4. DEMAND ANALYSIS

4.1 Introduction

The development of a water demand management or efficiency plan requires the accurate and reliable forecasting of water demand, as well as a detailed understanding of internal and external water usage. As part of this project a detailed demand analysis was undertaken to:

- Determine the underlying per capita water consumption and the factors that affected the usage patterns. Factors such as climate, conservation, water use restriction and demographic issues, all affect the use of water.
- Define the internal and external usage on a per capita basis.
- Develop an initial forecast for water demand for the next 30 years (extent of economic analysis).

Initial projections are made for future internal and external water use via a three-step process:

1. Projecting bulk water use per person per day (L/p/d) based on historical consumption data.
2. Projecting population growth based on data provided by the local governments. These projections were adopted in preference to the DCILGP projections as they include only those areas connected to the water supply and are therefore the most applicable to this study.
3. Forecasting total system demand by combining the water use projections in L/p/d with the population growth figures.

The initial demand forecast is made without regard to naturally occurring conservation or programmed conservation measures by the communities. Naturally occurring conservation and new conservation programs are identified, justified, and integrated with the initial forecasts in Section 8 to 10 of this report.

4.2 Demand Data Collection

4.2.1 Demand Data Requirements

As part of the project, visits were made to each of the pilot Local Governments for the purpose of data collection. A list of data requirements was provided prior to the visit to focus the data collection discussions. Data collected included monthly bulk water demand, monthly climate variation, demand for various customer categories and information relating to pricing and WaterWise implementation.

Data used in the analysis of historical water demand was provided primarily by the local government. Where data was unavailable, additional sources such as the Australian Bureau of Statistics and the Bureau of Meteorology were used. The data collected for the demand analysis falls into three categories:

- **Bulk Water Production**

  Average monthly production (ML/d) for each pilot community was provided for the following periods:

- Emerald	July 1991 through June 1999
- Ingham	July 1995 through June 1999
- Mackay	July 1987 through August 1999
- Maroochy	January 1985 through April 1999
- Toowoomba	January 1985 through June 1999

  To efficiently analyse consumption patterns and responses to price changes and restriction programs, it is important to have consumption by customer type by month, as different customer groups respond to differently to various stimuli. Residential customers generally have higher irrigation requirements than commercial establishments and can achieve a higher redirection in water use during voluntary or mandatory restriction programs. Residential customers are also generally more sensitive to increases in water tariffs.

  It will be shown that there is a great deal of volatility in water use in some communities. This variation cannot be completely explained by weather, price, restrictions or other known influences. More detailed water use by customer types would help explain some of the volatility, but it is not necessary to explain all responses to construct useful forecasting models and effective conservation programs.

  It is particularly important to have consumption data by consumption blocks (0 to 100kL/a, 101 to 200kL/a, etc), to enable the evaluation of the impact of price on different customer categories. Consumption by customer category (residential, pensioner, commercial, and total) and by selected blocks was collected where available. This data is used in the evaluation of water price impacts for alternative pricing structures.

- **Weather Data**

  Weather data was collected and used to normalise actual water consumption, that is, to remove the effects of weather and to identify the normal water use patterns. This enables more accurate projections of baseline water use to be made. The weather variables used in this analysis were:

  - Mean maximum day temperature per month
  - Total rainfall for month
  - Total rain days per month
  - Total evaporation per month (available for Maroochy only)

This data was analysed using regression techniques to isolate the effects of weather on water use.

- **Population History and Projections**

  Historical and projected population was provided by each local government. Data needed to be supplemented in some cases by the Australian Bureau of Statistics (ABS) and Queensland State Government projections. Where data was not available from the local government for all 5 year periods up to the year 2030, growth rates were assumed based on growth predicted for the previous periods.

  Population data provided by the DCILGP often includes the entire shire, not only the population served by the water supply scheme. It is not possible to fully utilise the population data provided through this process for water supply planning. Population projections were generally based on current water supply planning reports or Total Management Plans provided by the local governments. This highlights an issue relating to the consistency of population projections throughout the State. Projections are based on various data sources determined for various reasons and are not necessarily consistent with the published State Government figures.

  A summary of the population projections for each community is provided in **Table 4.1**.

Table 4.1: Actual and Projected Population

Town	Population							
	Actual	Projected						
Year	*1996*	*2000*	*2005*	*2010*	*2015*	*2020*	*2025*	*2030*
Toowoomba	86,569	89,244	91,816	94,388	96,960	99,532	102,104	104,679
Maroochy	92,706	116,693	148,088	179,483	210,878	242,273	273,668	305,198
Mackay	63,556	68,787	75,326	82,116	89,909	97,919	106,793	115,695
Ingham	6,665	6,769	6,784	6,799	6,814	6,829	6,844	6,859
Emerald	11,528	12,440	13,730	15,160	16,730	18,460	20,370	22,469

4.2.2 Base Data Gaps and Assumptions

The total per capita usage (L/p/d) is determined for each community by dividing total production by population. If consumption were available by customer category for the years of analysis, the water use per person for residential customers could also be calculated to assist in the development of conservation opportunities. For Ingham and Mackay only partial data for water use by customer category was available, e.g. residential and non-residential.

Water pricing structures and specific water rates were provided by each community for all years analysed except for Maroochy, where only recent tariffs were provided. An analysis of the impact of water prices on water use is presented in Section 5.

4.2.3 History of Water Use Restrictions

Three of the pilot communities implemented water restrictions during the demand analysis period. Toowoomba engaged in a restriction program which included odds/evens watering since 1993 and a sprinkler hours control regulation. Toowoomba also implemented various forms of water restrictions throughout the 1980s, however the demand continued to increase.

Maroochy Shire reported the use of restrictions between March 1987 and July 1991. Unfortunately, this period cannot be used to evaluate the performance of the restriction program on a per capita basis as the consumption actually increased during this period from 432 L/p/d to 485 L/p/d or 2.3 % per annum. Population also increased by 7.4 percent per annum during this period, which is the result of extensive expansion of residential development, resort accommodation and associated services. By way of comparison, population increased only 2.7 percent per annum from 1981 to 1987 while L/p/d increased 0.3 percent per annum.

Water restrictions were used by Hinchinbrook Shire to control excessive water usage in Ingham in the mid to late 1980's. No records of the restrictions were available for this study.

4.2.4 Current Water Efficiency Programs

Most of the communities targeted for this study are currently involved in water conservation and the WaterWise program at various levels. Each of the communities is committed to the implementation of efficient water usage and has undertaken a wide range of initiatives to achieve this aim. This is a positive result for the WaterWise program however it appears that the measures are implemented without significant data collection to ascertain probable cost effectiveness or water savings and without comprehensive monitoring and post implementation plans in place. Therefore limited feedback from the initiatives can be provided to the community and in particular to the elected members. Programs need detailed design and evaluation of outcomes to ensure lasting and improving benefits. A summary of the actions taken to date is as follows:

4.2.4.1 Emerald

Emerald Shire Council has previously implemented the following water conservation measures:

- Metering installed in early 1980's
- User pays since 1999
- Showerhead rebate program (5 to 10 per annum)
- Brochures with water bills
- Telemarketing for showerhead retrofit plus audit (1999)
- Washing machine rebate during local show period ($150, part from electricity board)
- Tap timer giveaway
- WaterWise plumbers
- Water Week shopping centre display

- School WaterWise program (2 year cycle) and regular competitions
- Radio advertisements during Water Week
- 1999/2000 budget of $34,000

4.2.4.2 Ingham

Hinchinbrook Shire Council has previously implemented the following water conservation measures:

- Metering installed in 1989
- User pays from 1995
- Display at local show aimed at leakage reduction (bi-annually)
- WaterWise week newspaper feature
- School WaterWise program (1998)
- 1999/2000 budget of $3,000

4.2.4.3 Mackay

Mackay City Council has previously implemented the following water conservation measures:

- Metering installed in 1970
- Full user pays not yet adopted
- Showerhead rebate program $20 for 300 units in 1999
- Workshops for caravan park operators, garden groups etc.
- Industry information evening 1999
- Brochures available at Council offices and libraries
- “Leaks” advertisement on local television
- WaterWise week shopping centre display
- School WaterWise program (2 year cycle)
- 1999/2000 budget of $11,000 (from $3,000 in 1995)

4.2.4.4 Maroochy

Maroochy Shire Council has previously implemented the following water conservation measures:

- Metering introduced in 1993
- User pays since 1997
- Showerhead rebate program since 1996 (approximately 1500 rebates)
- Brochures with water bills
- Water Week shopping centre display
- School audit program (large leakage located)
- Rainwater Tank rebate program from 1996 (approximately 250 rebates)
- Regulations for urinals being investigated
- School WaterWise program
- 1999/2000 budget not known

Maroochy Shire Council's shower rebate program ($20 for a AAA showerhead, redeemable at the Council office on production of receipt) has received a strong level of interest from the community, with over 1500 accounts participating in the program. The results for the program over the past four years are summarised in **Table 4.2**.

Table 4.2: Maroochy Shire Council Shower Rebate Program Results

Year of Rebate Issue	Number of Rebates	Approximate Participation Rates
1995/1996	440	2%
1996/1997	363	1%
1997/1998	244	1%
1998/1999	307	1%
1999/2000 [2]	38	< 1%

As well as the showerhead rebate program, Maroochy Shire Council has also offered a rebate for the installation of rainwater tanks. A range of rebates were offered to the community, depending on the size of rainwater tank installed on a property. The results of this program are listed in **Table 4.3**.

Table 4.3: Maroochy Shire Council Rainwater Tank Rebate Program Results

Rebate Issued	$20	$40	$80	$175	$250	Total
Year of Rebate	Rainwater Tank Size (kL)					
	0.1-1	**1-2.5**	**2.5-4.5**	**4.5-10**	**> 10**	
1995/1996	14	13	7	18	14	66
1996/1997	15	10	1	10	8	44
1997/1998	6	9	2	6	4	27
1998/1999	38	24	8	14	13	97
1999/2000 [3]	5	3	0	1	2	11
Total	**78**	**59**	**18**	**49**	**41**	**245**

A total of 245 properties have participated in the program, which represents approximately 1% of all accounts in the area or 0.25% per annum. However, the effect of this measure on the water consumption of participating properties has not been analysed.

4.2.4.5 Toowoomba

Toowoomba City Council has previously implemented the following water conservation measures:

- Water metering installed in 1978
- User pays since 1995

[2] Progressive total - as of September 1999.
[3] Progressive total - as of September 1999.

- School WaterWise program
- Showerhead rebate program (196 over five years)
- Public education for community, real estate and commercial groups
- WaterWise garden competition
- Brochures with water bills
- Water audits on 20 non-residential sites
- Urinal upgrade in public toilets ($18,000 in 1999/00)
- 1999/2000 budget not known

Toowoomba City Council's showerhead rebate scheme involved a rebate of $20 being issued to each account that provided proof of purchase of a AAA rated showerhead. Over a five-year period, almost 200 residences have participated in the program. Regular meter readings were taken for most of the participating properties over a five year period. However, the specific effects of the measure could not be gauged, as some properties actually increased their overall water usage. A more intensive study would need to be carried out to accurately determine the real effect of replacing the showerheads in these properties.

4.3 Demand Analysis Overview

The methods used to analyse historical water demand include a combination of time series analysis, multiple regression or econometric analysis. The results of all of the applied methods are built into a forecasting model for each of the five pilot communities that:

- ➢ Summarises historical data by month
- ➢ Defines seasonality (seasonal water usage patterns)
- ➢ Normalises actual water use to remove the effects of abnormal weather
- ➢ Separates winter and summer consumption
- ➢ Tracks actual consumption patterns with a Weighted Moving Average (WMA)
- ➢ Derives initial demand forecasts for key years through 2030
- ➢ Provides monthly forecasts of demand to measure conservation performance (optional).

A brief overview of the application of analytical methods is provided in **Appendix B**. The appendix text introduces the types of analytical methods listed above and how they are used in water demand modelling.

4.4 Analysis Results - Mackay

4.4.1 Introduction

Although five communities have been analysed, and the results of the analysis are summarised in this section, the Mackay demand analysis was selected to illustrate many of the methods and findings for several reasons:

- Production data is available for a lengthy period i.e. 1987-1999.
- Mackay has a strong weather impact that illustrates the effects of weather departures from normal (long run average).
- Regression analysis results in a significant price coefficient.
- A strong pricing impact is evident.
- Consumption data is available for residential customers by consumption block for 1999.
- The overall regression fit for the analysis is good at $R^2 = 0.80$

4.4.2 Regression Analysis Results

Regression analysis attempts to statistically identify, the relationship between a dependent variable (water production) and one or more independent variables that cause the dependent variable to behave in the manner that it does. Each variable can be tested for its "goodness of fit" in explaining the dependent variable activity, and the overall "goodness of fit" is commonly measured by a factor referred to as R^2. This parameter gives the percentage of variation in the dependent variable that is statistically explained by the independent variables. It is desirable to have an R^2 as close to 1.00 as possible with the use of logical and appropriate variables. For monthly *residential* water use, an R^2 of 0.90 or more is common, meaning that 90% or more of the monthly variation in water use is explained by the independent variables. For commercial, industrial and total production data, the R^2 values are much lower, reflecting the diversity that exists in the consumption data. In the case of Mackay total production data was used and, the R^2 value for the model was 0.80. (Refer to **Appendix C** for a copy of the regression analysis summary and graphics.)

Detailed demand analysis is undertaken using per capita demand, not total production. This approach is adopted to ensure that population growth is removed as a variable in the analysis, allowing impact on this base unit of demand to be effectively analysed as the dependent variable.

The list of independent variables could include (depending on the nature of the regression analysis): seasonality, various weather variables, pricing, use of restrictions, family size, income, type and number of water using fixtures, and so forth.

The results of the analysis of the Mackay demand data is as follows:

- Seasonality is defined as the long term pattern of monthly water use across the year expressed in terms of a dimensionless ratio termed a *seasonal index*. In all of the regression analyses, a seasonal index is used to define the normal monthly water use. The seasonal index expresses the ratio of each month's water production relative to a moving average of the previous 12 months data. The long term seasonal index is then determined for the community. For Mackay, the maximum seasonal index is shown in **Figure 4.1**. The index is 1.27 for October, which means that water production in that month is 1.27 times the average monthly production. In the month of May the index is at its lowest at 0.79 times the average month production. Since this index is based on an average of 12 years production data, it basically represents a long term, weather normalised, pattern of water use. Year to year fluctuations in water use are "averaged out" in the process.

Figure 4.1: Mackay Seasonal Index – Total Production

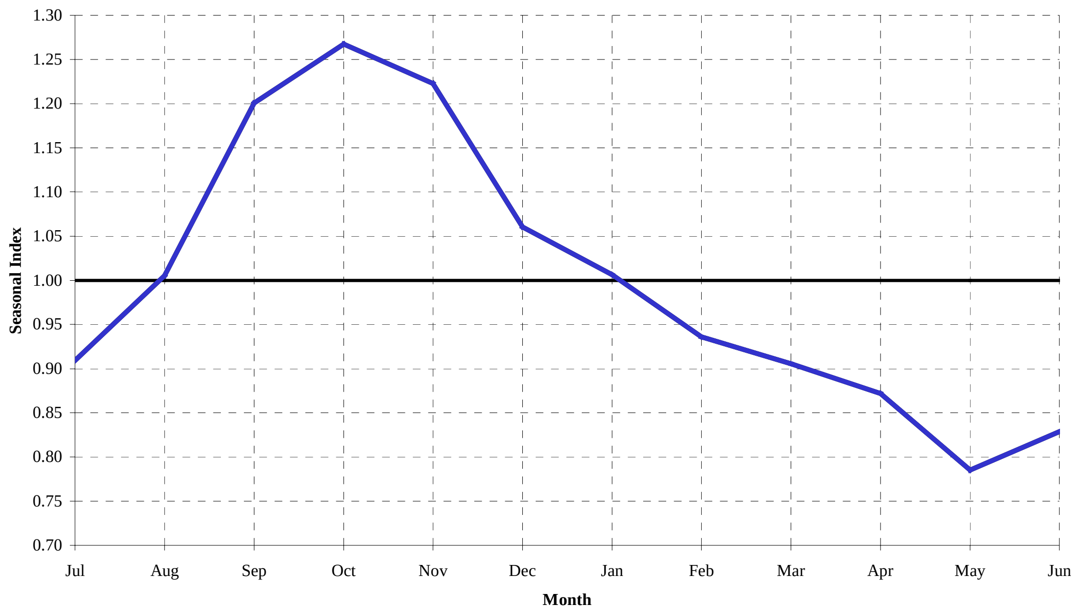
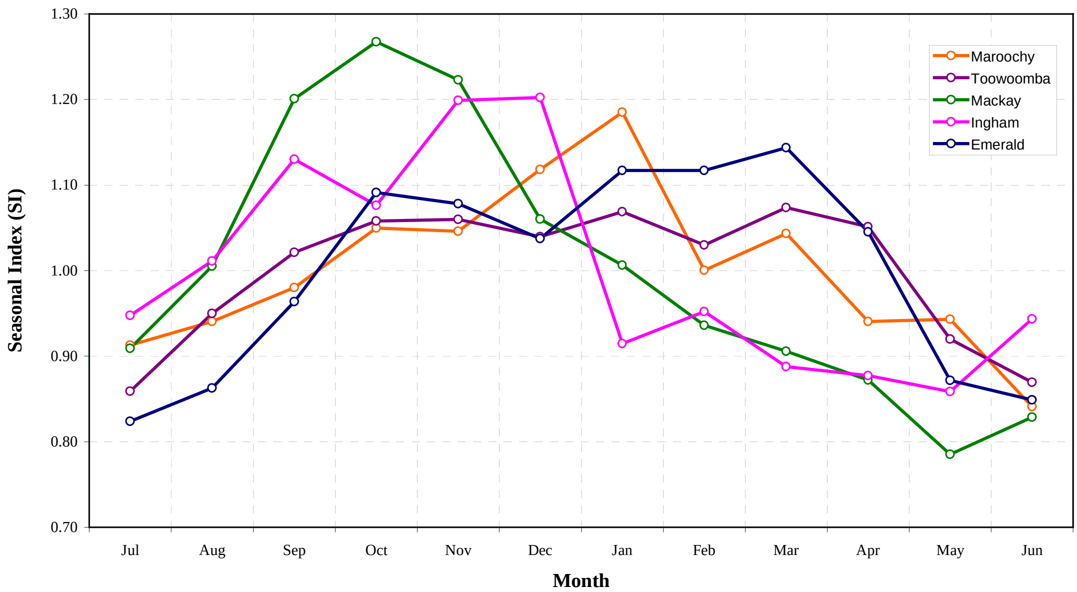


Figure 4.2 shows a comparison of the resulting seasonal indices for each of the pilot communities.

Figure 4.2: Seasonal Index Comparison

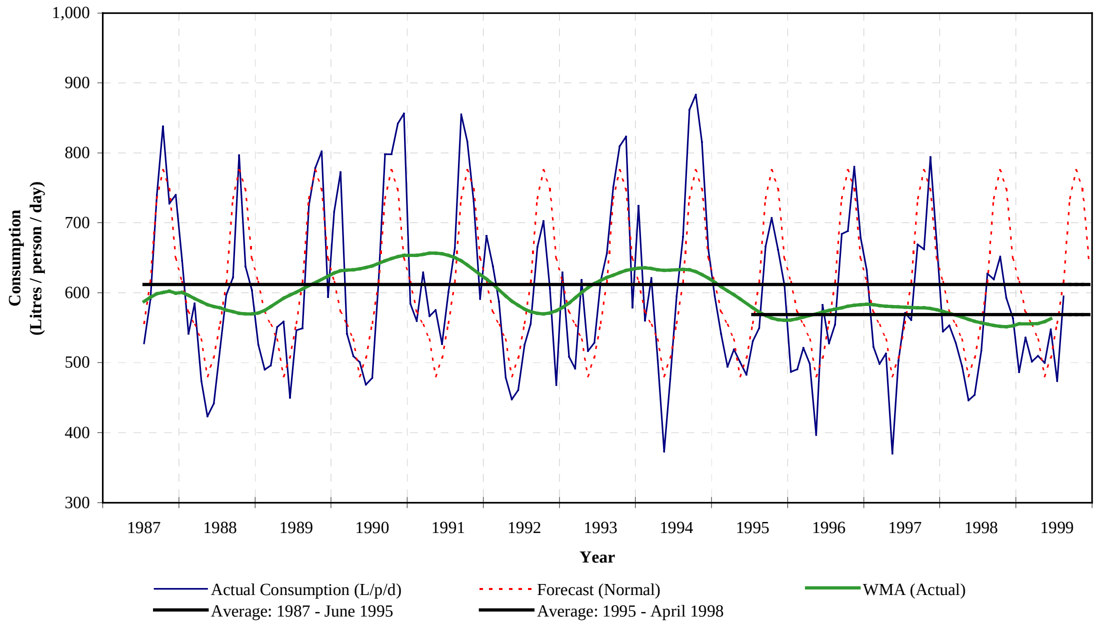


- **Weather** - The weather variables used in the regression analysis are expressed in terms of departures from normal weather. Rainfall for each month is expressed as the departure from normal rainfall for that month, and similarly for the other weather variables (rain days, maximum day temperature, and evaporation). In this way, departures of water use from normal (given by the seasonal index) can be correlated with departures of weather variables from their normal values.

  In the regression analysis process, various combinations of weather variables are used to isolate only those variables that best explain the variation in monthly water use. For Mackay, the departures of rainfall from normal (DR), departure of rain days from normal (DRD), and departure of maximum day temperature from normal (DT) were each strongly (statistically) significant in explaining the departures of production from normal. It is interesting that the departure of rain days is a much stronger predictor of the production pattern than departure of rainfall from normal. It is the frequency of rainfall, not the amount that affects the external use of water. Also, when the rain days and temperature departures are combined, the rainfall variable is so strong that the temperature variable is no longer statistically significant. Therefore it is evident that the number of rain days each month is the dominant weather variable affecting Mackay's demand.

  Using the derived coefficient for the impact of the departure of rain days from normal, the actual production was adjusted to remove the weather impact i.e. the production figures were normalised. The weather normalised production (per capita) for the period of the analysis is shown in **Figure 4.3**.

Figure 4.3: Mackay Total Production – Comparison of Forecast and Actual (Weather Normalised)



The data presented in **Figure 4.3** may be explained as follows:

- Actual Per Capita Consumption (L/p/d) – recorded total monthly production (ML/d) divided by the population.

- Forecast (Normal) – The long term forecast demand derived from the seasonality analysis.
- Weighted Moving Average (WMA) – The actual average consumption (L/p/d) over the previous twelve months
- Average (various periods) - The average consumption for a selected (stable) period of demand.

The deviation of the WMA from the long term average demand defines the demand fluctuation that cannot be explained by climate. In the case of Mackay demand increases in 1989 – 1991 and in 1993/4 as well as the demand reductions since 1994 are not due to climate.

- **Water Prices** - The only variable, other than weather, that was significant for Mackay was water price. In 1994/5, Mackay City Council introduced a version of user pays pricing, which increased the fixed charge from $108 to $223 per year with the same 300 kL annual allowance. Water use above 300 kL and less than 1,500 kL was charged at $0.40 in 1994/5 (increasing to $0.44 in 1999/0). Usage above 1,500 kL (a new block) was charged at $0.56 in 1994/5 (increasing to $0.61 per unit in 1999-00). Although the fixed charge more than doubled in 1994/5, the pay for use charge only increased from $0.35/kL to $0.40/kL for the majority of consumers. **Figure 4.2** shows that water use declined from 612 L/p/d to 568 L/p/d during the 1995-99 period. This represents a 7.2 % reduction in per capita water use. The price increase from the period immediately before the demand reduction was an increase of $115 or 106 % in the fixed charge. Technically, this tariff increase has nothing to do with pay for use. However, for the higher residential users, there was a pay for use effect. If the unit rate before and after user pays pricing is compared ($0.35 and $0.40), the increase is 14.3 percent. The impact of this change in price can be defined in terms of price elasticity as follows:

  Price Elasticity = % Change in Quantity Consumed / % Change in Price

  The price elasticity in this case would be 7.2 % / 14.3 % = –0.5. This is at the high end of the expected range of feasible water price elasticities, but it is not considered to be a good measure of elasticity for reasons that are discussed in Section 5.

  A price coefficient was also derived in the regression analysis for annual water bills for 300 kL/a customers. The price coefficient determined for Mackay was –0.23 (that is quantity of water produced decreases by 0.23 L/p/d for each $1.00 increase in the water bill). This coefficient relates to an elasticity of –0.07, which is considerably lower than the –0.50 figure calculated above. The reason for this difference is that the sharp increase in the annual bill in 1994/5 is diffused due to the regression analysis being undertaken over a longer period. However, the results from this method are also not truly price elasticity for reasons provided in Section 5. The correct interpretation of the downturn in water use in 1994/5 and the continuation of that downturn through to mid-1999 should be that all water related activities (including pricing changes) by the City resulted in a 7.2 % reduction in water usage. These activities included the increasing of the fixed charge by 106%, community education and conservation measures implemented through the WaterWise program.

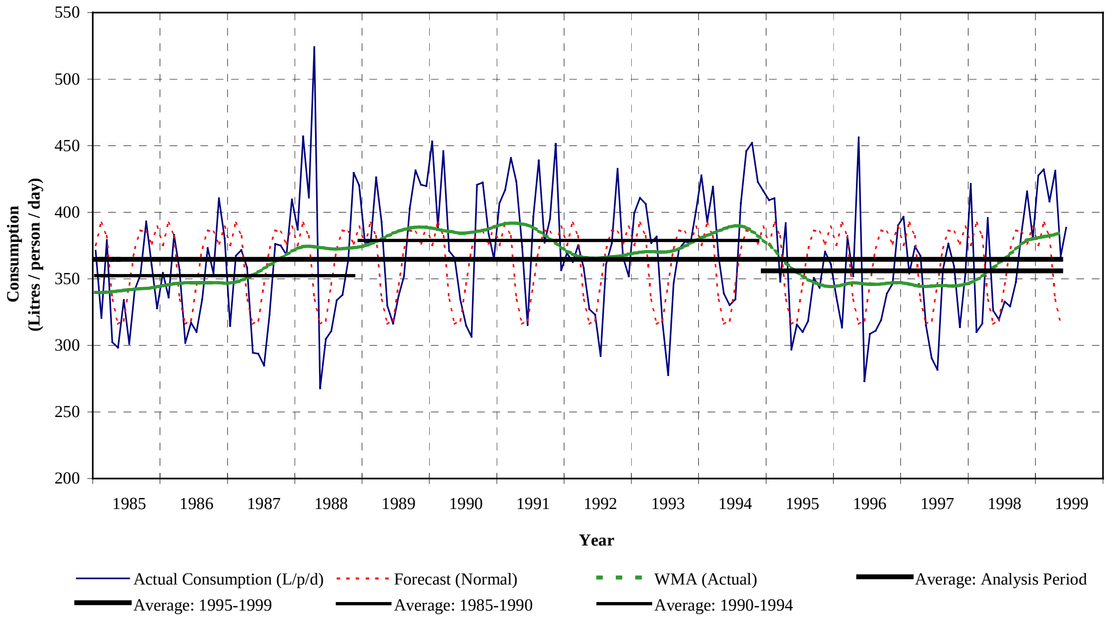
Based on the result of the weather normalised analysis the following summary observations are made:

- The departure from normal rain days per month is the dominant weather variable identified in this analysis.
- Demand performance indicates a reduction of 7.2 % reduction in water production for the city since 1994/5.
- The reduction in demand can be attributed to the various water related activities including a 106% increase in the fixed charge for water in 1994/5. Other activities included community education and WaterWise initiatives.
- The effect of individual conservation activities (pricing, community education and WaterWise initiatives) over the past five years cannot be isolated using the current demand model.

4.5 Analysis Results – Toowoomba

The regression analysis for the city of Toowoomba was undertaken using bulk water data for the period January 1985 to September 1999. The results of the analysis are given in **Figure 4.4**.

Figure 4.4: Toowoomba Total Production – Comparison of Forecast and Actual Demand (Weather Normalised)



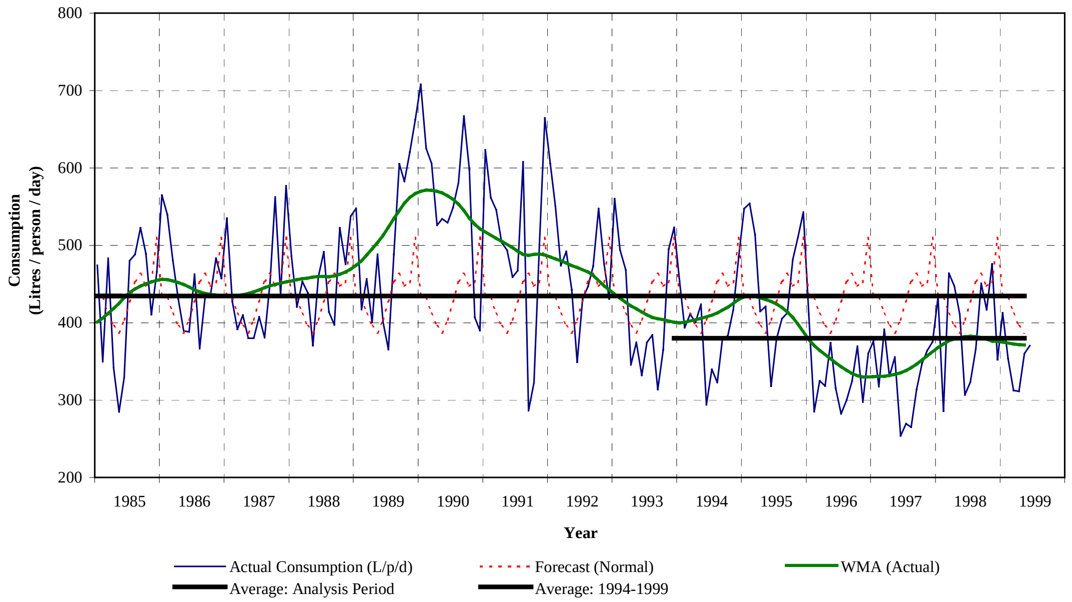
Based on the results of the weather normalised analysis as shown in **Figure 4.4**, the following observations are made:

- The departure from normal rainfall and temperature were the significant weather variables in this analysis.
- Demand performance indicates three distinct trends – a growth period for demand during the 1980s, a levelling out of demand from 1991 and 1994, and a decrease in demand during the period 1994 to 1996.
- The demand growth during the 1980s may be attributed to the changing attitudes following the severe price changes in the late 1970s. Consumers were gradually hardened to these changes and demands increased gradually over this period.
- A comprehensive user pays pricing policy was implemented in July 1995 and a strong public education campaign was undertaken during the six months prior to implementation. The result of the introduction of user pays was an immediate decrease in water consumption (reflected in the weighted moving average in 1995) of approximately 12% over the average from 1989 to 1994. As evident in **Figure 4.3** the initial reduction has fallen significantly in 1999. Reasons for the "bounce back" of demand since the initial reduction in 1995 may be related to the 6-month frequency of water bills and the high proportion of the fixed charge component of the average water bill (65%), providing little reward for low water use.
- The effect of the introduction of the Council's Demand Management Plan and WaterWise initiatives over the past five years cannot be individually isolated. These initiatives are believed to have contributed to the reduction since 1995.

4.6 Analysis Results - Maroochy

The regression analysis for Maroochy Shire was undertaken using bulk water data for the period January 1985 to mid 1999. The results of the analysis are given in **Figure 4.5**.

Figure 4.5: Maroochy Total Production – Comparison of Forecast and Actual Demand (Weather Normalised)



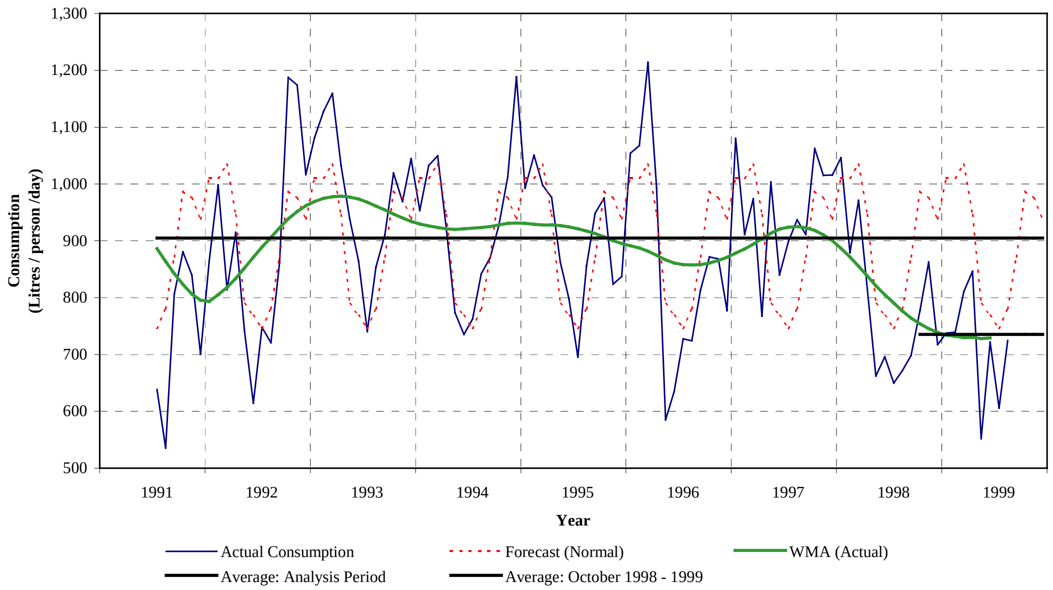
Based on the results of the weather normalised analysis the following observations are made:

- The departures from normal rainfall and from the number of raindays were the significant weather variables in this analysis.
- Demand performance indicates two distinct trends – a growth period for demand during 1987 and 1991 and a significant lowering of demand during the period 1992 to 1996.
- The significant increase in per capita demand in period 1988 to 1990 is believed to be related to the construction of the Baroon Pocket Dam and associated publicity. During this high growth period a number of high water using resorts were established in the shire. In addition, considerable development occurred in the residential sector. Such growth generally increases demand to cater for the establishment of gardens.
- The most significant impact on demand was the introduction of universal metering and associated changes to water pricing during 1992/3. This action was the major reason for a reduction of around 18 % in water usage.
- Further changes to the water pricing policy in 1994/5, together with various demand management and WaterWise activities have enabled the reduction in demand to be sustained at a level of around 380 L/p/d. Activities have included rebates for showerhead replacements and rainwater tanks.

4.7 Analysis Results - Emerald

The regression analysis for the township of Emerald was undertaken using bulk water data for the period mid 1991 to mid 1999. The results of the analysis are given in **Figure 4.6**.

Figure 4.6: Emerald Total Production – Comparison of Forecast and Actual Demand (Weather Normalised)



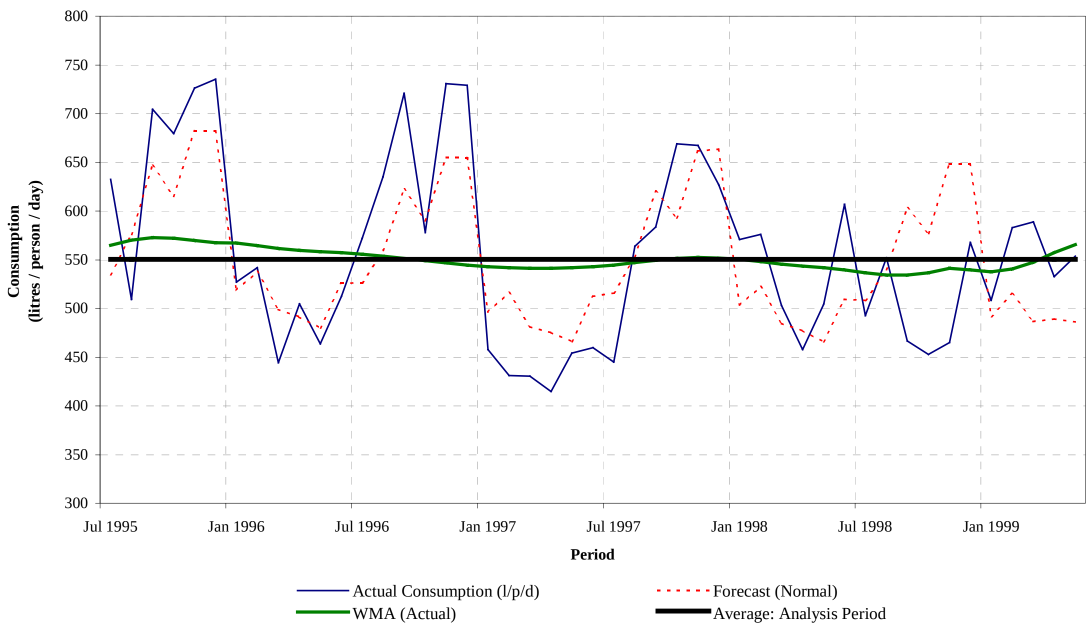
Based on the results of the weather normalised analysis the following observations are made:

- The departures from normal rainfall and from average temperature were the significant weather variables in this analysis.
- Demand performance indicates two distinct trends – a stable demand pattern up to the middle of 1997 and a significant lowering of demand since that time.
- The response to changes to the base allowance from 750 kL/a in 1993 to 450kL/a in 1997 was noticeable, but not significant.
- The response of demand to the lowering of the base allowance to 250kL/a in 1998 was significant. This action was the major reason for a reduction of up to 150 L/p/d or 16% in water usage. The implementation of this initiative was a transition to full user pays and was evaluated by a community based Water Pricing Committee. Full user pays was introduced in 1999 and it can be expected that demand may fall further.

4.8 Analysis Results – Ingham

The regression analysis for the township of Ingham was undertaken using bulk water data for the period mid 1995 to mid 1999. The results of the analysis are given in **Figure 4.7**. Data during the period 1998/9 appears erratic and may be erroneous.

Figure 4.7: Ingham Total Production – Comparison of Forecast and Actual Demand (Weather Normalised)



Based on the result of the weather normalised analysis the following observations are made:

- The departures from the normal number of rain days and from average temperature were the significant weather variables in this analysis.

- Demand performance indicates no reduction in demand resulting from the introduction of user pays in 1995/6. At that stage the allowance was eliminated and the fixed charge was increased by 39%. Despite this large increase in fixed charge the total water bills did not significantly increase as discussed in Section 5.5.3.
- Additional production data for the period 1983 to 1993 was provided through the DNR annual statistics. The data indicated a gradual demand reduction from 1983 levels of around 30 %. This reduction related to the installation of water meters in 1989, as well as to the imposition of restrictions on an ad-hoc basis. During this period, sprinkler times were regulated and odds / evens restrictions were imposed. In addition the demand for the period 1993 to 1995 appears to have decreased by a further 20%. Reasons for this reduction are not known however may be associated with the pricing changes, demand management activities, weather effects or a combination of these issues.

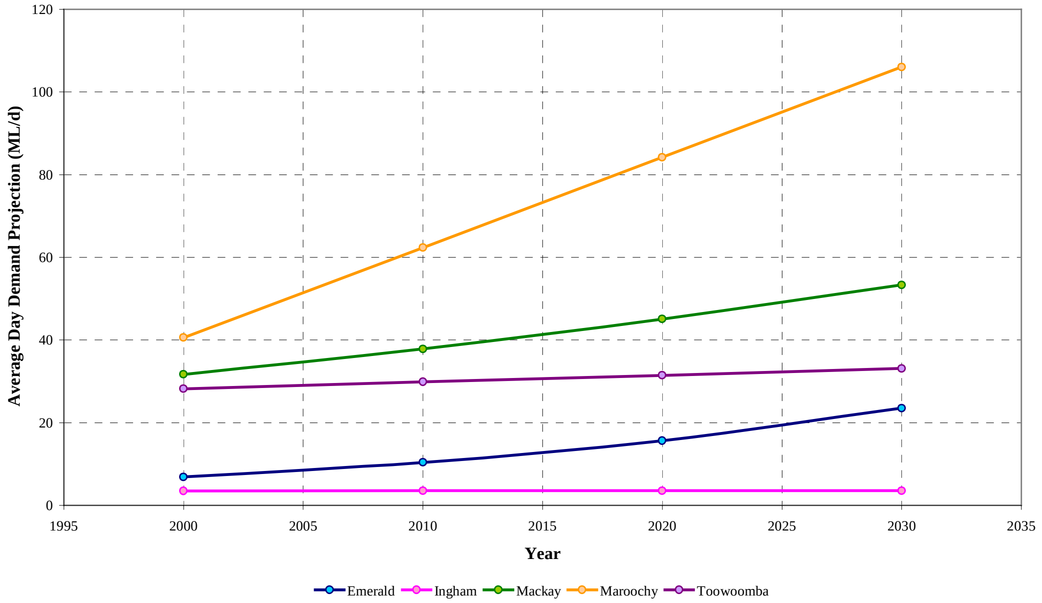
4.9 Projected Water Demand

Population projections for the respective communities were provided for the next 30 years in **Table 4.1**. Demand projections, based on the detailed demand analysis undertaken for the each community and the assumed population projection are given in **Table 4.4** and **Figure 4.8**. These estimates assume a continuation of existing per capita demand levels and do not take into account naturally occurring conservation. *Derived per capita demand* shown in this table is for total production, including demand for all customer categories.

Table 4.4: Population and Demand Projections for Pilot Communities (Excluding Natural Conservation)

Pilot Area	Derived Per Capita Demand (L/p/d)	Average Day Demand (ML/d)			
		2000	2010	2020	2030
Emerald	740	6.7	8.2	10.0	12.2
Ingham	560	3.5	3.5	3.5	3.5
Mackay	610	31.7	37.8	45.1	53.3
Maroochy	380	40.6	62.4	84.2	106.1
Toowoomba	360	28.2	29.8	31.5	33.1

Figure 4.8: Average Day Demand Projection (ML/d) - Excluding Natural Conservation



4.10 Internal/External Use

It is important to determine internal and external water use to evaluate water efficiency opportunities. To define internal and external demand it is first necessary to determine the total residential account usage. This is undertaken as follows:

- Bulk demand for the study area is obtained, and entered into the DSS (in ML/d)
- An estimate of Unaccounted For Water (UFW) is determined for the community. Most local governments have an estimate of UFW, which is usually comprised of un-metered demand, leakage and other system water losses (e.g. slow reading meter, un-metered demand). This is expressed as a percentage of the bulk water usage figure.
- UFW is subtracted from the bulk water usage, and the remainder is assumed to be actual water usage (i.e. total metered water usage by each property type – RF, RH, etc.).
- Billing records were analysed to obtain the proportion of demand taken up by each customer category. The actual water usage is then proportioned between each category. The amount of water consumed by the residential sector is then obtained, and an average per account, calculated.

The analysis of the seasonal trends in each of the communities shows that the lowest demand period varies but is normally during the May/June/July period. This is due to the lower temperatures in autumn/winter, and occurs following the end of the wet season when irrigation requirements are minimal. This observation is used to assist in the prediction of the internal / external water demand. It must be noted, however, that the demand during this period includes non-residential demand, which may distort the minimum demand figures.

Another approach to the determination of average external usage is to review daily consumption and rainfall data. This information may be analysed to give a reasonable estimate of internal water use from which the external water usage may be derived. Alternatively, analysis of sewage flow data is extremely useful. From flow hydrographs the daily volume per person may be determined by removing the base or dry weather infiltration flow from the total. These approaches are outlined in detail in **Appendix A**.

For this study the internal consumption was determined from published water consumption figures and sewage flow studies for areas such as Maroochy Shire and Gold Coast City. The adopted figures were compared with the per capita minimum demands determined from the demand analysis and seasonal indices.

Table 4.5 summarises the internal/external demands adopted for this study.

Table 4.5: Summary of Average Consumption Breakdown (Excluding Unaccounted For Water)

Pilot Community	Adopted Internal Demand (L/account/d)	Derived External Demand (L/account/d)	Total Residential Demand (L/account/d)	Total Annual Demand (kL/account/a)
Emerald	482	665	1147	419
Ingham	502	325	827	302
Mackay	501	325	826	302
Maroochy	404	344	748	273
Toowoomba	410	164	574	210

4.11 Estimated End Use Breakdown

To enable economic analysis of water efficiency initiatives to be undertaken it is necessary to estimate the various end uses of water in residential dwellings. There is a significant database of information on which to base these assumptions. Data adopted for this study is based on research in Australia by many organisations such as Brisbane Water, ACTEW, WAWA, Rous County Council and Sydney Water. Data from these organisations is discussed and presented in the DSS User Manual.

For this study, the information was combined and entered into the DSS where the water usage was calibrated using the demand calculation undertaken in the spreadsheet.

Based on previous experience, a standard end use breakdown is derived as a proportion of both the total internal and external water usages. Because internal and external water usage is different for each area, the final end use figures vary from community to community. Details of the adopted end uses are given in **Table 4.6** and a diagrammatic representation of the adopted figures (in litres per day) for each of the pilot areas is shown in

Figure 4.9 to **Figure 4.13**.

Table 4.6: Adopted End Use Breakdown (per Residential Account)

End Use Description	Percentage of End Use	*Toowoomba*	*Maroochy*	*Mackay*	*Ingham*	*Emerald*
Internal		**410**	**404**	**501**	**502**	**482**
Toilets	25.0%	103	101	125	126	121
Baths	2.0%	8	8	10	10	10
Showers	30.0%	123	121	150	151	145
Taps / Sinks	13.0%	53	53	65	65	63
Dishwashers	2.0%	8	8	10	10	10
Laundry	20.0%	82	81	100	100	96
Internal Leakage	8.0%	33	32	40	40	39
External		**164**	**344**	**325**	**325**	**665**
Garden Watering / Irrigation	80.0%	131	275	260	260	532
Pools / Fountains	5.0%	8	17	16	16	33
Wash-Down	5.0%	8	17	16	16	33
Car Washing	5.0%	8	17	16	16	33
External Leakage	5.0%	8	17	16	16	33
Total		**574**	**748**	**826**	**827**	**1147**

Figure 4.9: Toowoomba Estimated End Use (L/p/d)

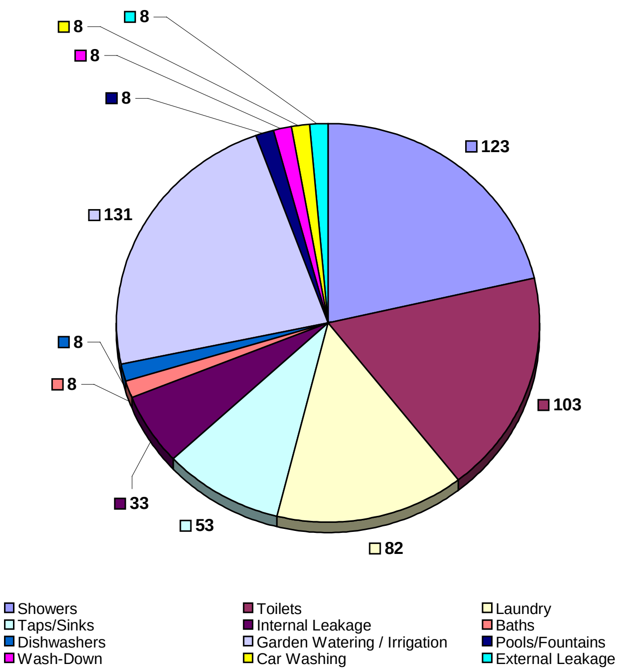


Figure 4.10: Maroochy Estimated End Use (L/p/d)

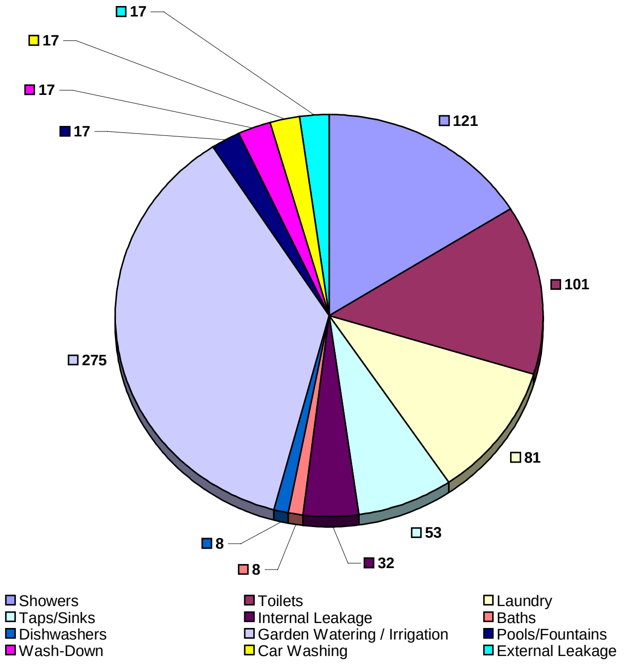


Figure 4.11: Mackay Estimated End Use (L/p/d)

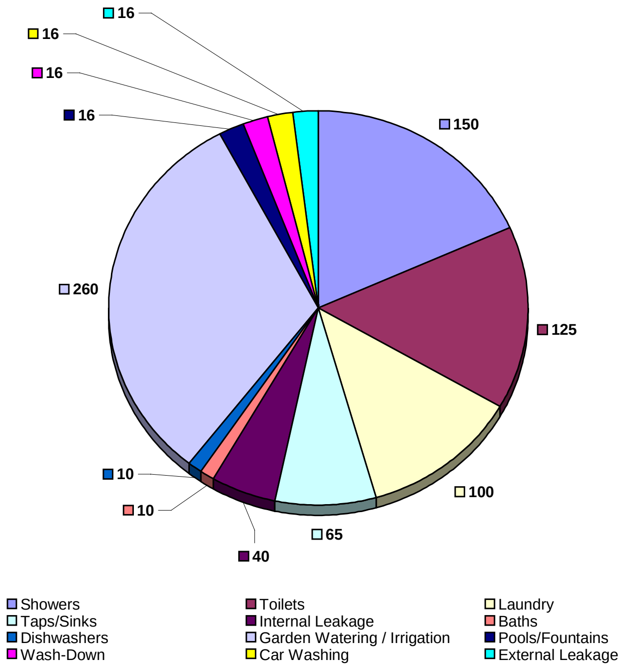


Figure 4.12: Ingham Estimated End Use (L/p/d)

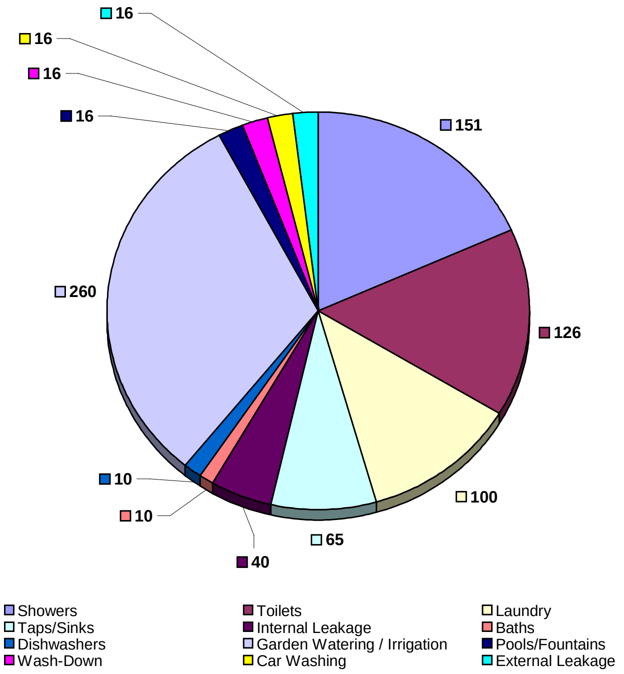
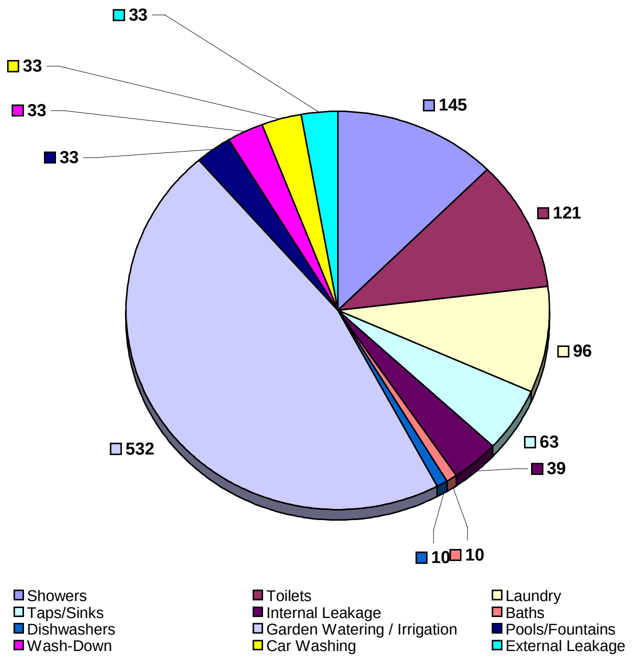


Figure 4.13: Emerald Estimated End Use (L/p/d)



4.12 Summary of Findings and Recommendations

The following conclusions were drawn from the demand analysis undertaken for this study:

- Seasonal indices (monthly) developed for each community indicates that a maximum variation from average monthly demand of 1.2 to 1.25 was found in Mackay, Ingham and Maroochy. The high season index for Maroochy is believed to be partially the result of the peak tourist season. For Mackay and Ingham, the variation is due to the pronounced wet and dry seasons in tropical areas of Queensland. The minimum seasonal variation is found in Toowoomba which has a peak month of only 1.07 times the average month.
- Analysis of the historical demand for the five communities indicated that
  - the departure from normal of the number of raindays per month was found to be the most statistically significant climate variable affecting water demand in the coastal communities of Maroochy, Mackay and Ingham.
  - the departure from normal monthly rainfall and from average monthly temperature were identified as the statistically significant variables affecting water demand in the inland communities of Toowoomba and Emerald.
- Demand reduction since the adoption of user pays pricing was evaluated and it was found that the responses were as follows:
  - Maroochy (1992) 18% (reduction sustained)
  - Emerald (1998) 16% (demand falling)
  - Toowoomba (1995) 12% (demand increasing)
  - Ingham (1995) 0% (demand constant)

  Maroochy’s introduction of user pays pricing coincided with the introduction of universal metering. The Toowoomba policy coincided with the introduction of sprinkler hours regulations.

  Assessment of the performance of user pays pricing in Ingham was complicated by the lack of monthly demand data. Data provided following the completion of the analysis indicates that a reduction of up to 20% may have been achieved during the implementation period.
- Mackay City has achieved a sustained 7.2% reduction in water demand since 1994, when the fixed charge was increased by 106%. Full user pays has not been implemented to date and therefore additional demand reduction may occur following the introduction of a new pricing policy.
- All of the pilot communities have engaged in demand management initiatives since at least 1995. Water demand reductions achieved since the introduction of user pays water pricing are therefore the result of all actions including public education, demand management measures, pricing policy media releases, general environmental awareness campaigns and the like. It may be assumed, however that the majority of the demand reductions (possibly up to 90%) result from the introduction of user pays pricing or a significant price increase (as in Mackay).
- Demand analysis of residential accounts shows that the total average water consumption of a household ranges from approximately 574 L/d to 1,147 L/d for the communities studied.

- External usage ranges from 164 L/d to 665 L/d. The highest levels of external usage was determined for Emerald, with Mackay, Ingham and Maroochy exhibited relatively low levels of external water use, and Toowoomba exhibiting the lowest external water usage.

Recommendations relating to the demand analysis phase of Least Cost Planning are as follows:

- The use of a demand analysis and forecasting model should be adopted for Queensland local government water supply planning. A demand model similar to that adopted in this study, provides the following benefits:
  - a clear understanding of the impact of climate on water demand is achieved
  - information for the development of pricing policies, which ultimately rely on the accurate forecast of demand, is available from the model
  - more accurate forecasts result in the cost effective programming of major water supply projects
  - the performance of pricing policies and water efficiency measures can be reliably evaluated.
- Data collection, verification and archiving procedures should be improved in Queensland local governments to provide the information required for detailed demand analysis to be undertaken in future.
- Planning of the implementation of water efficiency initiatives needs to be improved to include detailed design and assessment aspects such as full cost tracking, performance evaluation and feedback to the community.