CHAPTER 5 – WATER CONSERVATION

5.1 Introduction

This chapter presents a summary of opportunities for GWA to undertake to improve the efficient use of existing water resources through urban water conservation. Water utilities worldwide are facing water shortages for a variety of reasons, including diminishing new water supplies for development; inability or unwillingness to raise water rates to maintain existing and expand new water infrastructure; and climate change causing drought or flood-related emergencies from a lack of potable water supply.

In the past, water conservation was perceived to be applicable only during drought as a way to ration customers when supplies were severely limited. Today, water conservation (also known as water use efficiency) has progressed into everyday standard utility operations, or "business as usual." Many utilities rely on water conservation as part of their integrated water resources portfolio of supplies and seek to maintain the water conservation needs in the forefront of utility staff and customer minds. These programs also exist for utilities from a few thousand to over 100,000 connections in both water scarce and water rich watersheds. For example, over 330 water utilities in California, servicing over 85% of the state's population of 36 million residents, currently have embraced urban water conservation programs based on custom designed Best Management Practices (BMPs). These utilities have voluntarily committed to implement the 14 BMPs defined in the Memorandum of Understanding (MOU) Regarding Urban Water Conservation that is overseen by the California Urban Water Conservation Council (CUWCC). Another example is the commitment of the federal government to drive changes at existing and new facilities to conserve both water and energy through the various initiatives of the Federal Energy Management Program.

This chapter describes water conservation program elements that may be feasible for GWA and provides overall recommendations for GWA on the design of a water conservation program. Once sufficient data on GWA customer use and information related to feasibility has been gathered, it will be possible in the future for GWA to proceed with using existing technical analysis tools to plan a long-term, measurable water conservation BMP program.

5.2 General Background

There are various types of water conservation programs based on cost-efficient and attainable BMP implementation strategies. Over the past decades, key lessons learned from either voluntary or mandated utility water conservation agreements elsewhere will help the consultant team and GWA management and field staff understands the BMPs that may be most effective for GWA. Key drivers for GWA to engage in water conservation include:

- Stewardship of the limited water resources on Guam and building the ethic of future water users.
- Reduction of wasteful water losses on the customer side of the meter (for losses in the distribution system, see Volume 2, Chapter 4 – Water Loss Control).
- Benefits of increased system pressure by reducing peak demands.
- Opportunities for reducing energy and other production costs associated with pumping from existing water sources.

- Deferred need for pursuing new water sources.
- Improved customer relations - when rate increases occur, GWA will receive calls from customers with complaints related to higher water bills. Also, water conservation assists with the customer service response to educate callers on GWA assistance for the customers' ability to reduce wasteful or excessive use by both commercial and residential customers.

Taking these drivers into consideration, an analysis of feasible BMPs is a means for water conservation decision makers to better design a conservation program. The analysis will provide information not previously available about the estimated water savings, costs, and benefits of conservation programs.

The original purpose of this chapter was to present the findings of a water conservation technical analysis to include a summary of the following:

- Past water conservation accomplishments and any resulting water savings of quantifiable BMPs; and
- BMP modeling effort to include an analysis of the future costs and water savings of the quantifiable BMPs for two alternative water conservation plans.

Because GWA does not have a comprehensive water conservation program to evaluate, this chapter has been written to provide an overview of methodology for performing such an analysis. It also provides limited recommendations from general observations based on minimal data available from customer billing records provided by GWA.

5.3 Methodology for Estimating Water Savings

This section provides an explanation of the methodology used to estimate projected water savings based on quantifiable and non-quantifiable BMPs. The BMPs considered are listed and the terminology and general assumptions are defined.

5.3.1 Quantifiable and Non-Quantifiable BMPs

Using the CUWCC as a reference, some BMPs have water savings that are considered non-quantifiable by planners. The quantifiable BMPs are those for which water savings can be estimated. The non-quantifiable BMPs are those for which water savings cannot be accurately estimated.

For GWA, any number of BMPs may be combined into a water conservation program. First, a list of over 100 BMPs may be considered for initial feasibility screening. Second, a list of quantifiable BMPs would be evaluated based on water savings assumptions and each BMP's projected activity as determined appropriate for GWA. An example list of commonly used quantifiable and non-quantifiable BMPs is provided in Table 5-1. The BMPs are listed according to the CUWCC name and numbering system for the standardized program of BMPs implemented by utilities in California.

Table 5-1 – Quantifiable and Non-Quantifiable BMPs

BMP	BMP Description	Quantifiable	Non-quantifiable
1	Interior and Exterior Water Audits and Incentive Programs for Single Family Residential, Multi Family Residential, and Institutional Customers	X	
2	Plumbing Retrofit of Existing Residential Accounts	X	
3	Distribution System Water Audits, Leak Detection, and Repair	For metered systems	For unmetered systems
4	Non-Residential and Residential Meter Retrofit	X	
5	Large Landscape Water Audits and Incentives for Commercial, Industrial, Institutional and Multi-Family Developments	X	
6	High Efficiency Washing Machine Rebate Program	X	
7	Public Information		X
8	School Education		X
9	Commercial and Industrial Water Conservation	X	
10	Conservation Pricing for Metered Accounts		X
11	Water Conservation Coordinator		X
12	Water Waste Prohibition		X
13	Ultra-Low Flush Toilet Replacement Program for Residential and Non-Residential Customers	X	

5.3.2 Analysis Perspective

A benefit-cost analysis can be performed from several different perspectives. This benefit-cost analysis is based on the benefits and costs to GWA. This perspective considers the program costs that will be directly borne by GWA. This enables the GWA to compare various water supply options and the potential investments for saving water. This utility perspective does not count the benefits accrued or costs incurred outside of the utility.

5.3.3 Analysis Terminology and General Assumptions

Each component of the water savings analysis is described below. In addition, general water savings assumptions are provided. Industry experience-based "common" assumptions from the CUWCC MOU and the American Water Works Association are the basis for the water savings assumptions.

- **Incremental Water Savings** – Incremental water savings are the new water savings realized as a result of new interventions implemented during the corresponding year. Incremental water savings do not include water savings from interventions implemented in previous years.
- **Annual Water Savings** – Annual water savings are the total water savings of the BMP for each year. Annual water savings include the water savings being realized from previous years' interventions.
- **Intervention** – Each individual water conservation action the agency performs is called an intervention. For example, an individual action for one customer, such as one meter installation or one water audit, is considered an intervention.
- **Unit Water Savings** – A summary of BMP specific water savings assumptions is provided in Table 5-2. Water savings for each conservation measure are considered in terms of end-use water reductions. Each conservation measure evaluated in this analysis targets a particular water user group (e.g., single family residential, multi-family residential) and a particular water use within that user group (e.g., toilets, shower heads). In some cases, a conservation measure targets

multiple end uses. For example, residential water surveys often target indoor uses such as toilets, showerheads, and faucets, and outdoor water use.

- **Water Savings Life** – The average water savings life of an intervention is the duration of time during which the intervention will realize water savings. The life span of an intervention will vary by customer. However, for this analysis it is assumed that water savings will be realized for the length of the assumed average life span.

Table 5-2 – Water Savings Assumptions

BMP number	BMP Description	Affected Account Category [1]	Affected End Use(s)	% Reduction in Water Use	Water Savings Life (year)
1	Residential Water Audits	RSF	Internal	5% [2]	4 [2]
		RMF			
		RSF	External	10% [3]	
		RMF			
2	Plumbing Retrofit	RSF	Toilets	10.0% [4]	4 [2]
		RSF	Showers	21.0% [4]	
		RSF	Faucets	10.0% [4]	
		RMF	Toilets	10.0% [4]	
		RMF	Showers	21.0% [4]	
		RMF	Faucets	10.0% [4]	
4	Meter Retrofit	URSF	All	20.0% [3]	Permanent [8]
		URMF	All		
		UCOM	All		
		UIST	All		
		UIND	All		
		UMUN	All		
5	Large Landscape Water Audits	COM	Irrigation	15.0% [3]	4 [9]
		IND	Irrigation		
		INS	Irrigation		
		MUN	Irrigation		
		IRR	External		
		LND	External		
6	Clothes Washer Rebates	RSF	Laundry	34.0% [5]	Permanent [10]
		RMF			
9	Water Audits	COM	All	12% [2]	4 [9]
	Water Audits	IND	All	15% [2]	
	Water Audits	INS	All	12% [2]	
	Water Audits	MUN	All	12% [2]	
9	ULFT Rebates	COM	Toilets	Fixture Model [6]	Permanent [10]
		IND			
		INS			
		MUN			
14	ULFT Rebates	RSF	Toilets	Fixture Model [7]	Permanent [10]
		RMF			

1. RSF=residential single family, RMF=residential multi-family, URSF=unmetered single family, URMF=unmetered multi-family, UCOM=unmetered commercial, UIND=unmetered industrial, UINS=unmetered institutional, UMUN=unmetered municipal, COM=commercial, IND=industrial, INS=institutional, MUN=municipal, IRR=irrigation, LND=landscape
2. BMP Cost and Savings Study (CUWCC, 2005)
3. MOU (CUWCC, 2004)
4. A & N Technical Services report (2005)
5. A & N Technical Services report (2005, p2-13), derived from THELMA (1997) data.
6. CII ULFT Savings Study (CUWCC, 1997)
7. MOU Exhibit 6, Tables 1&2 (CUWCC, 2004)
8. Professional judgment – assuming the meter will not be removed once it is in place.
9. A & N Technical Services, 1999
10. Professional judgment that user will not replace an efficient machine with an inefficient one.

To determine how much water is saved from implementing each conservation measure, water reductions are applied to the specific end use targeted by the BMP. Water savings, in the form of a percent, are multiplied by the appropriate water use. The percent reductions are only applied to the amount of water identified for the end use, not the entire category of use. The water use varies by utility and still needs to be further understood for uses by GWA customers before this analysis could proceed.

Permanent life measures are applied to conservation measures that involve the replacement of water use-equipment, such as clothes washers, or recommend specific equipment replacement, such as a meter retrofit. For these measures, the life is assumed to be permanent because it is highly unlikely that when the equipment wears out, it would be replaced with an inefficient model.

Measures that rely on the behavioral change of a homeowner or water user are assumed to have a finite life. For example, a water conservation measure that involves a homeowner setting an irrigation controller to reduce water use does not create permanent water savings because the house may be sold to another owner and there is no guarantee that the new homeowner will continue the same behavior. This is particularly true when the action requested is voluntary and there is no compliance monitoring. In these cases, a finite water savings life is assumed. A summary of the water savings life per type of intervention used in this analysis is provided in Table 5-3.

Table 5-3 – Summary of Intervention Life Span Assumptions

BMP	Intervention	Water savings life span, years	Reference
1	Single family survey Multi-family survey Institutional survey	4 4 4	BMP Cost & Savings (C&S) Study, page 2-44 (CUWCC, 2005)
2	Plumbing retrofits	4	C&S Study, page 2-44 (CUWCC, 2005)
4	Meter retrofit	Permanent	Permanent water savings is assumed
5	Large landscape audits	4	A & N Technical Services, 1999 (page 2-20)
6	Washing machine rebates	Permanent	Permanent - - - - - - - - - - - Professional judgment that user will not replace an efficient machine with an inefficient one, given pending state standards
9	Commercial/industrial audits	4	A & N Technical Services, 1999 (page 2-20)
14	Residential toilet rebates Commercial toilet rebates Industrial toilet rebates Institutional toilet rebates	Permanent Permanent Permanent Permanent	Permanent water savings is assumed

5.3.4 Benefit Cost Modeling Overview

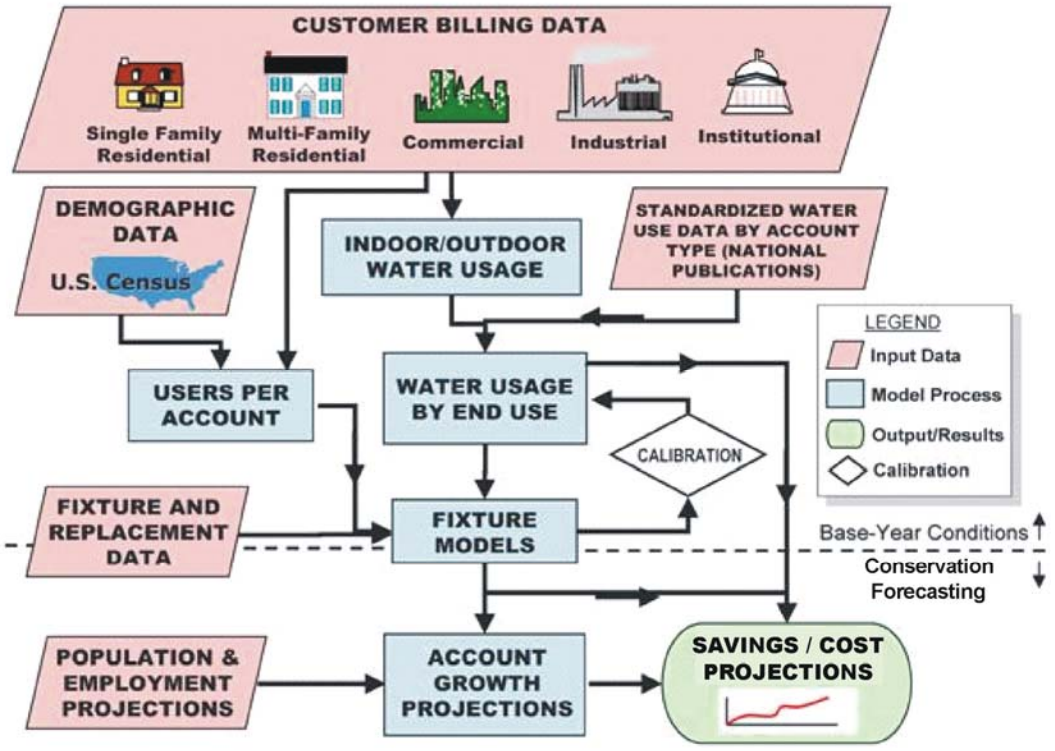
The BMP modeling analysis can be performed using existing Microsoft® Excel 2003 spreadsheet calculations. These spreadsheet models have been used elsewhere and have proven effective for providing a planning evaluation framework for water demand management programs. The spreadsheet calculations perform a cost-effectiveness evaluation for each BMP using the data on market potential for each conservation measure and the assumptions for each conservation measure variable. The cost-effectiveness evaluation using the spreadsheet program projects the number of interventions, water savings, and the dollar values of the benefits and costs that would result from implementing the BMPs on an annual basis. The benefit cost model components consist of the following steps:

- Establish customer base-year water use conditions by customer-billing category and then by end use;
- Establish service area conditions for evaluation of conservation measures by creating a database of service area data relevant to the conservation measures to be evaluated; and
- Use the service area data to perform a benefit and cost evaluation of each BMP.

5.3.5 Model Inputs and Data Analysis

Model inputs, such as annual and unit costs and water use characteristics, from data to be collected by GWA will be needed for the future modeling analyses. The data collected from GWA will need to include water demand by customer category, number of customers in each customer category, system production, and water loss. When the additional data becomes available, several analyses would be possible to determine the base year conditions including analyses of service area characteristics, annual account water use, indoor/outdoor water use, large landscape data, and BMP program cost data.

Figure 5-1 – Benefit to Cost Modeling Process Flow Chart

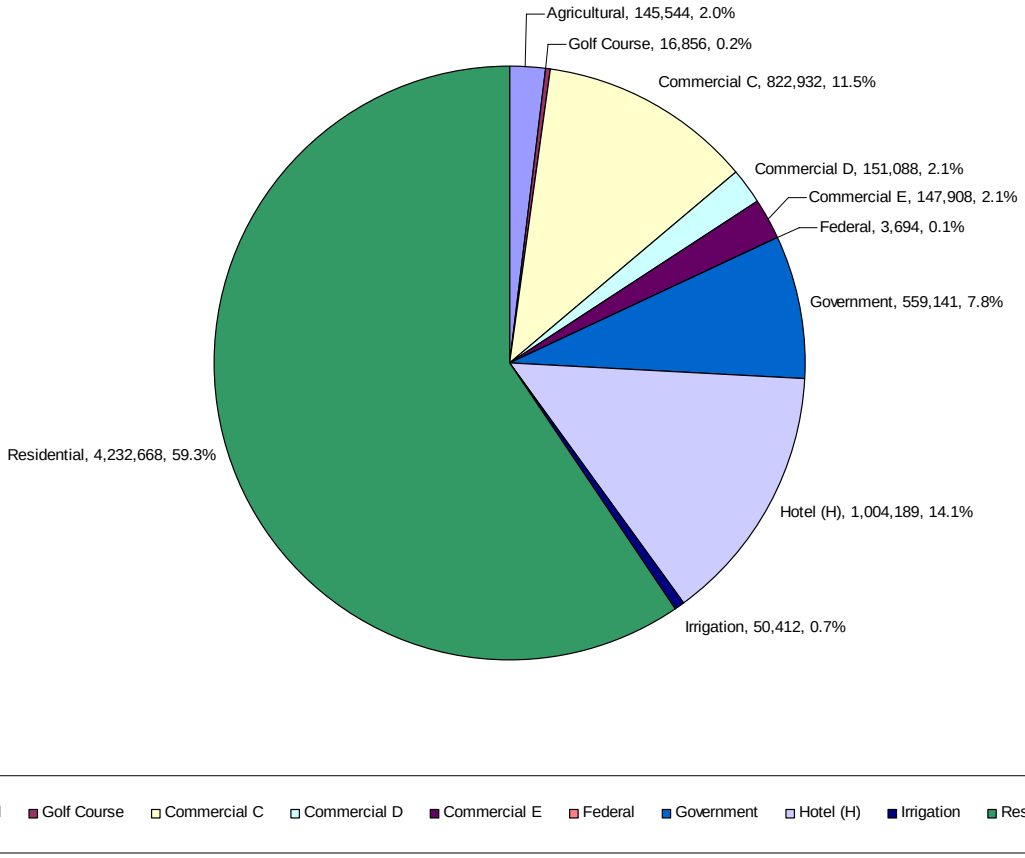


5.3.6 GWA Customer Characteristics

Overall assessment of the total water demand in FY 2005-06 by customer category is shown in Figure 5-2. The data show that approximately 59% of water demand is from residential customers. A total of 34,171 accounts are residential customers, which equates to 94% of the total customers served by GWA. The second and third largest sectors of water demand include hotel commercial accounts (14.1%) and commercial customer category C (11.5 %).

The next largest category of use is the government sector (7.8 percent). These four customer categories form the basis of highest potential water savings and thus warrant further analysis for water conservation program planning purposes.

Figure 5-2 – FY2005-06 Water Use by Customer Category (kgal)



To evaluate each BMP in GWA's three system service areas, it is necessary to determine the potential "market" for feasible implementation of water conservation measures within each customer category (residential, hotel, commercial category C and government). The applicable markets for each of the BMPs include factors such as number and types of toilets, number of large landscape areas (parks, schools, golf courses, cemeteries, etc.) and number of un-metered accounts. In addition to the data collected, estimates would be made regarding water use for particular categories of use within GWA's service areas such as the amount of water use per commercial or residential toilet and the average amount of irrigable land per park, school and commercial site.

5.3.7 Annual Account Water Use

A basic analysis was performed to determine the water use in average gallons per day per account for each customer category. The results of this analysis are presented in Table 5-5, FY 2005. It includes the customers by customer category, consumption by customer category, and the average water use per account. The water use characteristics for these metered customers could be developed further based on more detailed billing records analysis.

Based on the total annual water demand by residential and hotel categories, and the relatively few accounts for hotel customers, this presents a key opportunity to analyze further the feasibility of a targeted water efficiency program to change water use fixtures to more efficient models and for additional efforts to lower leaks on site. For example, according to the American Water Works Association, over 20 percent of toilets leak and waste water. This is added expense for water production, wastewater treatment, infrastructure operational costs, and capital expansion costs. The customer also benefits. Significant energy savings on customer bills in the hotel and residential sector would accrue to the customer for hot water savings (e.g., showerheads and clothes washer replacements).

GWA's average residential account water use of 339 gallons per day is high relative to mainland U.S. systems. In California, accounts with a comparable number of persons per household average more commonly 200-275 gallons per account per day. This higher than expected account water usages by GWA customers points to inefficient fixtures, lack of awareness for the need for efficiency, and leaks on the customer side of the meter. Aggressive implementation of the meter replacement program is expected to result in an increase in residential account water use (and bills). Additional water use inefficiency will be uncovered also. GWA's customer service response to this foreseen rise in customer bills should be an active water conservation program. Recommendations for initiating a near-term program are provided in Section 5.4.

Table 5-4 – FY 2005-06 Customer and Water Use Characteristics by GWA

Customer Category	Total Water Sales (thousand gallons)	No. of Customer Accounts	Average Water Demand gpd/account/day
Agricultural	145,544	533	748
Golf Course	16,856	14	3,299
Commercial C	822,932	2,144	1,052
Commercial D	151,088	32	12,936
Commercial E	147,908	192	2,111
Federal	3,694	12	843
Government	559,141	435	3,522
Hotel (H)	1,004,189	56	49,129
Irrigation	50,412	228	606
Residential	4,232,668	34,171	339
Total[1]	7,134,433	37,817	--

Note: Customers are for total of northern, central and southern system service areas.

1. Total customers may not include all customer categories. For example categories such as "construction" or customers such as industrial for the GWA are not included.

5.3.8 Indoor/Outdoor Water Use

Upon completion of the meter replacement program, another more refined analysis should be performed to determine the indoor and outdoor water use for each customer category. A review of existing water sales indicates relatively consistent water use year-round, suggesting minimal irrigation peak demand for urban landscapes, parks, and schools. When more accurate monthly water use data are available by customer category, it should be assumed that 90 percent of the lowest month of water use is for indoor use.

5.3.9 Annual Market Penetration/Implementation Requirements

The annual market penetration identifies how many fixtures, rebates, surveys, and other approaches GWA needs to offer annually to reach implementation goals for a given BMP. The implementation goals will need to be established in the future.

5.3.10 Water Conservation Program Costs Inputs

The cost of implementing each BMP is an input into the analysis. GWA and a consultant team will need to work together to determine GWA's costs to perform each BMP according to each unique, water demand reduction strategies. Annual fixed costs and intervention unit costs are the two cost component inputs for each BMP. The annual fixed costs are annual program costs that do not vary significantly with the number of interventions implemented annually. These include marketing and administrative costs. Intervention unit costs are the costs to perform each intervention. These may include the cost of staffing to implement the BMP, and the costs of purchasing and maintaining the equipment necessary for implementing the BMP.

The time-value of money is considered in this analysis. The value of all future costs and benefits are discounted (e.g. to 2005 or selected base year). The benefit-cost calculates the "real" interest rate, by adjusting the current nominal interest rate (commonly assumed to be 6.1 percent) by the rate of inflation (commonly assumed to be 3 percent). Cash flows discounted in this manner are referred to as "Present Value" sums. The higher the discount rate, the lower the present value of future expenditures.

5.4 Recommended Next Steps

This section describes the overall next steps for the design of a water conservation program for GWA based on a BMP analysis. It should be noted that the water savings estimated in a BMP analysis will not occur unless the required activities and interventions are performed. The BMPs are typically modeled based on the definition of the BMPs as defined by GWA goals.

This analysis requires further data collection on the part of GWA and the consultant team. These overall data collection activities will include categorizing the BMPs into purveyor-controlled and customer and/or outside agency-dependant categories, and organizing and screening the data for applicability to GWA and its customers. Estimates of the level of effort including program staffing needs and associated costs for GWA can also be provided when BMP program is designed from additional data pending from GWA.

5.4.1 GWA Controlled and Customer and/or Outside Agency Dependent

Water conservation BMPs can be grouped into two categories:

- **GWA controlled BMPs** - BMPs whose level of implementation is directly controlled by the water purveyor; and
- **Customer and/or outside agency dependant BMPs** – BMPs whose level of implementation is dependant upon customer participation or participation of an agency outside GWA. The agency must rely on the customer's and/or outside agency's willingness to participate in the BMP.

Table 5-6 provides a list of the BMPs separated into the two control categories. Based on the other utility experience with program implementation, it has been observed that relatively high goals (e.g., greater than 2% of the customer category accounts) for customer

and/or outside agency dependent BMPs can be difficult to achieve. This is because GWA must rely on customers to volunteer their participation in the program. Customers would need to be surveyed or more experience obtained with GWA customers to better understand their willingness to participate in water conservation BMPs.

Table 5-5 – Purveyor Controlled versus Customer and/or Outside Agency Dependent BMPs

BMP	BMP Description
	Purveyor controlled
3	Distribution System Water Audits, Leak Detection, and Repair
4	Non-Residential and Residential Meter Retrofit
7[1]	Public Information
8[2]	School Education
11	Conservation Pricing for Metered Accounts
12	Water Conservation Coordinator
13	Water Waste Prohibition
	Customer and/or outside agency dependant
1	Interior and Exterior Water Surveys and Incentive Programs for Single Family Residential, Multi Family Residential, and Institutional Customers
2	Plumbing Retrofit of Existing Residential Accounts
5	Large Landscape Water Surveys and Incentives for Commercial, Industrial, Institutional and Multi-Family Developments
9	Commercial and Industrial (CI) Water Conservation
14	High Efficiency Flush Toilet Replacement Program for Residential and/or Non-Residential Customers

Note: BMPs are numbered according to Water Forum numbering system unless noted otherwise.
1. Level of implementation is partly dependant upon participation of other community organizations.
2. Level of implementation is partly dependant upon school district participation.

It is important that all program elements be recorded, monitored, and analyzed, including implementation numbers, costs, and pre- and post-water consumption. In addition, it is useful that conservation staff be able to query a database for customer information within each customer category.

5.5 Conclusions

The following conclusions can be made about water conservation in GWA's service area:

- GWA does not have an effective water conservation program
- Water conservation is a viable approach for reducing consumption of water resources from all sources

5.6 Recommendations

This section outlines recommendations for GWA to implement within the next 1 to 3 years. There are several key activities that can be undertaken almost immediately with minimal planning, although careful tracking of activities and water savings are essential. Some water efficiency initiatives that require relatively low cost and minimal staff time to start-up, maintain and document will benefit GWA. These initiatives include:

- Develop education campaigns with targeted messages and activities. These campaigns should identify "what's in it for me?" benefits that each customer category will achieve through hardware changes in fixtures and appliances, fixing leaks, and wasting less water. Less emphasis may be placed on behavioral changes, which can be viewed as "sacrifices" and will be needed most drastically in the next step for more likely implementation.
- Develop conservation pricing strategies to charge higher users rates that are more equitable with their share of higher marginal costs of new supplies.
- Target commercial and government buildings for full change-out of inefficient plumbing fixtures and landscape irrigation inefficiencies.
- Institute customer leak detection service or referral lists for metered, customer-side repairs (to assist with high bill complaints when rate changes occur).
- Develop a water waste watch program with incentives for efficient use by customers, neighborhood awareness (educate on stewardship and the connection for opportunities to increase low system pressures would be areas targeted first).
- Implement retrofit programs or incentives for showerheads, aerators, and other fixtures that can be accomplished through school education programs with turn-in of older fixtures to confirm change-outs (e.g., LivingWise program can be co-funded with electric utility).
- Implement a retrofit or incentive program for replacement of higher flush toilets (greater than 1.6 gallon per flush) with high efficiency toilets (less than 1.28 gallons per flush).
- Offer education for more efficient irrigation to lessen run-off and wasteful practices.

5.7 CIP Impacts

Water conservation is not included in the CIP or in the decision-making process to evaluate and recommend CIP projects. Despite being excluded from the CIP, we recommend that GWA aggressively implement a water conservation program through its operating budget. Water demand that is reduced through conservation could impact the timing of some CIP projects, particularly new supply. Water conservation programs can save 0.5 to 2% per year in water demand.

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