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FINAL REPORT:

WATER DEMAND MANAGEMENT DATA AND ANALYSIS RECOMMENDATIONS FOR THE WATER DEMAND MANAGEMENT UNIT, MINISTRY FOR WATER AND IRRIGATION, HASHEMITE KINGDOM OF JORDAN

By

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August 18, 2003

DEMAND MANAGEMENT DATA AND ANALYSIS RECOMMENDATIONS FOR WDMU

GENERAL OVERVIEW AND RECOMMENDATIONS

Making more efficient use of existing water resources through demand management is an economical and environmentally responsible way to meet growing demand for water. A Demand Management Plan should outline a strategy for developing demand management as a proven water resource. If Jordan committed to aggressive pursuit of demand management, it would help preserve Jordan's existing valuable and limited natural water resources, and provide a readily available and low cost water resource for the coming years. Pursued in conjunction with new water supply resources, demand management can help Jordan meet the present and future needs of the nation's people.

Jordan has already begun a demand management effort, through the help of the Water Efficiency and Public Information for Action Project (WEPIA), and the establishment of the Water Demand Management Unit (WDMU) in the Ministry for Water and Irrigation. These efforts include: modifying plumbing codes that mandate low-water use sanitary ware; free audits to large consumers; educating the public on to reduce water consumption; creating advocacy groups; reforming school cirriculum to include water issues; encouraging the use of low-cost water saving technologies; and educating key professionals in the principles of water demand management. The efforts to date will produce effective water savings over the next twenty years. The WDMU is developing a plan for continuing and expanding demand management in Jordan to increase the benefits from demand management in the next decade and beyond. ***In order to plan and implement demand management most efficiently and successfully, the WDMU must begin an ongoing program of data collection, research, modeling, analysis, monitoring and evaluation.***

The primary focus of WDMU's near term data and analysis efforts should be to complete a Water Demand Management Potential Assessment. The Potential Assessment should provide a rigorous analysis and evaluation of the cost, volume, and reliability of demand management opportunities available in Jordan over the next decades. The Potential Assessment will determine the level of water savings that can be achieved, and compare the cost at various levels and to the cost of new water supply. The WDMU can use the results of the Potential Assessment to set goals and targets over the next ten years, and to determine the programs and costs to achieve those targets.

In order to provide a framework and context for the data and analysis planning needs, including the Potential Assessment, the following Sections outline the general strategies, principles and measures often contained in a demand management program plan.

PRINCIPLES OF DEMAND MANAGEMENT PROGRAMS

Demand management measures should be set in a context of cost effectiveness. In this way, program cost can be minimized given any targeted volume of savings to be achieved, and avoided cost can be maximized, compared with the cost of providing similar volume via conventional water supply. Given Jordan's national policy of water utility cost recovery, overall, the result of the demand management actions should be lower long run average water bills for Jordanian consumers.

The demand management initiatives should be achieved on a collaborative basis with water supply managers and customers. Although the responsibility for planning and delivering regional demand management programs currently resides with the WDMU, the involvement and support of all stakeholders and participants is critical. Demand management programs are customer driven - they need to be tailored to the customer's needs and motivations to be effective.

Other principles applied should include: ensuring equity among consumers; making the greatest impact by concentrating program resources; reducing costs or providing additional benefits by seeking partnerships and avoiding lost opportunities; ensuring program success by monitoring and evaluating program savings and costs; and testing program design with pilot efforts prior to full-scale program implementation.

Strategies and Measures Overview

Measures can be usefully grouped into five demand management strategies: water rate structures; codes and regulations; customer incentives; public information and education; and water supply system efficiency. In addition, the demand management programs should be designed based on how the water is used. Water use by customers can be divided into three categories: Domestic -- drinking, cooking, cleaning and sanitary use; Landscape -- lawn and garden irrigation by businesses, parks, governments and homes, and; Process -- cooling, heating, manufacturing, and product use. Water used for water supply system operation itself and water lost through leaks, evaporation and other causes is fourth category of water consumption.

An efficient program will generally pursue all the avenues of demand management discussed in more detail below. In some cases, programs have already been started by WEPIA and WDMU, and have achieved savings. In other cases, programs are ready to begin to ramp up, other programs must complete the research and development phase. WDMU's Water Demand Management Plan should address specific savings targets, costs, budget and schedule associated with the general programs discussed below.

Rate Structures Generally, the greater the cost of water per additional amount used, the less customers will use. Structuring water rates to encourage demand management is a key demand management strategy and gives customers more control over their water bills.

Efficient Price Signals Water rates that reflect the marginal cost of providing water ensure that the value of consumers' use is equal to the cost of producing water. Marginal cost rates mean supply cost subsidies are eliminated. Rate structures that encourage efficient use include seasonal or inclining block rates.

Inform customers about water use Include a consumption history on the water bill to provide a visual demonstration of their current use compared to previous months and years.

Codes and Regulations A highly effective demand management strategy is to adopt codes and regulations that require certain efficiency levels, or prohibit certain kinds of water waste. Expected savings from codes should be incorporated into WDMU's demand management plans and demand forecasts.

Plumbing Code Efficiency Standards Plumbing code efficiency standards can require that the only efficient toilets, showerheads, aerators, washing machines or other water using appliances can be sold or installed, including retrofit upon remodel or sale of property.

Landscape Codes Water efficiency landscape codes can be adopted to ensure compliance with a water budget or to plant materials, landscape designs or irrigation systems that must be efficient water use types.

Process Codes Water efficiency codes can be adopted for commercial and industrial processes, such as cooling designs or recirculating manufacturing uses.

Public Information and Education Public information and education programs are the backbone of an effective demand management program. Through a variety of messages and media, customers learn why and how they should conserve as well as about demand management programs available to them. Ongoing demand management information and education programs are an essential element of a demand management plan. The following is a list of ongoing promotion and marketing efforts commonly used.

Residential Efficient Plumbing Fixture and Appliance Promotion Encourage residential customers to remove inefficient plumbing fixtures and appliances and install efficient replacements.

School Programs Offer a variety of services including presentations, curriculum development, training seminars, work books, maps, quizzes, etc.

Promotion and Outreach Brochures, public service announcements, paid advertising, newspapers articles, presentations, talk shows, trade fairs, etc.

Water Demand management for Apartments and Businesses Promote water use efficiency in apartments and businesses.

"Smart Business Recognition" Feature the demand management commitment and achievements of businesses, with awards and public recognition.

Resource Efficiency Education Awareness and motivation of water use efficiencies and impact on environmental issues.

Lawn Research and Demonstration Demonstration gardens installed at public places to show how to be water efficient.

Public Media Campaign Educate the public about why and how to conserve water with TV, radio and other media advertising.

Point of Purchase Program Point-of-purchase promotion for water efficient products.

Incentives Providing customers financial incentives to convert to a more water efficient fixture, technology or behavior is a necessary strategy to overcome the many barriers that sometimes prevent customers from taking actions on their own. These barriers include skepticism about new technologies, lack of adequate economic incentives, lack of available capital, lack of knowledge and too many competing demands for time. Incentives can take a variety of forms including rebates, technical assistance, low interest loans or even "give-aways" of demand management products.

Incentive programs should undergo rigorous analysis before being implemented. The analyses include technical feasibility, market response and cost effectiveness. The following is a list of incentive programs commonly conducted.

Plumbing Fixture Retrofits A rebate incentive (toilets) or give-away (showerheads, aerators) program to encourage homes and businesses to replace old high use plumbing fixtures with efficient fixtures.

High Efficiency Appliances Rebates to purchase high efficiency appliances such as washing machines.

Water Efficient Irrigation Technical assistance, training, irrigation audits, and financial incentives for large commercial irrigators.

Water Smart Technology Technical assistance and financial incentives for commercial, industrial and institutional process demand management measures.

High Irrigation Consumption Audit for Residential Customers Individual customer audits and financial assistance for single family irrigators with high use.

Reclaimed Water Financial incentives to use treated effluent to provide industrial process and cooling water.

System Efficiency Water that is lost to leaks, unnecessary system use or spilling is wasted water. Inaccurate (i.e., slow) billing meters under-record actual water use and customers do not get an accurate picture of their water use, blunting the price signal that is important to achieve planned savings. Reducing water losses to acceptable levels is a key strategy for demand management savings and to signal to the public that water managers are "keeping their own house in order."

SPECIFIC RECOMMENDATIONS

Set Overall Planning Goals

The following tables show how WDMU might summarize the program plan after selecting from strategies such as those show above. The Potential Assessment and other data and analysis strategies will help create an accurate picture by translating the many elements of demand management into numbers.

Table 1 – Example of Budget on WDMU 10-year Program

Years:	2003-2013
Marketing, Education, Administration, Evaluation	JD xxx
Incentives, Subsidies and Direct Expenditures	JD xxx
Total Expenditures	JD xxx

Table 2 – Example of Savings on WDMU 10-year Program

Type of Water Use	Savings 2013
Domestic	Zz MCM
Landscape	Zz MCM
Commercial, Industrial and Institutional Process	Zz MCM
Total	Zz MCM

Begin Research and Development

Promising new water efficient technologies and demand management programs will emerge over time. Researching and testing them through demonstration and pilot programs produces new options for future demand management programs and can accelerate changes in the market place as interest in water efficient technologies increases. As new opportunities emerge, WDMU should refine savings and cost assumptions based on field testing of technologies with actual consumer experience.

Commit to Long Term Demand Management Effort

As Jordan's demand management program matures, especially efforts to promote knowledge and awareness of water issues proceeds, consumers will begin to believe demand management is vital. In the same way that investments are made in water supply sources, investments in water demand management will help meet consumers needs. Consumers can take pride in the active partnership in achieving demand management accomplishments, and recognize that there is more that can and should be done. Demand management will help meet the needs of a growing nation, doing so in a most cost-efficient and environmentally sound way, without compromising Jordanians' quality of life. Demand management is a good deal for people, for the environment, and for the future.

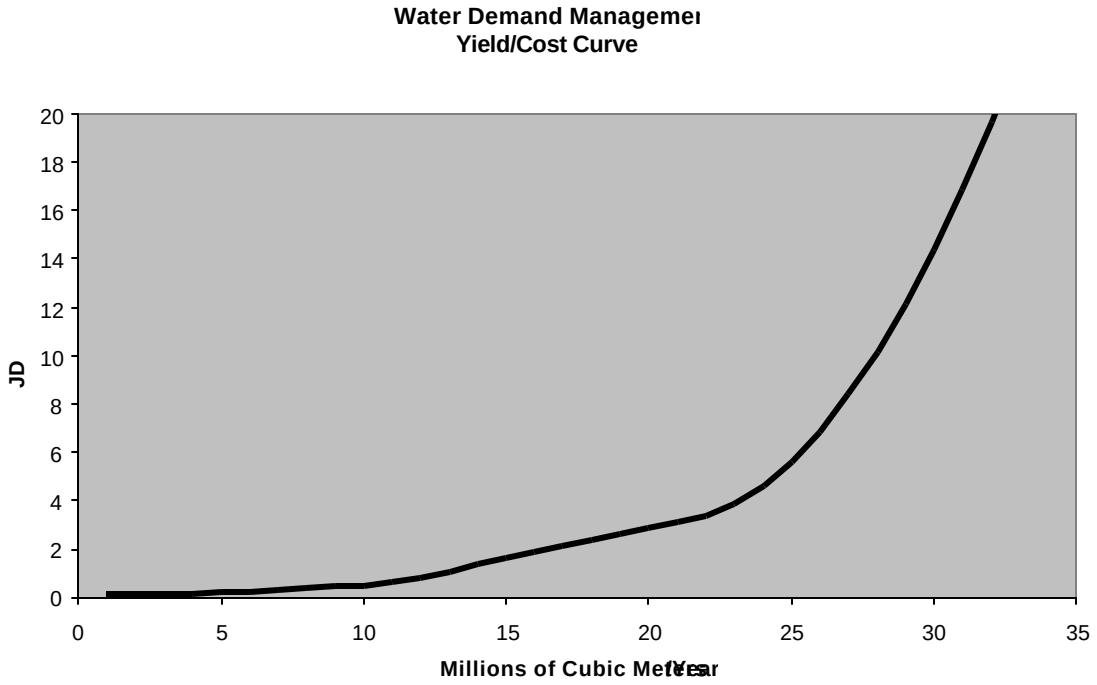
Develop Future Capabilities

As mentioned above, Jordan has already begun a demand management program through WEPIA and the WDMU. There are existing successful programs which will continue and other programs which can be started given existing, best-available information. However, to provide a rigorous analysis and evaluation of the cost, volume, and reliability of all demand management opportunities available in Jordan over the coming years, the WDMU should complete a Water Demand Management Potential Assessment. The Potential Assessment will determine the level of water savings that can be achieved, and compare the cost at various levels of demand management savings and also to the cost of new water supply. The WDMU can use the results of the Potential Assessment to set goals and targets over the next ten years, and to determine the programs and costs to achieve those targets. WDMU's Demand Management Plan will then include a plan for immediate program implementation, and a plan for developing future capabilities based on the gaps in required data and analysis capabilities from that currently available.

This section will outline the data, modeling and analysis needs to complete a Demand Management Potential Assessment. These data and modeling requirements will also include the requirements for an ongoing monitoring and

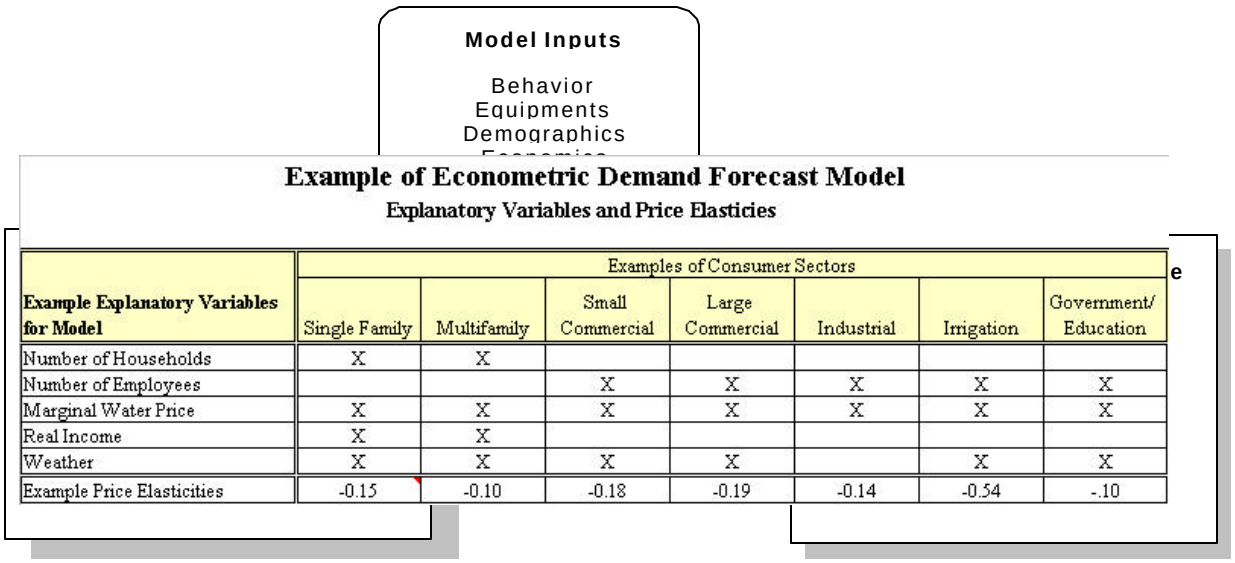
evaluation of demand management programs, the information contribution for the demand management component of an Integrated Supply/Demand Resource Least Cost Plan, and the basis for following a path of continuous improvement, including research and development.

Demand Management Yield/Cost Curve The primary result of the Demand Management Potential Assessment is a Demand Management Yield/Cost Curve. This curve shows the water savings available at any given cost level. This information allows the WDMU to set achievable demand management targets based on least cost principles. It allows program costs and savings to be compared to one another as well as to water supply sources. It is an integral input into an Integrated Resource Least Cost Plan. Given limited budgetary resources for water in Jordan, it will help determine an optimal cost-efficient order for expending scarce budgetary resources on demand management and/or supply. An example of such a curve is shown below.



End Use Modeling End use modeling is an approach that helps ensure a scientific basis for demand management savings and cost estimation. Understanding and modeling how water is used by consumers at their point-of-use can precisely show how, where, when and how much savings can be achieved at what cost. From an engineering perspective, demand management can be viewed as being equivalent to tapping many dispersed, micro-supply sources. This means it is amenable to a scientific, data and model driven approach. The value of demand management potential justifies the necessary data gathering and modeling. End use modeling allows WDMU to begin with the best available information, and this in turn highlights where the most critical data collection needs lie. The following chart shows a schematic diagram of an end-use water demand model.

End-Use Model

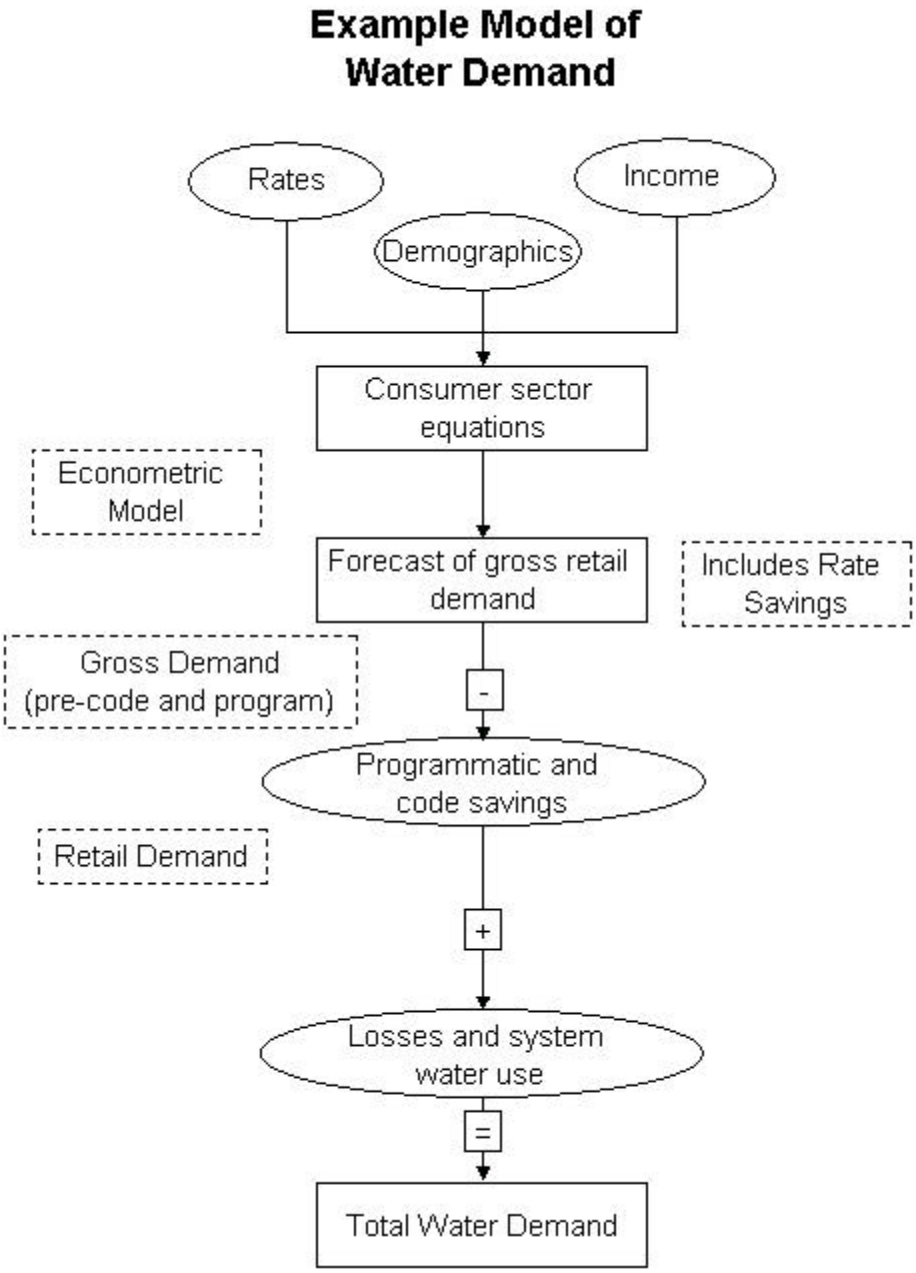


Example of Econometric Demand Forecast Model

Explanatory Variables and Price Elasticies

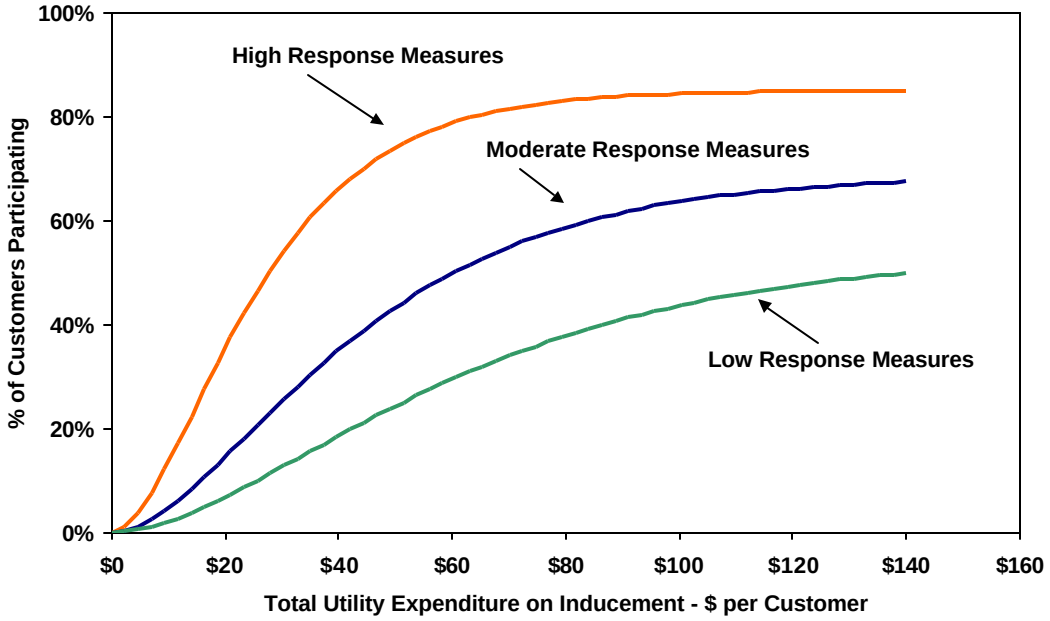
Example Explanatory Variables for Model	Examples of Consumer Sectors						
	Single Family	Multifamily	Small Commercial	Large Commercial	Industrial	Irrigation	Government/ Education
Number of Households	X	X					
Number of Employees			X	X	X	X	X
Marginal Water Price	X	X	X	X	X	X	X
Real Income	X	X					
Weather	X	X	X	X		X	X
Example Price Elasticities	-0.15	-0.10	-0.18	-0.19	-0.14	-0.54	-.10

Demand Forecasting Demand forecasting must be integrated into the evaluation of demand management potential. Because changing rates, income levels and consumer sector growth have an impact on demand separate from demand management programs, some type of multi-sector, econometric model must be used to forecast baseline, pre-demand management program demand, as shown in the examples below.



Program Participation Models Demand management savings are dependent upon consumer participation in the demand management programs. Consumers participate in voluntary programs based upon two primary driving factors. One is program awareness, understanding of benefits and ease of participation; this is determined by the program promotion, education, marketing and administrative efforts. The other factor is the level of direct benefits, or pay-back the consumer receives from participating; this is determined by the cost to the consumer of participating, and the water bill savings received. The most cost-efficient programs

will use a combination of promotion, education, marketing and administration, and consumer cost reduction through rebates or other subsidies. Use of either factor alone will produce less demand management savings per JD expended, than will a combination of the factors. A model of participation rates based upon expenditures on these factors will help ensure the most accurate estimate of demand management results and costs for a given program design. The chart below shows a graphical example of such a participation model.



Economics and Cost Minimization Providing for Jordanians water needs requires expenditure of economic resources. This is true whether the needs are met through supply or demand management. The key concept is how to minimize the economic resource use in order to provide for water needs most efficiently. By using life-cycle or levelized cost per unit of water provided, comparisons between supply and across demand management options can be quickly made, and cost-efficient targets can be set, as well as ensuring that budget expenditures are made in the most cost-effective way. The formula for levelized cost is shown below.

Levelized cost/MC = PV(Cost each year, life in years, annual discount rate)/
PV(Output each year, life in years, annual discount rate),

Where PV is present value calculation, and Output is savings for demand management, or water produced from supply; the others are self-explanatory.

This methodology allows comparisons to be made across options with different lives and scales, and allows a cardinal ranking to determine the least cost order of implementation.

Ongoing Program Monitoring and Evaluation Any program plan is only a forecast of expectations based on best available information and assumptions. By its nature, a forecast has some error and can be improved with information based on actual experience. This is the primary role of monitoring and evaluation – to continue to modify and improve program performance based on measured success compared with planning estimates. An important element of monitoring and evaluation is to establish a data collection plan prior to program implementation so that an accurate baseline (pre-program conditions) can be established. Failure to do this is often the cause of unreliable measurements, as once the program has been implemented, it is too late to measure the pre-program conditions. Thus, it is vital to include and follow a monitoring and evaluation plan in the overall Demand Management Plan in order to get to full value of program experience to improve program performance.

Continuous Improvement No program can afford to wait until all data research and modeling work is perfected before starting implementation. In fact, most improvement and perfection of data and modeling can only be gained through real experience and trial and error efforts. Program implementation should begin with analysis based on best available information and assumptions, with the expectation that improvements will be made continuously with experience and with improved research and development. Areas with most uncertainty should be delayed until better information is available through reseearch, and areas with higher knowledge confidence can be begun sooner, all else equal. The initial modeling and data efforts will show the areas that most critically need improvement, and a resultant research and development plan should be formed.

Modeling and Data Needs The following section addresses the immediate information gaps for WMDU to include in the Demand Management Plan, as implied and derived from the above areas addressed for future development.

WDMU should begin to create a baseline analysis of demographics, water consumption end uses and patterns, customer behavior and attitudes. Surveys of residential, commercial, industrial and institutional customers on water use and attitudes can begin to get needed information on behaviors and end use patterns. Additional research on metering of water use in a controlled setting can further inform data needs. Specific examples of near term actions are:

- ✓ Use existing data and staff experience to compile a list of water using equipment and end uses

- ✓ For each equipment end use, estimate the number of units in a given water service area, and the total volume of water used.

- ✓ Develop a list of demand management measures for each end use.

- ✓ Determine where additional research is most needed and plan for that research.

The above efforts will result in a matrix of end use behaviors and equipment indicating usage, potential demand management measures, savings, and research needed to complete additional analyses. An inventory and summary of existing research and data should be undertaken to help fill needed data gaps most quickly and efficiently.

A baseline analysis report should be completed indicating existing and forecast data on demographics, economics and water use broken out by customer sector, geography and end use. WDMU should also begin to prepare a long term research and monitoring plan to support analysis and program planning and implementation.

WDMU Staffing Needs Current WDMU has great analytical and quantitative skills fully capable of completing the necessary data and modeling requirements. However, the number of staff is insufficient to complete both the necessary research, analysis and planning functions as well as implement demand management programs. Additional support staff such as is now available from WEPIA would be required to both analyze and implement programs.

APPENDICES

The appendices give examples of the modeling and data inputs and outputs and other tools that are useful for program development as it matures. They are meant to be illustrative and give some concrete examples of where the recommendations contained in the main body of this report should lead, or in the case of models, they could be adopted to the needs of WDMU. Appendices are available only with the original printed version of this report, or provided electronically only as files in compressed folders which need to be uncompressed and viewed in the appropriate software. (In the case of models, they are only available electronically in separate folders).

1. RESIDENTIAL EFFICIENCY - Seattle.zip:

This folder contains an example of an empirical study of water end-use and the estimation of potential water savings from retofitting plumbing equipment. These data are useful in completing an accurate assessment of conservation potential.

2. CPA Data Model.zip:

This folder contains a generic data model showing the detailed data requirements by customer class and end-use that would be useful in guiding both data collection and modeling efforts.

3. CPA Spreadsheets.zip:

This folder contains a portion of a spreadsheet model showing the specific model and data by customer class and end-use developed from more the generic data model in the folder CPA Data Model.zip. The particular classes and end-uses can be customized according to Jordanian circumstances and data availability. As a first phase, many of the data elements can be estimated from best expert judgement, and continuous improvement made as empirical data becomes available.

4. Screenshots of CPA Model.zip:

This folder contains some screen shots of the model developed by Seattle Public Utilities using detailed end-use data of the sort illustrated in the folder CPA Spreadsheets.zip. While spreadsheets allow a more transparent view of data and algorithms in the model, a programming language and database software, such as Visual Basic and Access used in the model shown here, are required for ongoing model use.

5. End use charts.zip

This folder contains some illustrations of the algorithm routines that are required in modeling conservation potential assessment, and include impacts on the baseline of plumbing codes and participant response to conservation program promotion and incentives. Also shown are typical data reports useful for showing impacts over time, setting goals and benchmarks for "ground-truthing."

6. ECONSCON.zip:

This folder contains a report on the price elasticity of water demand to help provide a basis for including impacts of pricing on demand. The impacts of price are required to establish baseline demand prior to program implementation, and for conducting scenario analysis.

7. Demo of IWR Forecast Conserv Model.zip:

This folder contains a demonstration of a demand forecasting and conservation model available from the U.S. Corps of Engineers, called IWR/MAIN. It is available for a fee, training is also available. More information on this model is available at www.iwrmain.com.

8. Cost-efffectiveness spreadsheets.ZIP:

This folder contains two spreadsheet models for estimating conservation program cost-effectiveness. They might be useful in understanding the economic issues in least-cost planning using conservation programs.

9. Aquacraft ICM.zip:

This folder contains a spreadsheet model for forecasting demand and estimating conservation program effectiveness. It may be useful in showing the variety of approaches that modeling and data requirements can take.