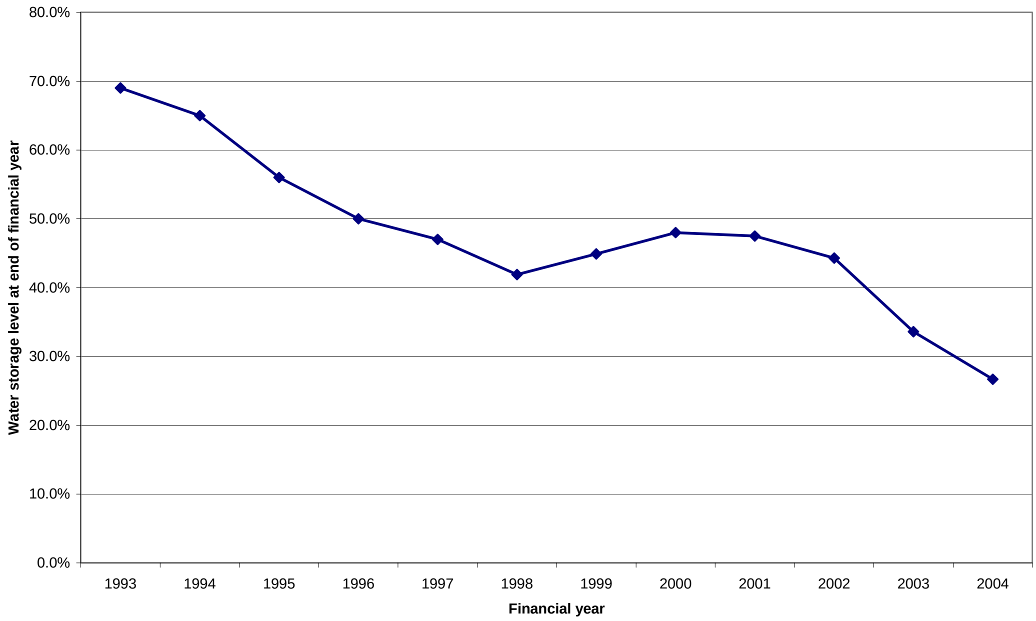
WSC. If the price increase is significantly lower, then a figure closer to 20% may be more realistic.

The difficulty then is deciding what level of restrictions to assume over the pricing period. This is a very difficult question to answer. The councils have in their medium forecasts assumed that Level 3 restrictions will be in place for three years, from January 2005 to December 2008, followed by lesser restrictions to 2010. Given high or even normal levels of rain, we would expect that the restrictions could be lifted at an earlier date. Conversely, given lower than average rain, restrictions could last longer and be more stringent.

The actual timing of future water restrictions will be based on the GWCWA guidelines provided in Table 50. The assumed timing of future water restrictions is therefore dependent on the GWCWA's assumptions regarding the rate at which storage levels are able to recover.

Figure 43 shows GCC's historic water storage levels at the end of each financial year since 1993.

Figure 43 – GCC historic water storage levels, %

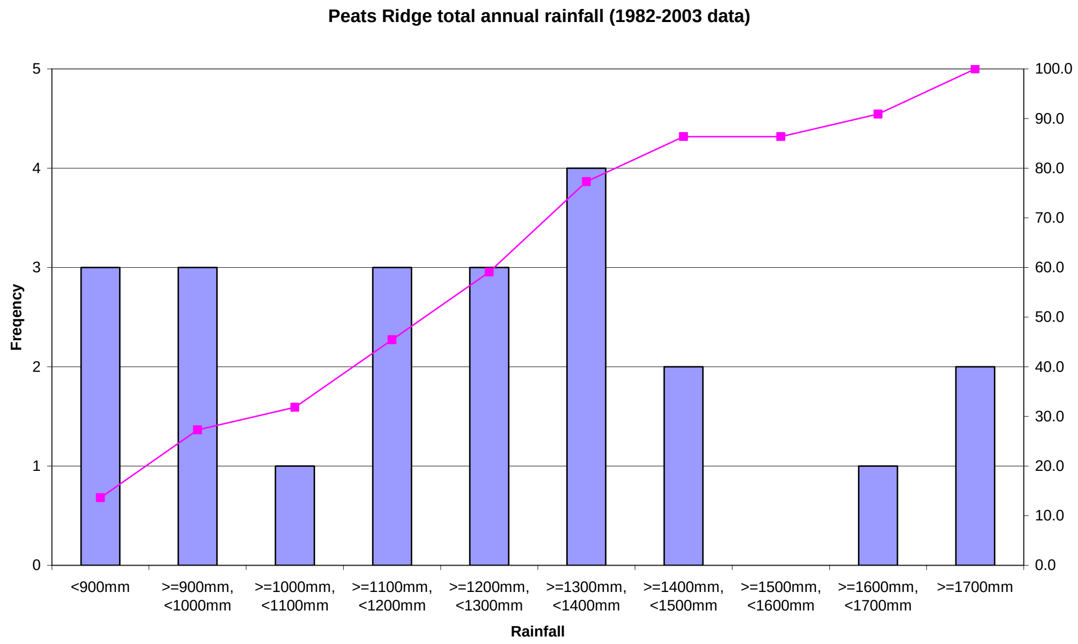


Current storage levels are in the range of 25-30%. However, apart from the past few months, the trend over the past few years has been for a steady decline in storage levels, as shown in Figure 43. The summer period typically results in storage reduction. In the medium restriction scenario, the GWCWA has assumed that storage levels will remain between 23% and 30% until December 2004, after which they will fall to between 18% and 22%. It has then been assumed that water storage will not recover to higher levels until a contingency input is available in December 2007.

MMA's has assessed the validity of GWCWA's assumptions regarding future restriction timing by estimating future water storage levels based on average annual rainfall and forecast total consumption.

A histogram of annual rainfall patterns at the Peats Ridge weather station is shown in Figure 44.

Figure 44 – Histogram of Peats Ridge rainfall



The observed average annual rainfall from 1982 to 2003 was 1,248 mm. Assuming average rainfall patterns over the determination period, MMA was able to produce estimates for GWCWA's water storage levels over the period. The results are shown in Table 53.

Table 53 – MMA's estimate of future GWCWA storage levels assuming average annual rainfall

Year	2004	2005	2006	2007	2008	2009	2010
Total storage capacity, (ML)	202,000	202,000	202,000	202,000	202,000	202,000	202,000
Storage level at start of year, (%)	30.2%	21.4%	26.2%	31.5%	36.8%	41.1%	44.7%
Opening storage level, (ML)	60,903	43,127	52,874	63,727	74,302	83,104	90,250
Actual/Forecast GCC total consumption, (ML)	16,696	14,765	14,129	14,286	15,208	16,062	17,732
Actual/Forecast WSC total consumption, (ML)	14,532	12,922	12,452	12,573	13,424	14,225	15,761
Actual/Forecast total combined consumption, (ML)	31,228	27,687	26,581	26,860	28,632	30,288	33,493
Average annual rainfall, (mm)	1247.8	1247.8	1247.8	1247.8	1247.8	1247.8	1247.8
Actual/expected inflow, (ML)	13,452	37,434	37,434	37,434	37,434	37,434	37,434
Storage level at year end, (ML)	43,127	52,874	63,727	74,302	83,104	90,250	94,191

The results in Table 53 indicate that GWCWA's assumptions regarding the timing of future restrictions under the medium restriction scenario are quite reasonable. However, any significant departure in annual rainfall levels from average values would of course vary this result.

Given the level of uncertainty, both WSC and GCC have recommended that either a short pricing period be adopted or that interim determinations be allowed.

MMA has produced two restricted forecasts for each of the agencies. The first forecast assumes the same restriction savings, timing and duration as GWCWA's medium case. The second case assumes storage levels recover faster than anticipated in GWCWA's medium case, therefore there is no need to impose Level 3 restrictions. MMA's second scenario corresponds with higher than average rainfall levels. The two sets of MMA forecasts are contrasted with the GCC and WSC forecasts in Table 54, Table 55, and Figure 45 and Figure 46.

Table 54 – MMA's restricted metered consumption forecast for GCC

Year	Unrestricted metered consumption, ML	Savings from water restrictions and DM programs (scenario 1), ML	Final Metered Consumption (scenario 1), ML	Savings from water restrictions and DM programs (scenario 2 - no level 3 restrictions), ML	Final Metered Consumption (scenario 2), ML
2001	15,643	0	15,643	0	15,643
2002	15,733	438	15,295	438	15,295
2003	15,703	1,256	14,447	1,256	14,447
2004	15,882	1,423	14,458	1,423	14,458
2005	15,962	3,187	12,775	2,554	13,408
2006	16,070	3,857	12,213	2,571	13,499
2007	16,235	3,896	12,338	2,598	13,637
2008	16,408	3,285	13,123	2,625	13,782
2009	16,485	2,638	13,847	2,638	13,847
2010	16,602	1,328	15,274	1,328	15,274

Table 55 – MMA's restricted metered consumption forecast for WSC

Year	Unrestricted metered consumption, ML	Savings from water restrictions, ML	Forecast metered consumption (case 1), ML	Savings from water restrictions without Level 3 restrictions imposed, ML	Forecast metered consumption (case 2), ML
2001	14,227	0	14,227	0	14,227
2002	14,421	401	14,019	401	14,019
2003	14,618	1,169	13,449	1,169	13,449
2004	14,863	1,332	13,531	1,332	13,531
2005	15,034	3,002	12,032	2,405	12,628
2006	15,255	3,661	11,594	2,441	12,814
2007	15,404	3,697	11,707	2,465	12,939
2008	15,628	3,129	12,499	2,501	13,128
2009	15,768	2,523	13,245	2,523	13,245
2010	15,951	1,276	14,675	1,276	14,675

Figure 45 – MMA and GCC metered consumption forecasts, ML

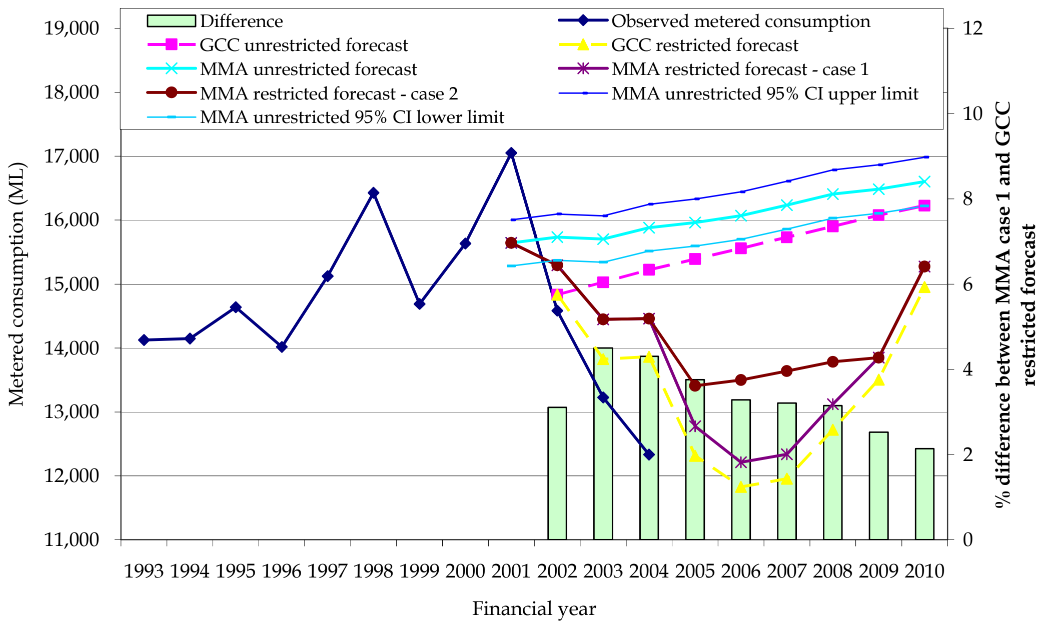
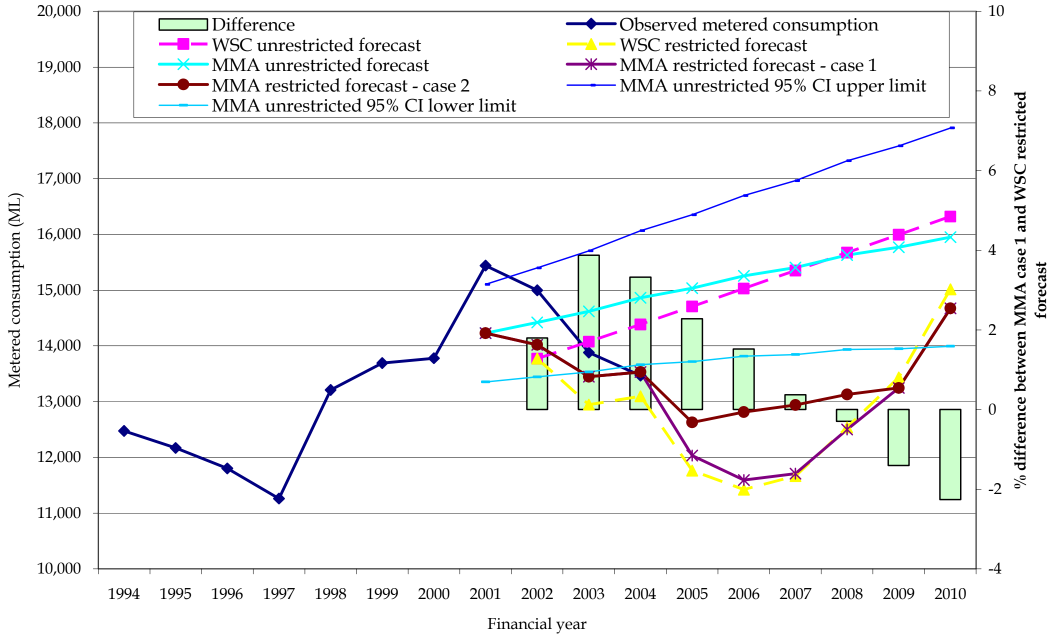


Figure 46 – MMA and WSC metered consumption forecasts, ML



MMA's case 1 restricted demand forecast is between 2% and 5% higher than GCC's forecast. The primary driver of the disparity in forecasts is the significant difference between total unrestricted annual demand estimates.

In the case of WSC, MMA's case 1 forecast ranges from between 2.3% lower to 3.9% higher than WSC's estimates.

It must be noted that MMA's forecasts are sensitive to changes in population data and it was quite difficult to obtain accurate population estimates because of the discrepancies between various data sources.

6.5 SUMMARY

This section summarises the areas of concern that MMA has noted in the GCC and WSC demand forecasts.

6.5.1 Base year

Both GCC and WSC have used 2002 as the starting point for demand projections. However, much of the 2002 financial year was impacted by water restrictions. MMA therefore believes that 2001 should be used as the base year, as it excludes any impact of water restrictions. If GCC and WSC had used 2001 as the base year, the resulting demand forecasts would have been noticeably higher.

6.5.2 Assumption of constant per capita demand

Both agencies have assumed constant per capita demand and based future unrestricted total demand projections entirely on expected population growth rates. MMA has shown that this assumption seems reasonable, however, for WSC there is a possibility of decreasing per capita consumption.

6.5.3 Failure to account for weather conditions

No weather correction has been included in the GCC or WSC forecasts. MMA has shown that including weather variables results in a significantly improved model.

6.5.4 Assumed level of unaccounted for water

MMA believes that GCC's estimate of unaccounted for water is feasible based on typical leakage rates experienced by other agencies around the world.

WSC's estimate of unaccounted for water seems quite low, but may be feasible given the very young age of the WSC system.

6.5.5 Assumed demand reductions under Level 1, 2/2A and 3 water restrictions

MMA believes the GWCWA has used a realistic estimate for achievable savings under a combination of Level 3 restrictions (with a virtual prohibition of external use), the significant price increases proposed and DM activity. Within this, it is not clear how the Level 1 and Level 2 target levels have been set, but these do not appear unreasonable.

6.5.6 Assumed duration of low water storage levels

Assuming average rainfall levels occur over the determination period, MMA believes GWCWA's assumptions regarding future water storage levels are quite reasonable.

7 SYDNEY CATCHMENT AUTHORITY

7.1 OVERVIEW

Sydney Catchment Authority (SCA) was established in July 1999 after the inquiry into the Sydney water contamination incident in 1998. SCA manages and controls Sydney catchments and water supply to its customers.

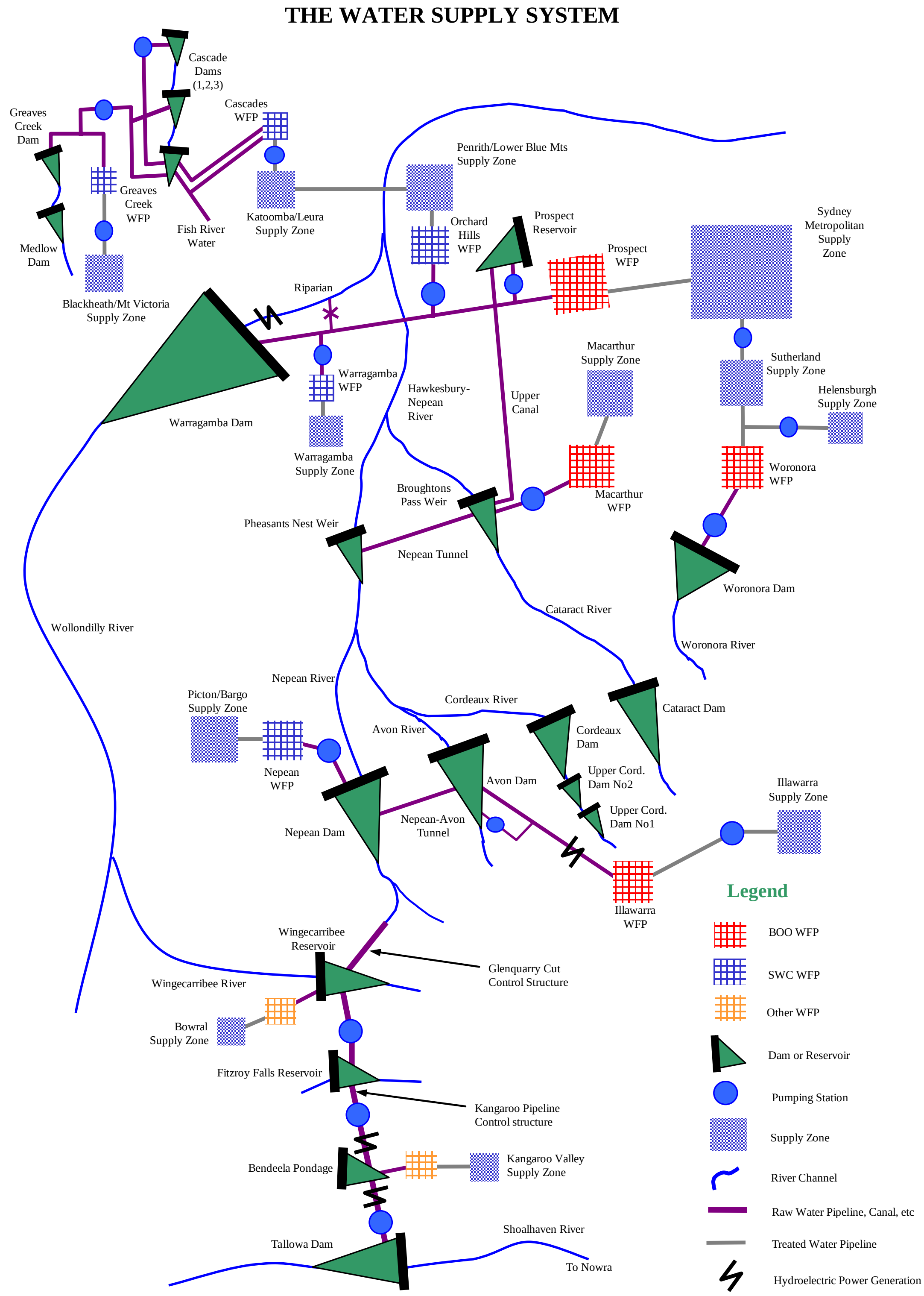
SCA's customers consist of:

- 61 small retail customers
- Sydney Water Corporation (SWC)
- Wingecarribee
- Shoalhaven.

The vast majority of SCA's water supply is sold to SWC. The supply is metered at SWC's filtration plant.

Figure 47 shows SCA's water supply system and the location of the dams and connecting rivers.

Figure 47 – SCA's water supply system



Source: SCA.

7.2 HISTORICAL TRENDS

SCA supplies bulk raw water to its wholesale customers, who then treat it and distribute it to their customers.

Approximately 99.3% of SCA's water is supplied to SWC. The water is then filtered and reticulated by SWC to retail customers in its service area. Table 56 shows the number of customers serviced by SCA and their percentage consumption of the total water distributed by SCA. Total annual consumption by customers other than SWC is 4.1 GL, which is about 0.7% of SCA's annual demand.

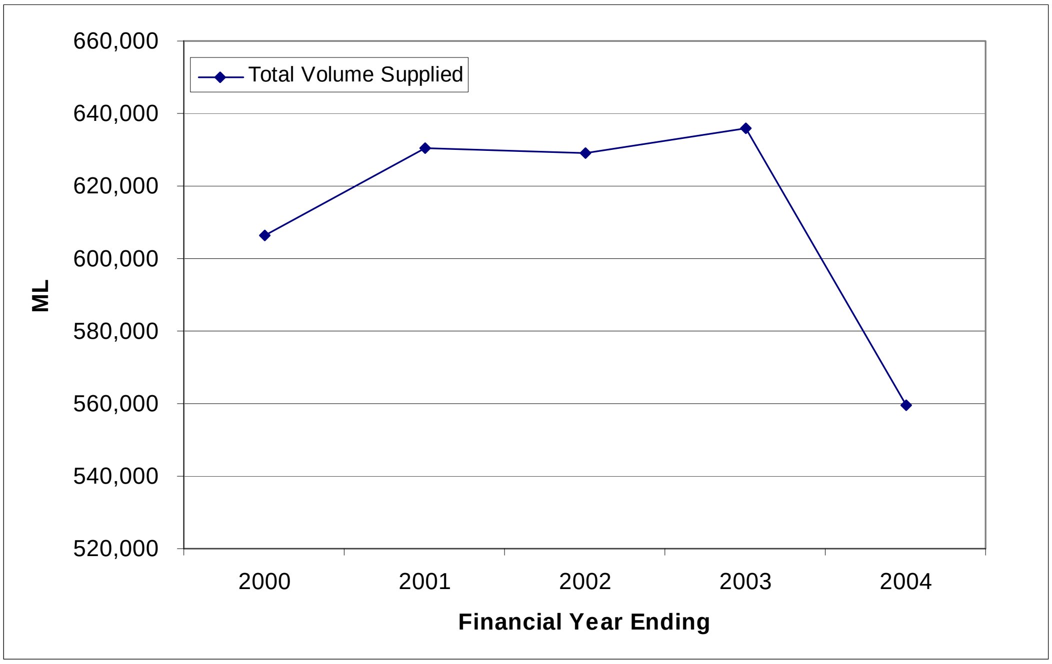
Table 56 – Bulk water supplies for financial year 2003/04

Water sales by customer group (metered)	Number of customers	Consumption (ML)	Percentage
Sydney Water Corporation	1	555,649	99.30%
Wingecarribee	1	3,442	0.62%
Shoalhaven	1	85	0.02%
Other retail customers	61	393	0.07%
Total retail customers	64	559,569	100%

Source: SCA, *Annual Information Return 2004.*

Over the last five years, average water supply to SCA's customers was approximately 612,000 ML/a. Water supply in 2003/04 declined due to the water restrictions in the Sydney Metropolitan area. Figure 48 shows the historical water demand since the establishment of SCA.

Figure 48 – Total volume supplied since 2000, ML



Source: SCA, *Annual Information Return 2004*.

There was a significant decline of 12% in water supply in 2004, which is approximately 76,000 ML. The decline was mainly attributed to reduced SWC demand due to the impact of the mandatory restrictions which commenced in October 2003.

7.3 FORECASTS – CONSUMPTION

7.3.1 Method and assumptions

MMA reviewed SCA's water demand forecasts as presented in their AIR to the Tribunal of September 2004. During a visit to SCA, the forecasts were discussed with staff in order to understand the methodology applied and the assumptions used in determining them.

In examining SCA forecasts, MMA concentrated on SWC's water release forecasts as the annual demand by SWC constituted 99.3% of the total water released by SCA.

SCA relies on forecasts prepared by SWC and its other customers (mainly Shoalhaven and Wingecarribee), as the major inputs into its own forecasts The forecasts used by SCA are produced by SWC and are based on consumption forecasts plus what used to be called the unaccounted for water component. The release data is metered at SWC's filtration plant.

Demand forecasts for Shoalhaven, Wingecarribee and the other 61 retail customers are projected by SCA with no growth rate over the forecast period.

Overall, SCA is forecasting a negative average growth rate of 0.15% pa over the period 2003/04 to 2009/10, which is mainly influenced by SWC's demand. This, in turn, is mainly influenced by DM activities as discussed in Section 4.4.

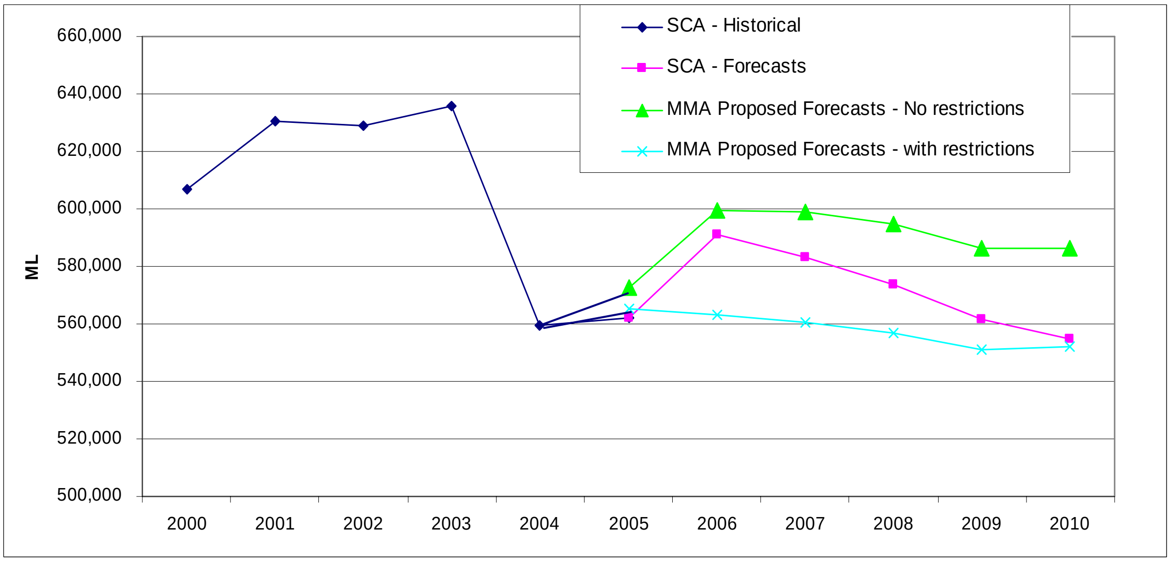
The forecasts in Figure 49 show a significant increase between 2004/05 and 2005/06. This increase of 5.2% is due to the SWC assumption that in January 2005 the mandatory restrictions will be lifted and that a lower level of permanent restrictions will remain.

MMA's indicative forecast for SCA is based on MMA's baseline forecast for SWC less the reductions due to:

- North Richmond supply
- SWC's customer related DM programs
- additional savings from SWC's leakage reduction and pressure management programs.

MMA's final forecast for SCA includes its retail and bulk supply customers.

Figure 49 – SCA's water consumption forecasts, ML



MMA examined SCA's forecasts for Wingecarribee, the second largest customer, which show an increase of 300 ML in the first year and a constant demand of 3,709 ML across the next regulatory period. Discussions with Wingecarribee indicated that their forecast demand for 2004/05 is 4,200 ML, with a 2% pa growth rate over the regulatory period. This difference of 500 ML/pa is not discussed in SCA's submission.

SCA advised that it had based its future sales on meeting 50% of Wingecarribee's projected 2010 total demand of 7,400 ML. In 2003/04, SCA supplied 3,400 ML of Wingecarribee's 6,000 ML total demand. SCA's projections allow for small reductions due to DM initiatives.

7.3.2 Comments, recommendations and likely impact

SCA produces its demand forecasts based on SWC's nominated forecasts of water releases. SCA's proposed forecasts therefore include SWC's assessment of the impact of DM programs undertaken by SWC and the unaccounted for water component.

MMA calculated SCA's demand forecasts by estimating SWC's water release forecasts as the baseline and then deducting SWC's savings due to their proposed DM programs, water supply from North Richmond and real losses. SWC's savings from DM activities include incremental savings due to their leakage reduction and pressure management programs.

SCA and MMA's forecasts are shown in Table 57.

Table 57 – SCA forecasts compared with MMA forecasts, ML

Financial year ending June (ML)	2005 (ML)	2006 (ML)	2007 (ML)	2008 (ML)	2009 (ML)	2010 (ML)
SCA forecasts	562,100	591,201	583,100	573,582	561,422	554,700
MMA forecasts – no restrictions	572,863	599,499	598,911	594,988	586,452	586,542
MMA proposed forecasts – with restrictions	565,250	563,299	560,404	556,831	551,211	552,188

While there is little difference between the forecasts over the entire forecasting period, the temporal distribution is quite different.

MMA considers that it is reasonable for SCA to rely on forecasts prepared by its major customers, however, it also believes that SCA should play a more active part in critically reviewing these forecasts, especially in the area of demand management.

APPENDIX A SWC'S BASELINE DEMAND FORECAST

Background

SWC's baseline demand forecast uses data from the most recent period in which there were no water restrictions (November 1996 to October 2002). The forecast is based on total per capita demand (in litres per capita per day, LCD) during this period.[62]

SWC's methodology for computing the baseline forecast involves a combination of seasonal decomposition and regression analysis. The seasonal decomposition component of the analysis normalises the LCD data in order to remove seasonal fluctuations in demand. Regression analysis is then applied to the seasonally adjusted series in order to reveal any LCD trends over time. SWC performed the analysis three times using the following variables:

i. Dependent variable: Seasonally adjusted LCD
Independent variables: Trend (represents the number of years from the beginning of the analysis period)

ii. Dependent variable: Seasonally adjusted LCD
Independent variables: Trend, temperature variation from monthly average, rainfall variation from monthly average, evaporation variation from monthly average

iii. Dependent variable: Seasonally adjusted LCD, corrected for savings from DM programs
Independent variables: Trend, temperature variation from long term monthly average, rainfall variation from long term monthly average, evaporation variation from long term monthly average.

MMA has replicated the baseline forecast produced by SWC using LCD calculated from (a) water release data (as per SWC's approach) and (b) metered consumption data.

A.1 Analysis of water release data

A.1.1 Seasonal decomposition and trend analysis of actual LCD data

Seasonal decomposition

SWC used the seasonal decomposition procedure in SPSS to calculate seasonal indices. This procedure decomposes the LCD time series into a seasonal component, a combined trend-cycle component and a random component. The seasonally adjusted LCD is calculated by dividing the observed LCD in each month by its seasonal index, as calculated by SPSS.

[62] SWC, 2004, *Recent trends in per capita demand*, Sustainability Division, October.

MMA performed seasonal decomposition of the LCD series calculated from SWC's AIR data[63] using Shazam instead of SPSS. Shazam performs the procedure in the same manner as SPSS.

The seasonal indices calculated by MMA are contrasted with SWC's indices in Table 58.

Table 58 – Comparison of seasonal indices calculated by SWC and MMA

Month	SWC Index	MMA Index	% difference
January	1.1466	1.1456	-0.09
February	1.0528	1.0735	1.97
March	0.9958	1.0150	1.93
April	0.9512	0.9481	-0.32
May	0.9193	0.9078	-1.26
June	0.9095	0.9086	-0.10
July	0.8698	0.8795	1.11
August	0.9324	0.9314	-0.11
September	0.9786	0.9831	0.46
October	1.0338	1.0410	0.70
November	1.0434	1.0484	0.48
December	1.1668	1.1657	-0.09

Table 58 shows that the two sets of indices match very closely, with a maximum difference in corresponding indices of less than two percent. The slight difference in results is due to slight differences in the water release and population data used to derive the LCD series. SWC's indices have been taken from *Recent trends in per capita demand*, which was provided to MMA on 1 Oct 2004. MMA's LCD series and hence seasonal indices are based on the most recent AIR data that SWC has submitted to IPART. There have been numerous revisions to the AIR data since the first draft submission, with population and water release data changing slightly in some of the revisions. It is therefore likely that SWC's analysis is based on older data than that used by MMA.

A comparison of Figure 50 and Figure 51 (SWC's data) with Figure 52 (MMA's data), provides a visual indication of the similarity between the two sets of data.

63 AIR nonfindata 271004.xls.

Figure 50 – LCD series used by SWC

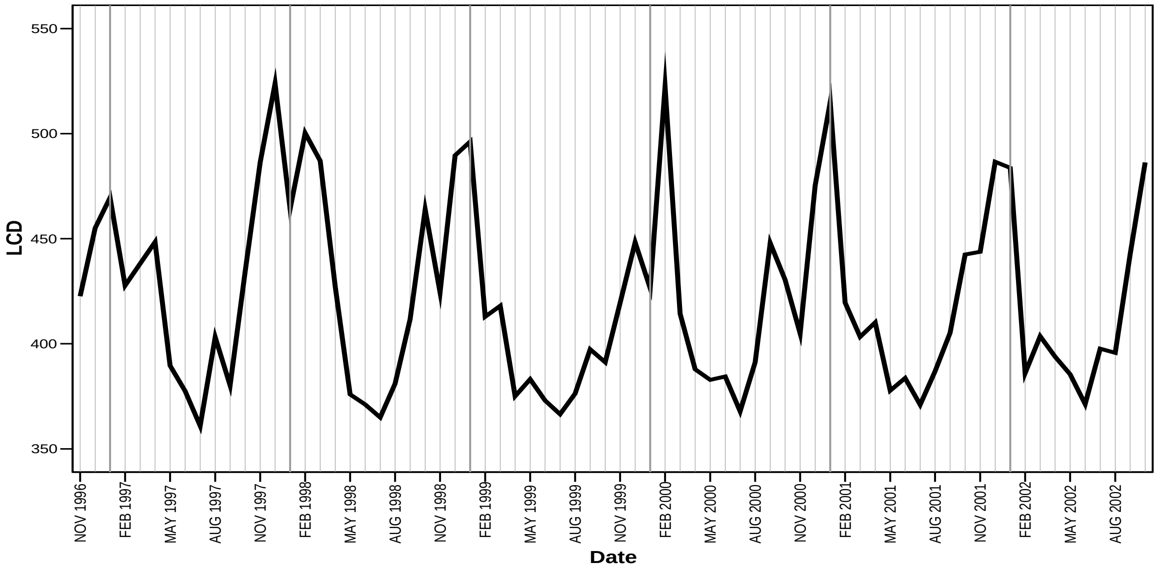


Figure 51 – SWC's seasonally adjusted LCD series (blue line)

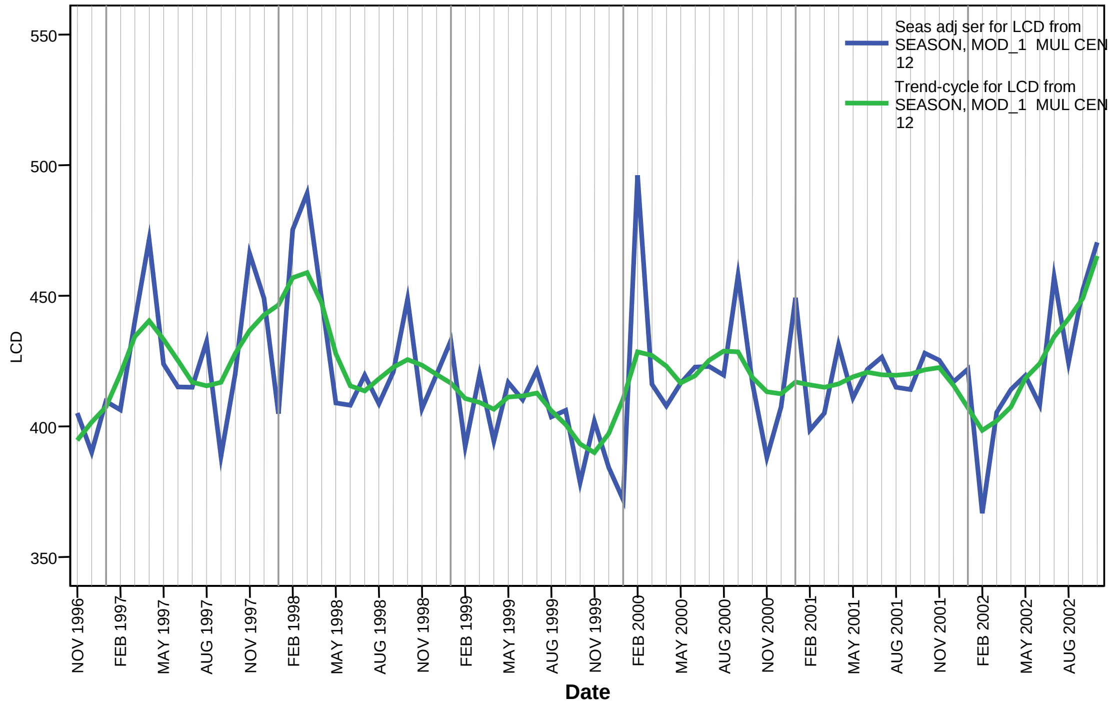
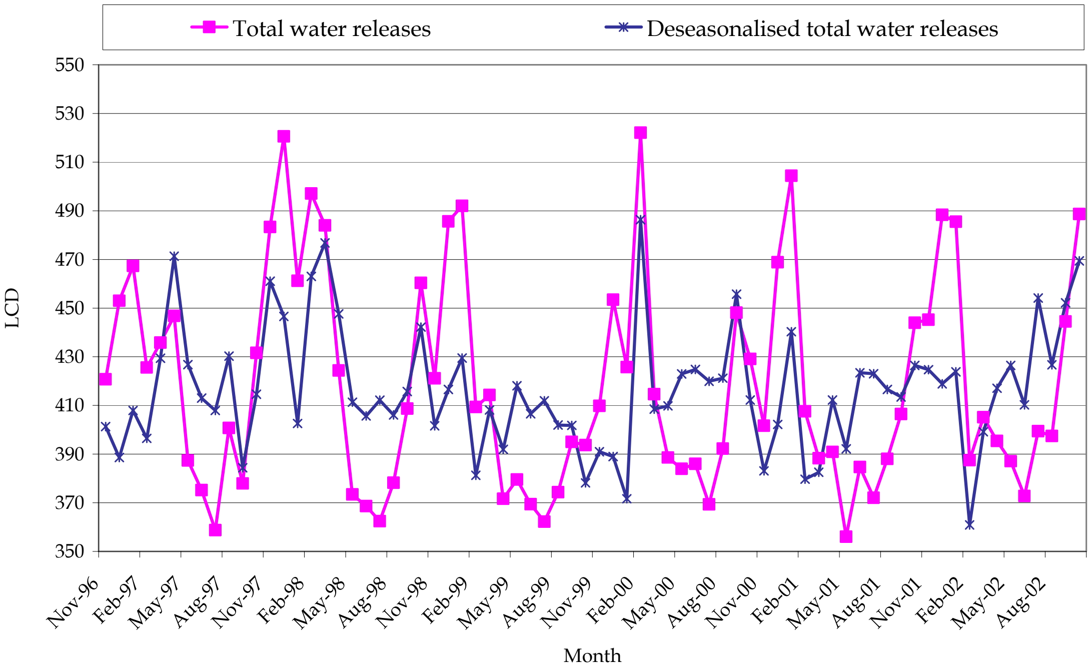


Figure 52 – MMA's actual and seasonally adjusted LCD



In *Recent trends in per capita demand*, SWC showed that regression analysis of the deseasonalised LCD series is greatly improved by including weather variables in the analysis. For this reason, MMA did not replicate the initial regression analysis performed by SWC (LCD regressed against trend only), but instead proceeded straight to performing the regression analysis with the inclusion of weather variables.

Regression analysis including weather variables

SWC used the following regression equation to model the seasonally adjusted LCD series:

$$LCD_{i,j}^{SA} = a + b_1 \times \left(T_{i,j} - \overline{T}_i\right) + b_2 \times \left(R_{i,j} - \overline{R}_i\right) + b_3 \times \left(E_{i,j} - \overline{E}_i\right) + b_4 \times Trend_i$$

Where:

$LCD_{i,j}^{SA}$ = seasonally adjusted LCD in month i of year j

$\left(T_{i,j} - \overline{T}_i\right)$ = temperature (average of maximum daily temperature) in month i of year j minus the average temperature for month i during the analysis period

$\left(R_{i,j} - \overline{R}_i\right)$ = total rainfall in month i of year j minus the average total rainfall for month i during the analysis period

$\left(E_{i,j} - \overline{E}_i\right)$ = total evaporation in month i of year j minus the average total evaporation for month i during the analysis period

$$Trend_i = \frac{\text{Sequence number month}_i}{12}$$

SWC has defined the trend variable in the manner shown so that its coefficient provides an indication of the annual upward or downward movement in per capita consumption.

SWC calculated averages for the weather variables by applying respective weightings of 0.27 and 0.73 to data from the Sydney Airport and Prospect Dam weather stations. These weightings were based on a trial and error process designed to maximise the R^2 statistic of the model. MMA applied the same weightings, however it must be noted that MMA used different values to SWC to indicate average weather conditions. Instead of calculating average values from data during the analysis period (November 1996 to October 2002), MMA's analysis used long-term averages obtained from Bureau of Meteorology data.

The main results of SWC's and MMA's regression analysis are summarised in Table 59.

Table 59 – Results of regression analysis of seasonally adjusted LCD

	SWC results	MMA results
Constant	422.602	417.173
Constant p-value	0.000	0.000
Trend coefficient	-0.682	-0.527
Trend coefficient p-value	0.519	0.619
Temperature coefficient	8.666	7.016
Temperature coefficient p-value	0.000	0.000
Rainfall coefficient	-0.035	-0.044
Rainfall coefficient p-value	0.332	0.197
Evaporation coefficient	0.769	0.809
Evaporation coefficient p-value	0.000	0.000
R^2	0.660	0.662
Adjusted R^2	0.640	0.642

The performance of both models is very similar in terms of the R^2 statistic.

The trend coefficient in SWC's model indicates an annual downward trend in per capita consumption of 0.68 LCD, however MMA's model estimates a more conservative decrease of 0.53 LCD per annum. Neither model gives a statistically significant estimate of the trend coefficient at conventional 95% confidence levels.

Temperature and evaporation are both highly statistically significant in both models.

The signs of the coefficients of all weather variables agree with what is intrinsically expected, thus consumption increases as temperature and evaporation increase and decreases as rainfall increases.

A.1.2 Seasonal decomposition and trend analysis of LCD data accounting for the impact of DM programs

SWC's DM program started in 1999, which falls within the baseline analysis period of November 1996 to October 2002. The baseline forecast is meant to indicate the future path of demand in the absence of any savings from DM programs hence the impact of any DM programs, during the analysis period must be removed in order to obtain a true picture of baseline demand.

Seasonal decomposition

In order to account for the effects of DM, SWC calculated an LCD series that was corrected for estimated savings from the two major components of the DM program up to the end of the analysis period - the leakage reduction program and the retrofit program.

Savings from the retrofit program were estimated by combining data on the number of retrofits completed each month with estimates of the savings per retrofitted household.

Savings from the leakage reduction program were calculated by linearly interpolating estimates of daily savings achieved by the program at 30 June of each year.

MMA estimated the DM savings in the same manner as SWC, using data supplied by SWC.[64]

The seasonal indices for SWC's and MMA's DM adjusted LCD data are shown in Table 60.

Table 60 – Seasonal indices for the DM adjusted LCD series

Month	SWC index	MMA index	% difference
January	1.1458	1.1439	-0.17
February	1.0529	1.0736	1.97
March	0.9959	1.0138	1.80
April	0.9517	0.9472	-0.48
May	0.9197	0.9071	-1.37
June	0.91	0.9075	-0.27
July	0.8704	0.8816	1.29
August	0.9328	0.9326	-0.02
September	0.9788	0.9847	0.60
October	1.0335	1.0415	0.77
November	1.0432	1.0482	0.48
December	1.1656	1.1655	-0.01

64 Data forwarded to MMA by SWC, *Leakage Reduction-pre2004.xls, EDC Indoor Retrofit $22_20040721.xls, EDC Indoor Retrofit Free_20040721.xls.*

Once again, the two sets of indices match each other to within two percent.

Figure 53 and Figure 54 show that MMA's DM adjusted deseasonalised series is very close to SWC's series.

Figure 53 – SWC's observed LCD and LCD adjusted for savings from the DM program

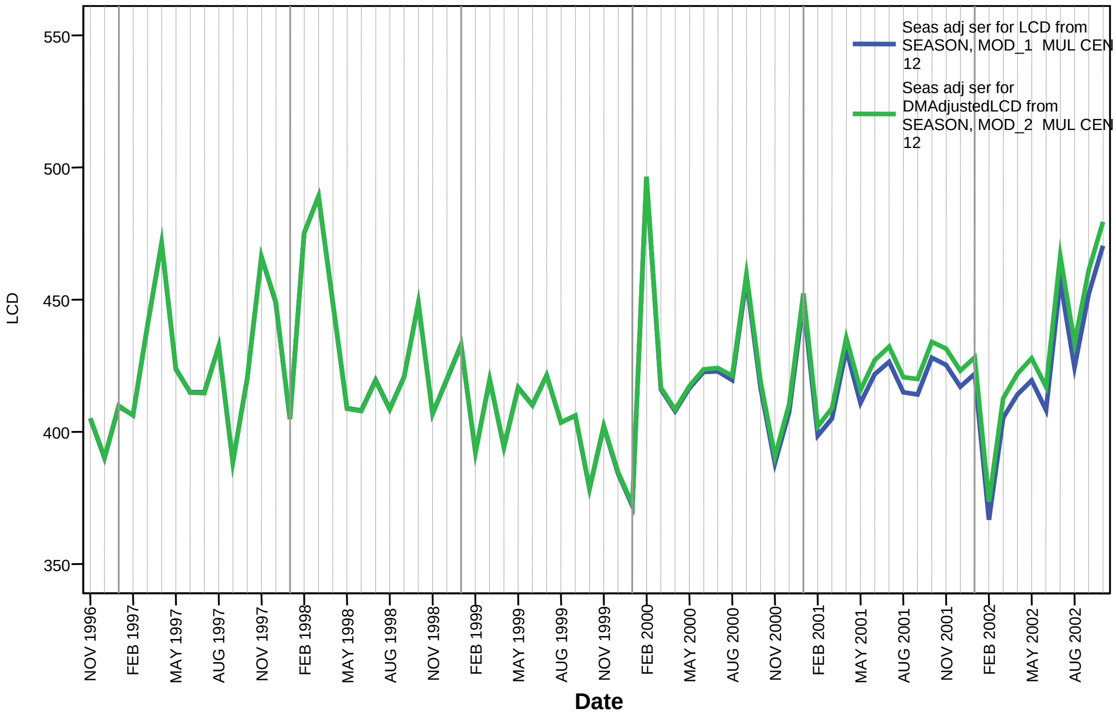
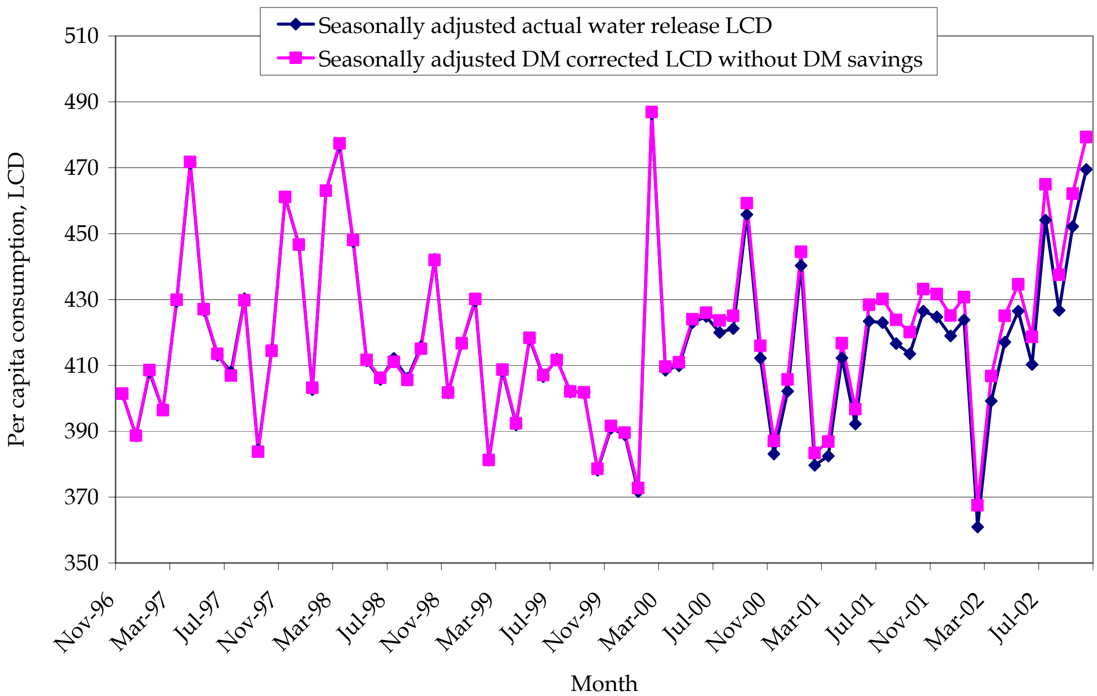


Figure 54 – MMA's observed LCD and LCD adjusted for savings from the DM program



Regression analysis of the DM adjusted LCD series

SWC performed a regression analysis of the deseasonalised DM adjusted LCD series using the same technique as for the non-DM adjusted series.

$$LCD_{i,j}^{DM,SA} = Constant + b_1 \times \left(T_{i,j} - \overline{T}_i\right) + b_2 \times \left(R_{i,j} - \overline{R}_i\right) + b_3 \times \left(E_{i,j} - \overline{E}_i\right) + b_4 \times Trend$$

where:

$LCD^{DM,SA}$ = seasonally adjusted monthly average LCD, corrected for savings from demand management.

Once again, MMA replicated this analysis using long-term average climate values.

The MMA and SWC regression results are summarised in Table 61.

Table 61 – Regression analysis of deseasonalised DM adjusted LCD

	SWC results	MMA results
Constant	420.134	414.705
Constant p-value	0.000	0.000
Trend coefficient	0.866	1.150
Trend coefficient p-value	0.412	0.285
Temperature coefficient	8.737	7.090
Temperature coefficient p-value	0.000	0.001
Rainfall coefficient	-0.036	-0.045
Rainfall coefficient p-value	0.320	0.189
Evaporation coefficient	0.792	0.834
Evaporation coefficient p-value	0.000	0.000
R^2	0.67	0.67
Adjusted R^2	0.65	0.65

Table 61 shows that the MMA and SWC models provided identical results in terms of the adjusted R^2 statistic. However, the two models gave noticeably different results in terms of the trend coefficient, with SWC's model predicting an annual increase of 0.9 LCD and MMA's model predicting an increase of 1.2 LCD. MMA's model gave a more statistically significant p-value for the trend coefficient, indicating that an increase of 1.2 LCD per annum may be more representative than SWC's 0.9 LCD per annum.

SWC used the regression results contained in Table 61 to predict future baseline demand under average climate conditions. This was accomplished by inserting long-term (30 year) averages as the observed weather values into the regression equation and multiplying the resulting figures by the appropriate seasonal index to obtain the estimated DM adjusted monthly average LCD. MMA employed the same technique, however, since MMA's regression models were originally derived using long-term weather averages, all weather terms in the model went to zero for future predictions.

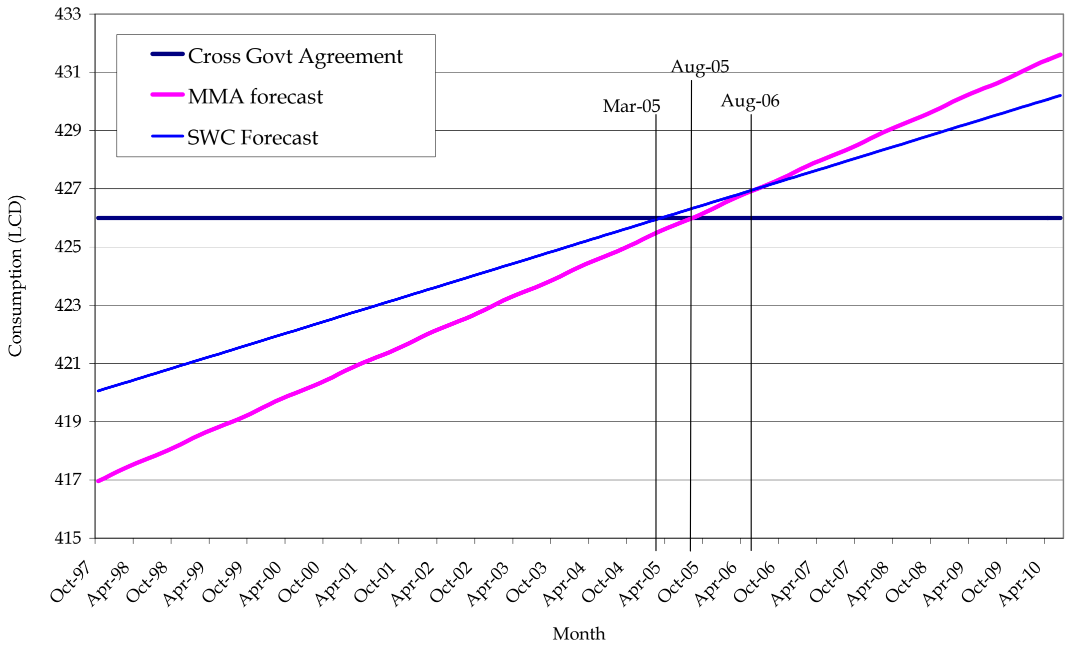
The long-term average weather values calculated by SWC and MMA were slightly different. The two sets of data are contrasted in Table 62.

Table 62 – Long term average weather conditions

Month	Mean maximum daily temperature, (deg C)		Total rainfall, (mm)		Total evaporation, (mm)	
	MMA	SWC	MMA	SWC	MMA	SWC
January	27.8	28.11	95.7	100.89	186.9	185.90
February	27.5	27.77	98.8	109.77	149.9	149.13
March	25.9	26.02	105.2	111.06	135.2	135.26
April	23.4	23.45	84.6	87.61	99.2	100.84
May	20.2	20.27	83.2	88.09	71.3	70.78
June	17.4	17.54	83.5	79.67	57.9	58.49
July	16.8	16.89	61.2	50.60	63.0	64.90
August	18.5	18.63	57.1	56.84	89.7	91.36
September	21.0	21.19	51.0	47.50	119.8	119.54
October	23.3	23.35	61.1	63.07	150.5	150.10
November	24.8	24.97	74.4	83.39	164.2	162.93
December	27.0	27.21	72.7	63.42	195.5	195.87

Figure 55 compares the predicted LCD obtained from the SWC and MMA models.

Figure 55 – 12-month moving average of predicted LCD under average weather conditions



It is interesting to note that although MMA's model predicts a greater rate of increase in LCD per annum, the lower value of the constant in the model actually results in the predicted LCD crossing the constant cross-government agreed value of 426 LCD at a slightly later date (approximately five months later, some time in August 2005). Beyond August 2006, MMA's model predicts higher rates of per capita consumption than SWC's model.

A.2 Analysis of metered consumption data

MMA applied the forecasting methodology outlined in section A.1.2 to metered consumption data.[65] Since metered consumption excludes water consumption that occurs before reaching the customer (for example, leakages), analysis of metered consumption data rather than water release data should provide a better indication of consumer water usage patterns.

Metered consumption data is only available on a quarterly basis, hence the analysis was performed using quarterly instead of monthly data.

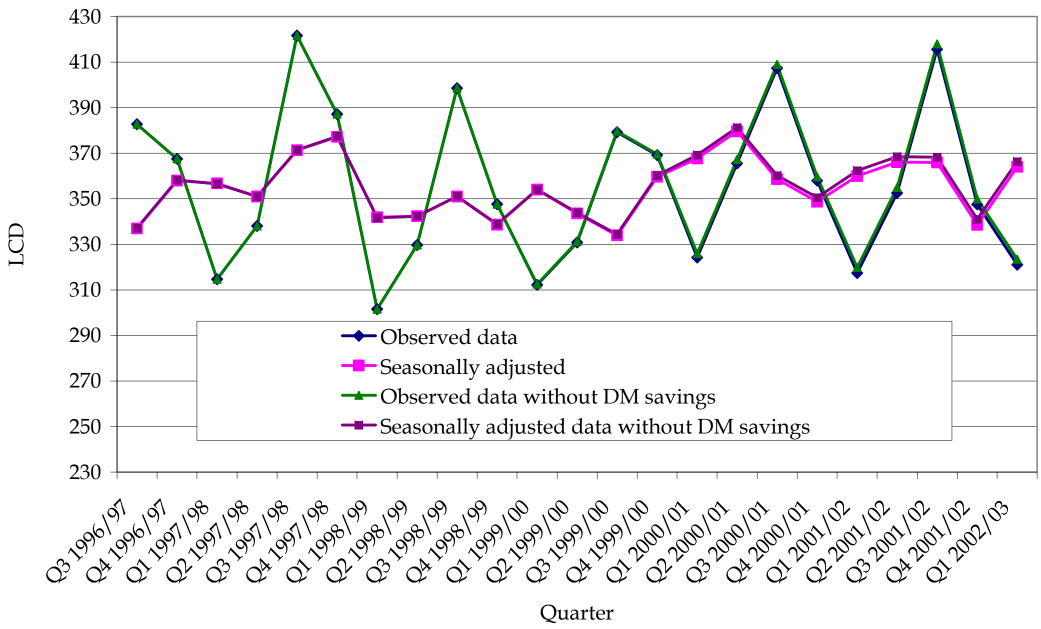
The only DM program during the analysis period applicable to metered consumption data was the residential retrofit program.

65 Data forwarded to MMA by SWC, *Historical Consumption 261004.xls.*

Seasonal decomposition

Quarterly metered consumption data with and without savings from the residential retrofit program was seasonally adjusted using the ratio to moving average method. The results are shown in Figure 56.

Figure 56 – Seasonal adjustment of quarterly metered LCD data



Regression analysis

Regression analysis of the seasonally adjusted series was performed using a number of different weather variables, as summarised in Table 63. New weather variables were defined in an attempt to increase the statistical significance of the trend variable and improve the overall performance of the regression model.

Table 63 – Variables used in regression analysis

	Dependent variable	Independent variable 1	Independent variable 2	Independent variable 3	Independent variable 4
Model 1	Seasonally adjusted metered LCD without savings from the retrofit program.	Trend	Weighted average quarterly max temp minus weighted 30 year average max temp	Weighted average quarterly total rainfall minus weighted 30 year total rainfall	Weighted average quarterly total evaporation minus weighted 30 year total evaporation temp
Model 2	Seasonally adjusted metered LCD (observed)	Trend	Same as model 1	Same as model 1	Same as model 1
Model 3	Seasonally adjusted metered LCD without savings from the retrofit program.	Trend	Quarterly weighted number of days max temp is 25% greater than the weighted 30 year average	Quarterly weighted number of days rainfall is 25% less than the weighted 30 year average	Quarterly weighted number of days evaporation is 25% greater than 30 year average.
Model 4	Seasonally adjusted metered LCD (observed)	Trend	Same as model 3	Same as model 3	Same as model 3
Model 5	Seasonally adjusted metered LCD without savings from the retrofit program.	Trend	Quarterly number of days Sydney Airport temp is 25% greater than 30 year average	Quarterly number of days Sydney Airport rainfall is 25% less than 30 year average	Quarterly number of days Sydney Airport evaporation is 25% greater than 30 year average.
Model 6	Seasonally adjusted metered LCD (observed)	Trend	Same as model 5	Same as model 5	Same as model 5

The trend coefficient was redefined to reflect the quarterly nature of the data:

$$\text{Trend}_i = \frac{\text{Sequence number of quarter}_i}{4}$$

The main results of the regression analysis are summarised in Table 64.

Table 64 – Regression analysis of quarterly metered consumption data

Variable	Statistic	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	**Coefficient**	346.9085	347.656	313.0098	314.2330	397.8641	399.0051
	p-value	0.000	0.000	0.000	0.000	0.000	0.000
	t statistic	57.99449	58.73497	29.26525	29.69856	11.95357	12.05333
Trend	**Coefficient**	2.261007	1.711476	3.152781	2.586942	2.429077	1.869832
	p-value	0.173848	0.29302	0.031284	0.06857	0.102334	0.199398
	t statistic	1.415997	1.083194	2.335615	1.937241	1.72132	1.332259
Temperature	**Coefficient**	6.745266	6.652589	0.303781	0.312275	1.309097	1.312181
	p-value	0.147157	0.148418	0.610434	0.596644	0.061476	0.059657
	t statistic	1.514914	1.509923	0.518487	0.538773	1.994427	2.010046
Rainfall	**Coefficient**	0.044702	0.044513	0.139326	0.140198	-1.13258	-1.12305
	p-value	0.13235	0.130069	0.126162	0.120186	0.042169	0.042723
	t statistic	1.576384	1.586357	1.603791	1.631358	-2.1872	-2.18064
Evaporation	**Coefficient**	0.070174	0.066693	1.134161	1.108117	1.000873	0.958199
	p-value	0.615176	0.629124	0.014595	0.015665	0.028202	0.033823
	t statistic	0.511562	0.491339	2.701839	2.668455	2.386414	2.297145
Model	**R^2**	0.312713	0.289292	0.512179	0.495819	0.45381	0.429421
	Adjusted R^2	0.159983	0.131356	0.403774	0.38377	0.332435	0.302626

The results in Table 64 show that the results obtained using the DM adjusted metered LCD are very similar to those obtained using observed metered LCD. This is because the residential retrofit program was in its infancy during the analysis period and did not have a major impact on consumption.

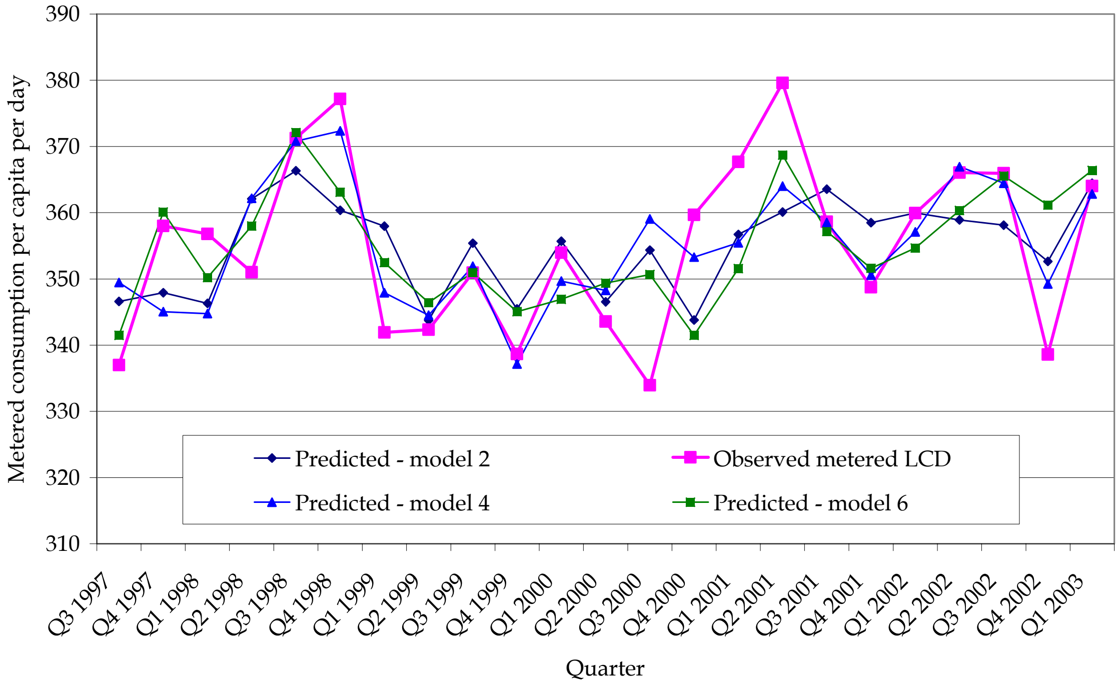
The adjusted R^2 values in Table 64 show that redefining the weather variables in terms of the number of days that a particular set of conditions is satisfied produces a greatly improved explanatory model. Comparing weighted average weather variables in models 1 and 2 with models 3 and 4, it can be seen that the adjusted R^2 more than doubled when the weather variables were redefined in this way. Furthermore, the trend coefficient in models 3 and 4 were considerably more statistically significant than in models 1 and 2. In model 3, the trend coefficient was found to be statistically significant at conventional 95% confidence levels.

Models 5 and 6 used weather data from Sydney Airport alone instead of the weighted averages from Sydney Airport and Prospect Dam. These models were included to test the validity of using data from two weather stations. The adjusted R^2 values in these models were lower than in models 3 and 4 (which used weighted average weather values), however the weather coefficients were more statistically significant.

Overall, the models using weighted average "number of days" weather data (models 3 and 4), appeared to be the best since all weather coefficients had the expected signs, the trend coefficient was most statistically significant, and the adjusted R^2 statistic was highest in these models.

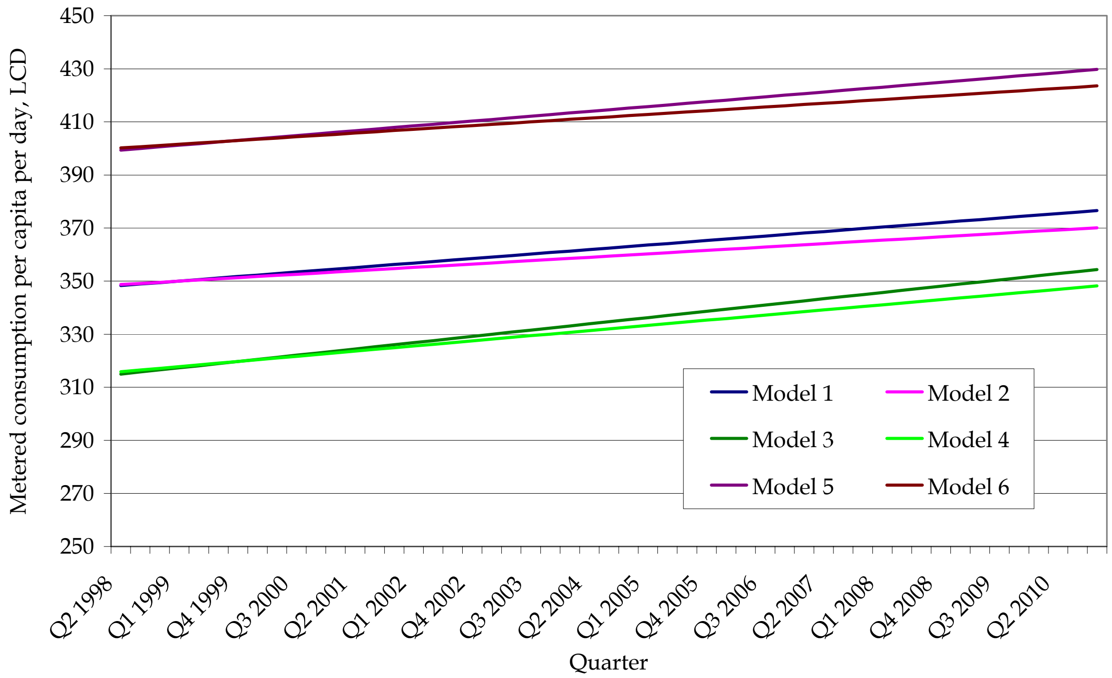
Figure 57 gives a visual indication of how well each model for deseasonalised metered LCD fitted the actual data.

Figure 57 – Observed metered LCD and fitted data



A plot of the forecast baseline demand from each of the regression models is shown in Figure 58.

Figure 58 – Metered consumption forecasts from each regression model



It can be seen from Figure 58 that the choice of weather variables has an enormous impact on the baseline forecast of metered demand.

A.3 Water releases versus metered consumption

Table 65 summarises the principal results from MMA's regression models using water releases and metered consumption data. For comparison purposes, regression analysis of the DM adjusted deseasonalised water release data was performed again using the "number of days" weather variables.

Model 1: Water release DM adjusted deseasonalised LCD using weighted weather variables

Model 2: Same as model 1, but using *metered* DM adjusted deasonalised LCD

Model 3: Water release DM adjusted deseasonalised LCD using weighted "number of days" weather variables

Model 4: Same as model 3, but using *metered* DM adjusted deseasonalised LCD

Model 5: Water release DM adjusted deseasonalised LCD using Sydney Airport "number of days" weather variables

Model 6: Same as model 5, but using *metered* DM adjusted deseasonalised LCD

Table 65 – Comparison of water release (monthly) and metered consumption (quarterly) regression

Variable	Statistic	Model 1 (water releases)	Model 2 (metered data)	Model 3 (water releases)	Model 4 (metered data)	Model 5 (water releases)	Model 6 (metered data)
Constant	**Coefficient**	414.705	346.909	292.455	313.010	310.800	397.864
	p-value	0.000	0.000	0.000	0.000	0.000	0.000
Trend	**Coefficient**	1.150	2.261	1.755	3.153	0.960	2.429
	p-value	0.285	0.174	0.139	0.031	0.441	0.102
Temperature	**Coefficient**	7.090	6.745	0.999	0.304	1.489	1.309
	p-value	0.001	0.147	0.322	0.610	0.179	0.061
Rainfall	**Coefficient**	-0.045	0.045	3.843	0.139	3.110	-1.133
	p-value	0.189	0.132	0.000	0.126	0.000	0.042
Evaporation	**Coefficient**	0.834	0.070	3.444	1.134	3.228	1.001
	p-value	0.000	0.615	0.000	0.015	0.000	0.028
Model	**R^2**	0.67	0.313	0.609	0.512	0.549	0.454
	Adjusted R^2	0.65	0.160	0.586	0.404	0.522	0.332

The data in Table 65 shows that the regression models obtained using monthly water release data were more robust than those obtained using quarterly metered consumption data in terms of the adjusted R^2 statistic.

Part of this difference in performance is probably attributable to the fact that monthly data will clearly yield better results than quarterly data. Unfortunately it is not possible to obtain metered data in monthly intervals.

A.4 Choice of weather variables

It has been shown that weighted average weather data from the Prospect Dam and Sydney Airport weather stations yields better results than data from Sydney Airport alone.

Defining the weather variables using SWC's method seems to produce better results when analysing water release data:

- Temperature variable = observed average maximum temperature minus long term average maximum temperature
- Rainfall variable = observed total rainfall minus long term average total rainfall
- Evaporation variable = observed total evaporation minus long term average total evaporation

MMA's alternative definition of weather variables appears to produce better results for metered consumption data:

- Temperature variable = number of days the observed maximum temperature is greater than 1.25 times the long term average maximum temperature

- Rainfall variable = number of days the observed total rainfall is less than 0.75 times the long term average total rainfall
- Evaporation variable = number of days the observed total evaporation is greater than 1.25 times the long term average total evaporation.

The choice of weather variables can have a significant impact on the baseline forecast.

A.5 Conclusions

MMA obtained very similar results to SWC for the baseline total demand trend using LCD data from the most recent AIR. However, MMA's model gave a slightly higher rate of increase in LCD per annum (1.2 versus 0.9 LCD per annum). Compared with SWC's forecast, MMA's model predicts slightly higher rates of per capita consumption from August 2006 onwards.

For the purposes of it's submission to the Tribunal, SWC has used the agreed cross-government baseline demand of 426 LCD throughout the determination period. SWC's analysis predicts an average LCD of approximately 428 LCD over the determination period and MMA's model predicts a slightly higher average of around 429 LCD. Both these values are within 1% of the cross-government agreed level, indicating that 426 LCD is a reasonable assumption.

It was found that for analysing total water releases, SWC's definition of weather variables produced the best results. However, for metered consumption data, redefining the weather variables in terms of the number of days that a set of conditions is satisfied produced better results.

APPENDIX B HWC TRENDS IN WATER CONSUMPTION PER RESIDENTIAL PROPERTY

Introduction

HWC has assumed a constant demand per residential tenement in its residential demand forecasts.

MMA has applied ordinary least squares regression analysis to metered consumption per property (disaggregated into houses and flats/units) in order to test this assumption.

B.1 Methods and assumptions

Total metered consumption per billing cycle[66] was used in conjunction with the number of connected properties in each billing cycle.[67] The number of connected properties was provided by HWC on an annual basis. MMA estimated the number of connected properties in each billing cycle by linearly interpolating between the observed values at the end of each financial year.

Since the analysis was performed using billing data there were three data points for each year. Seasonal variation is observed over the duration of one year hence the observed data was seasonally adjusted using the ratio to moving average technique prior to performing regression analysis.

Water restrictions were imposed in the Hunter region from 7 December, 1994 to 7 January, 1995. In order to gain a picture of consumption per property in the absence of water restrictions the regression was therefore performed using all available data after this period.

B.1.1 Basic trend analysis

Regression analysis was initially performed using one explanatory variable named "trend" in order to determine any statistically significant upward or downward trends over time:

$$\mathrm{CPT}_i^{SA} = \mathrm{Constant} + b \times \mathrm{Trend}_i$$

Where:

CPT_i^{SA} = Seasonally adjusted consumption per tenement in billing cycle i

$$\mathrm{Trend}_i = \frac{observation_i}{3}$$

and "Constant" and "b" are constants to be determined.

Given that HWC bills the customer approximately three times per year, the above definition of the trend variable means that its coefficient provides an indication of any changes in consumption annually.

66 Spreadsheet data supplied to MMA by HWC, 11 November, 2004; *cycle_data 111104.xls*

67 Spreadsheet data supplied to MMA by HWC; *Properties Water Connected 93-02 for MMA 18 Oct 191004.xls*

B.1.2 Weather corrected trend analysis

Regression analysis was then performed with the addition of three more variables designed to account for any weather deviations from long term averages. The three new variables were defined in two different ways:

Definition 1

Temperature variable = observed average maximum temperature minus long term average maximum temperature

Rainfall variable = observed total rainfall minus long term average total rainfall

Evaporation variable = observed total evaporation minus long term average total evaporation

Definition 2

Temperature variable = number of days the observed maximum temperature is greater than 1.25 times the long term average maximum temperature

Rainfall variable = number of days the observed total rainfall is less than 0.75 times the long term average total rainfall

Evaporation variable = number of days the observed total evaporation is greater than 1.25 times the long term average total evaporation

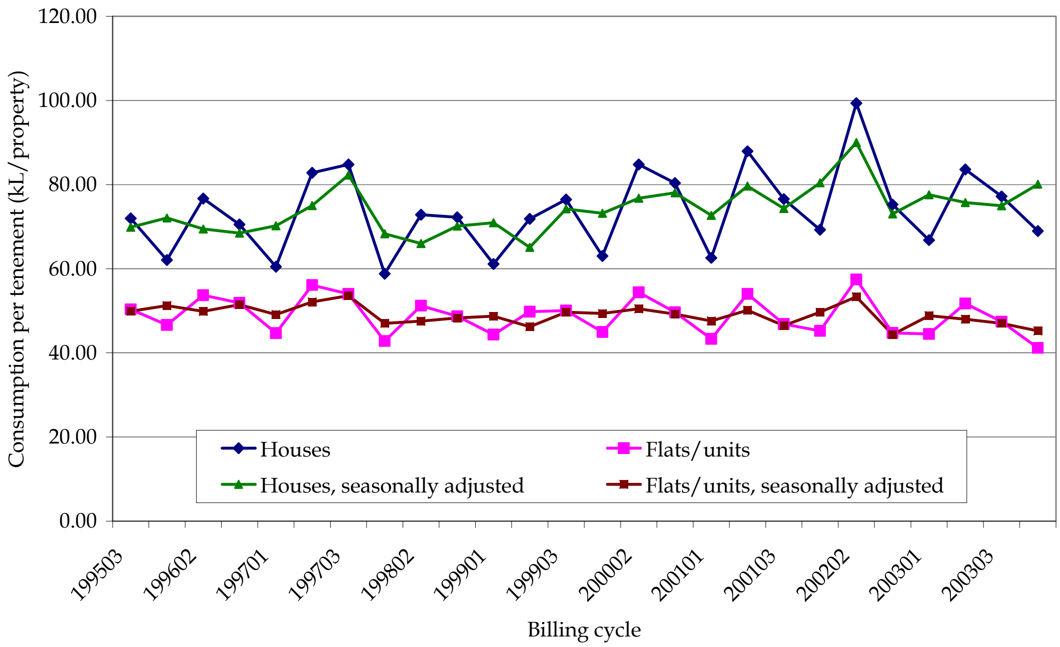
Based on advice from the Bureau of Meteorology regarding representative weather stations in the Hunter region, data from the following stations was used:

- temperature - Newcastle weather station
- rainfall – Newcastle weather station
- evaporation – Williamtown RAAF weather station.

B.2 Results

Figure 59 shows the observed and seasonally adjusted data.

Figure 59 – Observed and seasonally adjusted consumption per tenement



B.2.1 Consumption per house

The results of the basic trend regression analysis of seasonally adjusted consumption per house in each billing cycle are shown in Table 66.

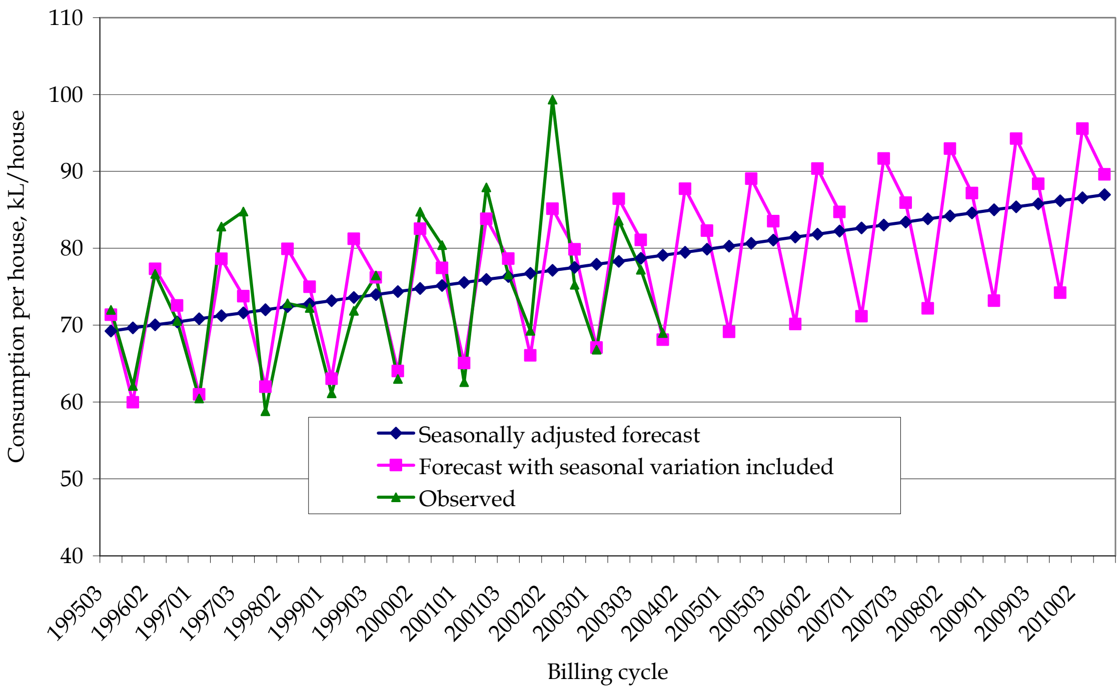
Table 66 – Regression analysis of consumption per house per billing cycle

	Statistic	Results
Constant	**Constant**	68.858
	t statistic	35.964
	p-value	0.000
Trend	**Coefficient**	1.181
	t statistic	3.175
	p-value	0.004
Overall model	**R^2**	0.296
	Adjusted R^2	0.266

The p-value and positive sign of the trend coefficient in Figure 60 indicate that there is a highly statistically significant upward trend in annual consumption per house. The approximate magnitude of this annual increase is 1.2kL per house. The adjusted R^2 value of 0.266 indicates that this simple regression model is able to describe 27% of the variation in seasonally adjusted data.

Based on these results, HWC's assumption of constant consumption per house may not necessarily be true.

Figure 60 – Forecast consumption per house per billing cycle



The results of the regression analysis, including the two sets of weather variables outlined in section B.1.2, are summarised in Table 67.

Table 67 – Regression analysis of consumption per house per billing cycle including weather variables

Variable	Statistic	Weather variables definition 1	Weather variables definition 2
Constant	**Constant**	69.303	65.301
	t statistic	32.427	4.505
	p-value	0.000	0.000
Trend	**Coefficient**	1.136	1.315
	t statistic	2.676	3.176
	p-value	0.014	0.005
Temperature	**Coefficient**	-0.975	0.063
	t statistic	-0.687	0.369
	p-value	0.500	0.715
Rainfall	**Coefficient**	-0.005	0.074
	t statistic	-0.430	0.416
	p-value	0.671	0.682
Evaporation	**Coefficient**	0.0049	-0.155
	t statistic	0.153	-1.120
	p-value	0.880106	0.275
Overall model	**R^2**	0.323	0.336
	Adjusted R^2	0.194	0.209

The results in Table 67 indicate that the inclusion of a weather correction does not improve the overall performance of the model. In fact, the adjusted R^2 statistic is actually lower in the climate corrected models than in the non-climate corrected model. Furthermore, none of the weather variables are statistically significant at conventional 95% confidence levels. This is quite a surprising result as water consumption for houses involves a significant outdoor component and is therefore assumed to be quite weather sensitive.

The poor performance of the weather corrected models may be due to the nature of the available data. The accuracy of weather data is highly dependent on the time interval used in data averaging. The best results are obtained by modelling time series data on a daily or weekly basis and relationships can be masked when longer time intervals are used.[68] Unfortunately, the time interval between meter readings precludes analysis on a daily or weekly basis.

B.2.2 Consumption per flat or unit

The results of the basic trend regression analysis of seasonally adjusted consumption per flat/unit in each billing cycle are shown in Table 68:

Table 68 – Regression analysis of consumption per flat/unit per billing cycle

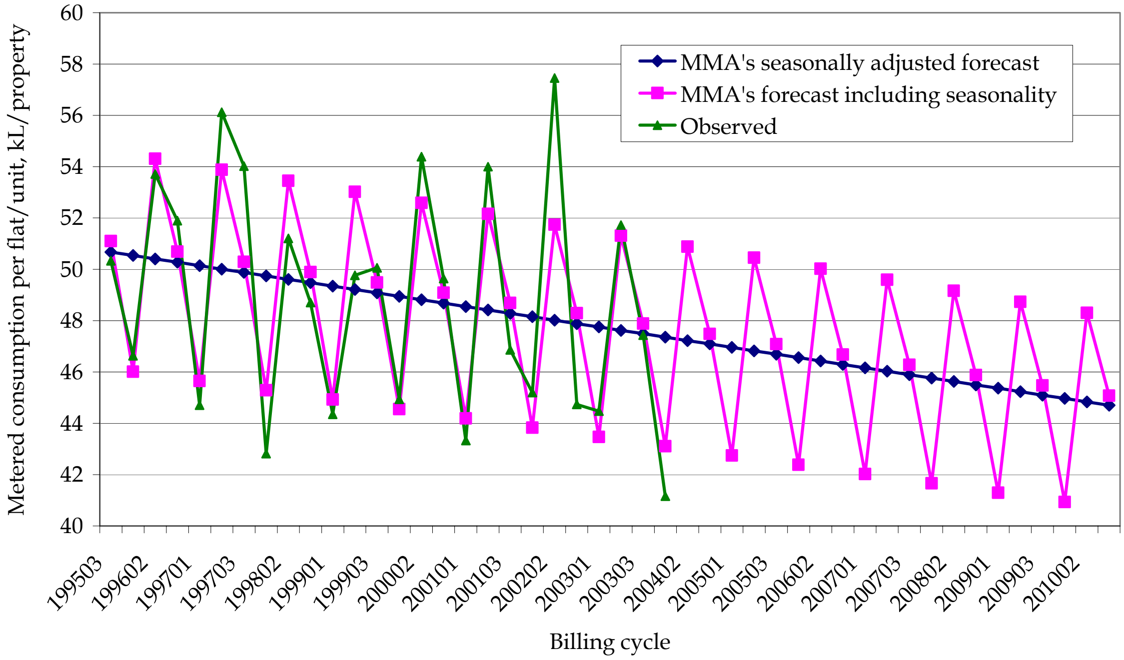
	Statistic	Results
Constant	**Constant**	50.806
	t statistic	60.417
	p-value	0.000
Trend	**Coefficient**	-0.398
	t statistic	-2.437
	p-value	0.023
Overall model	**R^2**	0.198
	Adjusted R^2	0.165

The p-value and negative sign of the trend coefficient in Figure 61 indicate that there is a highly statistically significant downward trend in annual consumption per flat/unit. The approximate magnitude of this annual decrease is 0.4kL per property. The adjusted R^2 value of 0.165 indicates that this simple regression model is able to describe 17% of the variation in seasonally adjusted data.

Again, these results differ from HWC's assumption of constant consumption per tenement.

68 Committee on USGS Water Resources Research, 2004, *Estimating water use in the United States: A New Paradigm for the National Water-Use Information Program* , National Academy Press, Washington D.C, p.103.

Figure 61 – Metered Consumption per Flat/Unit



Regression results including the two sets of weather variables are contained in Table 69.

Table 69 – Regression analysis of consumption per unit/flat per billing cycle including weather variables

Variable	Statistic	Weather variables definition 1	Weather variables definition 2
Constant	**Constant**	50.96	49.01
	t statistic	53.849	7.755
	p-value	0.000	0.000
Trend	**Coefficient**	-0.418	-0.332
	t statistic	-2.225	-1.836
	p-value	0.037	0.081
Temperature	**Coefficient**	-0.101	0.043
	t statistic	-0.161	0.578
	p-value	0.874	0.569
Rainfall	**Coefficient**	-0.003	0.034
	t statistic	-0.583	0.440
	p-value	0.566	0.664
Evaporation	**Coefficient**	-0.001	-0.075
	t statistic	-0.055	-1.232
	p-value	0.957	0.232
Overall model	**R^2**	0.217	0.255
	Adjusted R^2	0.067	0.113

Once again, the inclusion of weather variables does not improve the performance of the regression model. In the case of flats/units this is not particularly surprising because water consumption in this category is not expected to be very weather sensitive due to limited outdoor use.

B.3 Conclusions

Simple regression analysis of billed consumption data provided by HWC revealed that there is a statistically significant upward trend in annual metered consumption per house of approximately 1.2kL per house. Conversely, there is a statistically significant downward annual trend in consumption per flat/unit of approximately 0.4kL per property. These findings differ from HWC's assumption of constant consumption per residential tenement.

MMA proposes that the future consumption rates indicated in Table 70 are more plausible (calculated using the non-weather corrected regression models outlined above).

Table 70 – MMA's forecast annual consumption per residential property, kL/property

Financial year	Houses	Flats/units
2004	238.2	141.5
2005	241.7	140.3
2006	245.2	139.1
2007	248.8	137.9
2008	252.3	136.7
2009	255.8	135.5
2010	259.4	134.3

APPENDIX C GWCWA FUTURE WATER RESTRICTION ASSUMPTIONS

Table 71 – Medium restriction regime

Year ending	Existing / anticipated restriction regime	Metered unrestricted annual demand (ML)	Metered unrestricted annual demand with nominated restrictions applied (ML)
30 June 2002	Unrestricted then Level 1 restrictions from 24 February 2002.	14,834	14,834
30 June, 2003	Level 1 restrictions from 1 July 2002 to 30 June 2003.	15,027	13,825
30 June 2004	Level 1 restrictions to 17 May 2004. Level 2 restrictions from 18 May to 30 June 2004.	15,222	13,862
30 June 2005	Level 2 restrictions from 1 July to 1 August 2004. Level 2A restrictions from 2 August to31 December 2004. Level 3 restrictions from 1 January 2005 to 30 June 2005.	15,390	12,312
30 June 2006	Level 3 restrictions from 1 July 2005 to June 30 2006.	15,559	11,825
30 June 2007	Level 3 restrictions from 1 July 2006 to 30 June 2007.	15,730	11,955
30 June 2008	Level 3 restrictions from 1 July 2007 to 31 December 2007. Contingency input (20ML/d) available in December 2007. Level 2A Restrictions from January 1 2008 to June 30 2008.	15,903	12,722
30 June 2009	Level 2A Restrictions from July 1 2008 to June 30 2009.	16,078	13,506
30 June 2010	Level 1 Restrictions from July 1 2009 to June 30 2010.	16,225	14,954

Table 72 – High restriction regime

Year ending	Existing / anticipated restriction regime	Metered unrestricted annual demand (ML)	Metered unrestricted annual demand with nominated restrictions applied (ML)
30 June 2002	Unrestricted then Level 1 restrictions from 24 February 2002.	13,770	13,770
30 June 2003	Level 1 restrictions from 1 July 2002 to 30 June 2003.	14,073	12,947
30 June 2004	Level 1 restrictions to 17 May 2004. Level 2 restrictions from 18 May to 30 June 2004.	14,382	13,095
30 June 2005	Level 2 restrictions from 1 July to 1 August 2004. Level 2A restrictions from 2 August to 30 September 2004. Level 3 restrictions from 1 October 2004 to 30 June 2005.	14,704	11,469
30 June 2006	Level 3 restrictions from 1 July 2005 to 30 September 2005. Level 4 restrictions from 1 October 2005 to 30 June 2006.	15,026	10,518
30 June 2007	Level 4 restrictions from 1 July 2006 to 30 June 2007.	15,348	10,436
30 June 2008	Level 4 restrictions from 1 July 2007 to 30 September 2007. Level 5 restrictions from 1 October 2007 to 31 December 2007. Contingency input (20ML/d) available in December 2007. Level 5 restrictions from 1 January 2008 to 30 June 2008.	15,670	9,950
30 June 2009	Level 5 restrictions from 1 July 2008 to 30 June 2009.	15,993	9,915
30 June 2010	Level 4 restrictions from 1 July 2009 to 30 June 2010.	16,320	11,097

Table 73 – Low restriction regime

Year ending	Existing / anticipated restriction regime	Metered unrestricted annual demand (ML)	Metered unrestricted annual demand with nominated restrictions applied (ML)
30 June 2002	Unrestricted then Level 1 restrictions from 24 February 2002.	13,770	13,770
30 June 2003	Level 1 restrictions from 1 July 2002 to 30 June 2003.	14,073	12,947
30 June 2004	Level 1 restrictions to 17 May 2004. Level 2 restrictions from 18 May to 30 June 2004.	14,382	13,095
30 June 2005	Level 2 restrictions from 1 July to 1 August 2004. Level 2A restrictions from 2 August to 30 June 2005.	14,704	12,351
30 June 2006	Level 2A restrictions from 1 July 2005 to 30 June 2006.	15,026	12,622
30 June 2007	Level 1 restrictions from 1 July 2006 to 30 June 2007.	15,348	14,120
30 June 2008	Level 1 restrictions from 1 July 2007 to 30 June 2008.	15,670	14,416
30 June 2009	No restrictions	15,993	15,993
30 June 2010	No restrictions	16,320	16,320

APPENDIX D ECONOMETRIC MODELS OF WATER DEMAND

As part of this study, MMA developed alternative models for forecasting water demand for SWC and HWC. The models are based on econometric models of water demand, where demand is regressed with key explanatory variables. The results of the analysis are reported in this appendix.

Econometric models were developed for the following customer classes:

- separate dwellings and houses
- flats, units and apartments
- commercial enterprises (small, non-residential users in the case of HWC).

The models estimated the statistical relationships of annual water demand for each customer class with key economic, technical and demographic variables. The variables included:

- Income (measured either as Gross State Product or Average Weekly Earnings). Income growth may have a positive impact on growth as consumers buy more water consuming appliances or a negative impact on growth if consumers use additional income to buy more efficient appliances.
- Price, usually the tier 1 usage charge on a $/kL basis. Higher prices would be expected to lead to some reduction in demand.
- Technical change variables such as the adoption of dual flush toilets. Adoption of water efficient appliances would be expected to lead to reductions in water demand per tenement.
- Social changes like the trend towards having multiple toilets and showers may have a slight upward increase in water usage.
- Weather variables (rainfall, temperature and evaporation) can be significant explanators of year-to-year variation of water demand.
- Implementation of demand management programs would reduce water demand. This was modelled by using a dummy for the years in which a demand management program has been implemented.
- Mandatory water restrictions would also impact on water demand. This has been modelled as the number of days in each year with water restrictions.

Models were tested on a number of criteria including goodness of fit criteria (adjusted R^2 statistics) and to ensure autocorrelation and heteroscedasticity were not prevalent. The final models chosen exhibited high adjusted R^2 statistics, implying that they are a reliable forecasting tool on the assumption that the underlying structure of water demand does not alter significantly during the forecast period. However, most models exhibited some degree of multi-collinearity, so the models are less reliable as tools for determining the relative impacts of each explanatory variable. Further development of the models will be required to enable them to be used to provide reliable estimates for, say, price elasticities of demand or income.

D.1 Demand for SWC

Results for the fitted equations for customers supplied by SWC are provided in Table 74. Except for the commercial sector, the models exhibited high goodness of fit. The commercial demand equation also had a wrong sign on the price variable, although this variable was not statistically significant.

Table 74 – Results of statistical analysis for SWC

Item	Separate dwellings	Flats/units	Commercial
Parameter values			
Income	0.0013	0.0030**	0.0052*
Price	-1.1242**	NA	1.1624
Water efficient appliance uptake	NA	-22.4080	-2104.4
Social trends	67.259*	NA	NA
Demand management	-19.75**	-3.1535*	-28.8000*
Water restrictions	-0.0239**	-0.4169**	NA
Temperature	NA	1.5374	0.9783
Rainfall	NA	-0.3451	NA
Evaporation	1.4980**	NA	NA
Diagnostic			
Adjusted R^2	0.87	0.89	0.52
Von Neumann Ratio	3.03	2.44	2.63

** = significant at 5% level; * = significant at 10% level; Na = not applicable (variables were excluded in final model due to insignificance).

Significant explanatory variables included income, price, demand management and uptake of water efficient appliances. However, the impact of the economic variables were small, with price elasticities (at mean) of less than -0.15 and income elasticities at less than 0.7.

D.2 Demand for HWC

Results for the fitted equations for customers supplied by HWC are provided in Table 75. The models for all sectors exhibited high goodness of fit, with an adjusted R^2 of at least 80%.

Table 75 – Results of statistical analysis for HWC

Item	Separate dwellings	Flats/units	Commercial
Parameter values			
Income	0.0906*	0.0040**	-0.3474**
Price	-0.8199*	NA	-33.875
Water efficient appliance uptake	-51.1100**	-29.2830**	-10327**
Social trends	NA	NA	NA
Demand management	NA	-1.5476	NA
Water restrictions	-0.3257	NA	NA
Temperature	NA	NA	69.719**
Rainfall	NA	NA	NA
Evaporation	1.2200**	0.3405**	NA
Diagnostic			
Adjusted R^2	0.80	0.92	0.89
Von Neumann Ratio	2.52	2.80	2.47

** = significant at 5% level; * = significant at 10% level; Na = not applicable (variables were excluded in final model due to insignificance).

Significant explanatory variables included income, price (in separate dwellings only), demand management and uptake of water efficient appliances. However, the impact of the economic variables were small, with price elasticities (at mean) of less than -0.38 and income elasticities ranging from 0.24 for separate dwellings to -1.06 for commercial premises.

It should be noted that more work would be required before reliance is put on any hypothesis testing of the significance of the explanatory variables. Thus, although the equations are adequate for the purposes of forecasting, they are less reliable as indicators of the relative impacts of the explanatory variables.