3. DEVELOPMENT OF DECISION SUPPORT SYSTEM

3.1 Scope and Purpose

The Least Cost Planning Decision Support System (DSS) has been designed to provide a detailed evaluation framework for water demand management programs. In evaluating potential demand management programs, a large number of measures are usually considered. The DSS provides a standardised basis for the determination of the cost effectiveness of each measure, as well as comparison of the combinations of measures that make up a program.

The DSS has been designed to provide a familiar computational environment with a level of automation that enables the user to perform complex calculations without having to devise different systems for each community.

The DSS essentially calculates the Benefit/Cost ratio for any measure based on:

- Calculation of the **benefits** of a measure by estimating the reduction of water demand and determining the effect on delay of major (capacity related) capital works. In addition the benefits relating to reduced cost of production and transfer of water, and transfer and disposal of sewage are calculated.
- Calculation of **costs** of implementing any particular demand management measure. These costs include the cost of designing and managing a program including promotion and marketing, rebates and giveaways, and monitoring / analysis of the measure's effectiveness.

Following assessment of the benefit/cost ratio for various individual measures, the selected measures are combined in a cost effective program for implementation.

The cost effectiveness of a water efficiency measure or program can be viewed from three perspectives:

- *Authority* – The usual approach is to undertake analysis from the authority's perspective as these bodies are responsible for implementing cost effective programs on behalf of the community and to provide savings back to each customer in the form of reduced charges.
- *Community* – The perspective of the community is critical as this provides the public benefit test, taking into account all costs and benefits including electricity cost reduction. If a measure or program is found to be cost-effective from this perspective then the participating customers will obviously benefit. In simpler terms, the total community benefit is comprised water utility benefits plus hot water savings.
- *Customer* – The customer's perspective is usually taken for specific circumstances, for example, non-residential customers. It is difficult to specifically quantify the costs and benefits for residential customers because

of the combination of fixtures and appliances that a customer may possess. When a measure or program is being assessed for a customer, it is taken on a community basis, to ascertain the average potential cost and benefit. To analyse the costs and benefits for a particular customer, such as a commercial business, the customer's water usage and specific fixtures and fittings are audited. The costs of specific measures are then analysed to determine the potential benefits that could be realised.

The DSS has been developed to separately assess strategies relating *average* savings to the water authority and community, and therefore the customer's perspective is not needed.

A detailed discussion of the approach to the economic analysis of trialed measures is given in Section 8.2.

Figure 3.1 provides an overview in flow chart format of the approach adopted for the DSS.

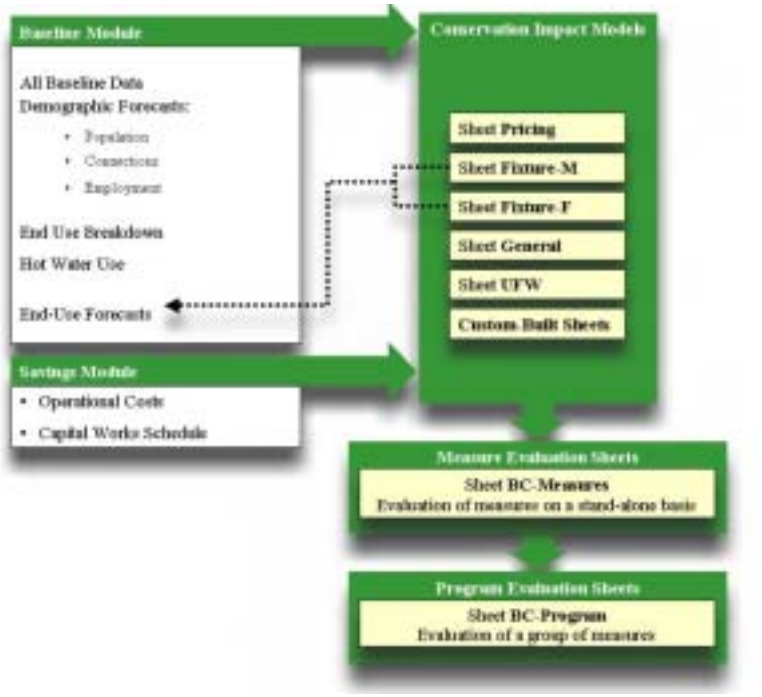
Figure 3.1: DSS Overview

3.2 Overview of DSS

3.2.1 Structure

The structure of the DSS is shown in **Figure 3.2.** The DSS is set up in the familiar environment of a Microsoft Excel spreadsheet.

Figure 3.2: DSS Structure



3.2.2 Data Requirements

Data for the Baseline Water Use and Savings modules are entered initially for each analysis. All other worksheets (Measure Impact and Program Evaluation Sheets) are copied and used to evaluate the cost effectiveness of each measure, and variations of the measure e.g. different rebate levels for showerheads.

The data requirements for the DSS are summarised as follows:

1. Annual Production (ML/d)

Annual production data is based on existing demand and projections are developed from the demand analysis and population projections.

2. Unaccounted for Water (UFW) Level (%)

Varying UFW levels can be assumed throughout the analysis period. The base level was assumed to be a constant percentage of bulk demand based on advice from the authority. The UFW for the communities in this study was determined by the Integrated Flow Method, where the total production and total sales volumes were compared to produce a % UFW.

3. Demographic Forecasts

Population forecasts and other demographic data was sourced from:

- Australian Bureau of Statistics (ABS)
- State Government bodies, such as the Department of Communication, Information, Local Government and Planning (DCILGP)
- Local Government, typically the water supply or town planning section of the shire or city council

4. Customer Categories and Number of Accounts

Using the local government billing database the count of properties for various customer categories was determined for use in the DSS.

Depending of the property classification system used in a billing database, it may be necessary to reclassify the properties. The customer categories adopted for the DSS were as follows:

- Residential House (RH) – Also known as single family residential properties, this category usually accounts for the majority of consumers in any community.
- Residential Flats (RF) – Also known as multi-family residential or flats/units.
- Commercial (COM) – Properties that are commercially based, i.e. shops or restaurants.
- Industrial (IND) – Industrial properties such as light, general and manufacturing.
- Public and Other (PUB) – Accounts for local, state or commonwealth owners of non-residential properties, such as hospitals, council buildings or public sporting facilities.
- Tourist (TOU) – Tourism based properties. This category includes larger tourist attractions, such as theme parks, but not resorts or tourist accommodation. This category is optional and should only be included for properties that have been specifically categorised as tourism.

5. Consumption per Account by Customer Category

Using the local government's billing database, it is possible to determine the proportion of demand consumed by each customer category. Approximate ranges of demand by customer category in Queensland are given in **Table 3.1.**

Table 3.1: Estimated Consumption by Customer Category

Customer Category	Proportion of Total Demand
Residential Houses (RH)	55 – 70%
Residential Flats (RF)	10 – 15%
Commercial (COM)	10 – 15%
Industrial (IND)	2 – 10%
Public/Other (PUB)	2 - 5%
Tourist (TOU)	0 – 3%

6. Internal & External Use Breakdown

It is necessary to estimate the internal and external use breakdown for each customer category. The methods adopted for determining the internal and external use in this study are described in Section 5. The internal and external use breakdown can be reliably determined for residential houses and residential

flats. However, the breakdown for the remaining customer categories is more difficult to ascertain because of the diversity of water uses.

7. End Use Breakdown

End use is defined as the demand used by a particular fixture or device within an account. A wide range of studies have been carried out both in Australia and overseas to determine end water use breakdowns in residential house and flats. The end use breakdown adopted for this study is discussed in section 4.11.

End use estimates are calibrated using known and estimated per capita usage figures for particular devices. As these usage figures represent the mean number of uses by a person for each fixture in a day, the model for each community must be calibrated. This ensures that the end uses assumed match the baseline projected demand.

8. Operational Costs

The marginal (or volume related) costs associated with the operation of water supply and sewerage systems is calculated and entered into the DSS. Costs included are as follows:

- Water Transfer Cost: includes the electricity cost of transferring raw water to the treatment plant and treated water to the service reservoirs or pumping to pressurise the system. The costs related to extraction of water from bores is also included in the component.
- Water Treatment Cost: includes the costs of electricity and chemicals for the treatment of raw water to a potable standard.
- Sewerage Transfer Cost: includes the energy cost for transferring sewage from pumping station to treatment plants, and the cost of pumping effluent to reuse and disposal.
- Sewerage Treatment Cost: includes the cost of electricity and chemicals used in the treatment of sewage, as well as license fees for the disposal of effluent (if applicable)

9. Capital Works Program

The cost of capital works projects relating to the augmentation of the raw water transfer, treatment, storage and reticulation of water are input to the DSS. A capacity (ML) and trigger capacity (in ML/d based on the current system planning) are input to enable delay costs and revised programs to be determined based on revised water demands.

3.3 Benefit / Cost Analysis

Each residential measure is formulated with the aim of reducing one or more end use demands within house or flat accounts on an individual basis, or a combination of both of these types of account.

A measure can be defined as an implemented action or device (or devices), distribution method and possibly an incentive, such as a rebate, which is targeted at a particular type of end user to save water. Each measure is assessed with the following considerations taken into account:

- **End Use Savings** – For each measure shortlisted for analysis, there is an assumed or known water saving. The saving, defined for each end use, is equated as the water consumption saving per account, and expressed as a percentage of each account's total consumption. Past experience, the results of previous studies and data from manufacturers, enable savings for each measure, to be determined for the analysis.

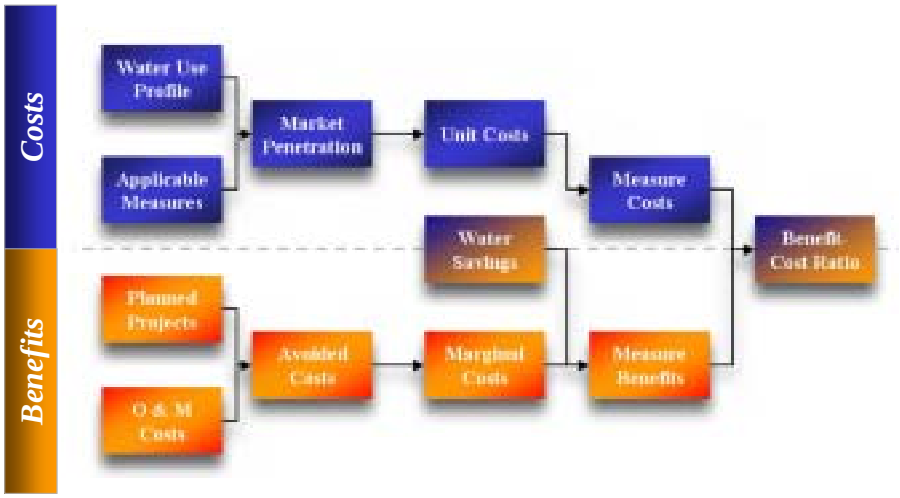
- **Participation Rates –** The participation rate is the assumed percentage of the existing customer base that would participate in a measure in any particular year. Possible measure participation rates were considered and accounted for depending on the type of measure being evaluated. Certain measures will have higher participation rates, especially where rebates to customers are involved. From previous experience, it has been shown that customer attitudes towards a measure are generally influenced by the offer of a rebate. The participation rate is also related to the marketing strategy adopted and the level of promotion. The perceived need to conserve also has a significant effect on the participation of customers.

- **Measure Life** – The life of a measure needs to be input to determine the impact of those measures that require repetitious implementation to maintain an effective water usage reduction. Measures that would have a "life" include public education that has an immediate effect on a select group of people. After a few years, the measure will have to be repeated to increase the awareness of another group of people to achieve the same savings.

- **Measure Cost** – The cost of each measure is calculated on the basis of the total implementation cost. The cost of materials and / or equipment, as well as staff salaries, are taken into consideration, and figured into the overall evaluation of each measure. Measure costs are assessed on a per account basis, plus setup fees if required.

The evaluation of water efficiency measures is undertaken using benefit/cost analysis. The purpose of this analysis is to identify which of the shortlisted measures would be cost effective to implement within the targeted pilot communities as a means to reduce water consumption. **Figure 3.3** gives an overview of the methodology used in the analysis.

Figure 3.3: Benefit/Cost Analysis Methodology



The following steps are undertaken in the benefit/cost analysis:

1. Develop baseline water use projections without conservation. Projections should cover each key customer category and be broken down into indoor and outdoor use.
2. Develop appropriate unit water savings and cost factors for each shortlisted measure.
3. Estimate the affected population (or number of accounts) for each conservation measure by multiplying the total service area population (or accounts) by the measure's projected population (or accounts) that implement the measure. This factor is called the market penetration or participation rate.
4. Estimate total annual average and peak day water savings. The water savings for any measure are calculated by multiplying unit water savings, per measure, by a market penetration or installation rate, and then multiplying by the number of units in the region targeted by a particular measure.
5. Calculate the unit value of capital project deferrals and reduced operation and maintenance costs. The results are then expressed in unit value form, ie. dollars per 1000 kilolitres (1 ML) saved.
6. Quantify total benefits for each year in the planning period by multiplying average water savings by the unit benefit.
7. Determine initial and annual costs to implement the measures based upon pilot projects, local experience, and the costs of goods, services, and labour in the region. These costs are multiplied by the number of accounts participating each year and added to overall administration and promotion costs to arrive at a total measure cost, which may be spread over a number of years.
8. Compare benefits and costs by computing the present worth of costs and benefits over the planning period. A discount rate of 5% is assumed for this analysis. This is based on a nominal interest rate of 8% and assumed inflation rate of 3%.
9. Develop a water efficiency plan containing a combination of cost effective measures (i.e., benefit/cost ratios greater than one and acceptable

non-quantifiable impacts). Combining the measures into a program takes into account the interaction of measures with respect to the overall program benefits. It needs to be noted that the program B/C ratio and the overall water savings are not simply the combination of the individual numbers determined from the analysis of measures. For each measure, and each end use saving, an Impact Factor is calculated as follows:

$$\text{Impact Factor} = \frac{\text{Modified End Use Demand}}{\text{Original End Use Demand}}$$

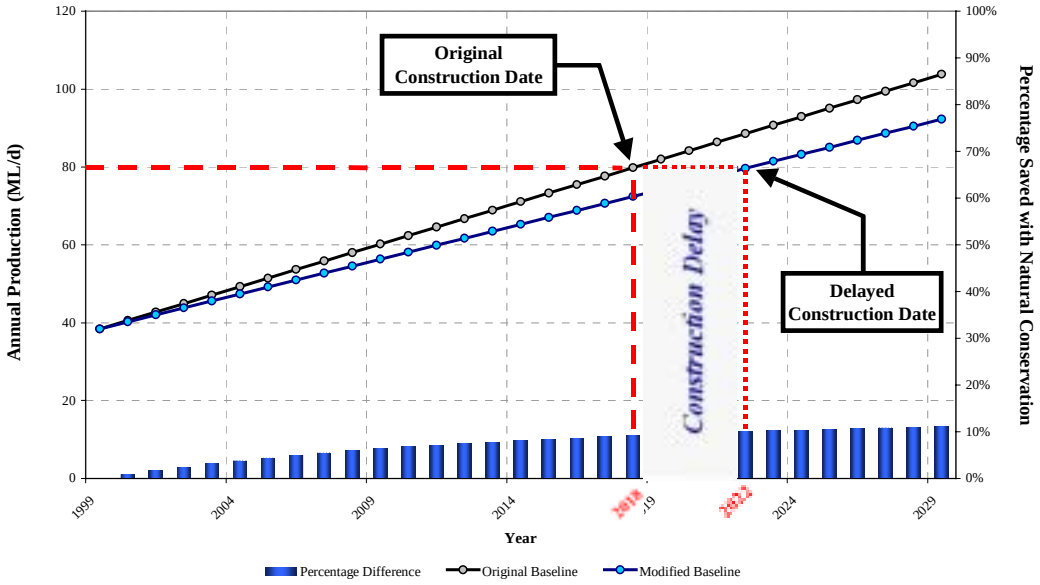
A Measure Impact Factor is then calculated by multiplying the individual end use impact factors. Finally program savings can be calculated by determining the product of the Measure Impact Factors of the selected measures and applying this figure to the sum of the water savings. In this way savings are not double counted or compounded, which would provide misleading, excessively high savings and B/C ratios.

The measures outlined in the brief were analysed in the DSS for each of the pilot areas. Each of these measures are discussed in Section 8.4. Limited sensitivity analysis was undertaken for some of the measures, typically to try and demonstrate the effect of financial incentives (rebates) being given to the community. To illustrate these effects, it was necessary to first formulate the costs associated with the measure and then assume different levels of rebate. Based on the rebate levels being assumed it was then necessary to assume participation rates in response to the rebates being offered.

3.4 Natural Conservation

Natural conservation is the result of a reduction in overall user consumption levels due to the installation of water efficient fittings and fixtures, without the implementation of a demand management program. Demand projections are typically based on current consumption levels, with projected bulk demand being factored up based on the increase in population. Devices such as 6/3 L flush toilets are to be installed in all properties. Installations of such devices in new buildings and the replacement of old stock will obviously reduce demand. With most demand forecasts used in water supply planning, natural conservation is not taken into consideration. Consequences of over estimation of demand are the early commissioning of major works, such as dams and treatment plants. An example of a demand forecast, (with natural conservation taken into account) and potential construction delays is given in **Figure 3.4**.

Figure 3.4: Example of Natural Conservation and Resultant Construction Delays



Demand projections for each community, taking into account natural conservation, are given in Section 10.1.3. The calculation of natural conservation is undertaken in the baseline demand analysis within the DSS.

3.5 User Manual

A User Manual was produced as part of the project and is contained in **Appendix A**. The manual provides a definition of terms, an overview of the inputs required and a description of each of the modules contained in the DSS.