

APPENDIX K

**ESTIMATION OF SAVINGS AND COSTS FOR
WATER CONSERVATION STRATEGIES**

Estimation of Savings and Costs for Potentially Feasible Water Conservation Strategies in Region C

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1.0 INTRODUCTION

The *2011 Region C Water Plan* ⁽¹⁾ updated the potentially feasible water conservation strategies from the *2006 Region C Water Plan* ⁽²⁾ as shown in Table 1.1. Extensive documentation of projected water savings and probable cost assumptions of conservation strategies is included in Appendix M and Chapter 4B of the *2006 Region C Water Plan*.

Table 1.1: Potentially Feasible Water Conservation Strategies

Strategy	2006 Category	2011 Category	User Group Type	Memo Section
Low-flow plumbing fixture rules ^(a)	Minimum	Minimum	Municipal	2.0
Federal residential clothes washer standards	Minimum	Minimum	Municipal	3.0
Public and school education	Basic	Basic	Municipal	4.0
Water use reduction due to increasing water prices	Basic	Basic	Municipal	5.0
Water system audit, leak detection and repair, pressure control	Basic	Basic	Municipal	6.0
Water conservation pricing structure	Expanded	Basic	Municipal	7.0
Water waste prohibition	Expanded	Basic	Municipal	8.0
Coin-operated clothes washer rebate	Expanded	Expanded	Municipal	9.0
Residential customer water audit	Expanded	Expanded	Municipal	10.0
ICI water audit, water waste reduction, and site-specific conservation program	Expanded	Expanded	Municipal	11.0
Irrigation Restrictions	Not Implemented	Expanded	Municipal	12.0
Manufacturing general rebate	Manufacturing	Manufacturing	Manufacturing	13.0
Golf course conservation	Irrigation	Irrigation	Irrigation	14.0
Efficient new steam electric power plants	Steam Electric	Steam Electric	Various	
Reuse of treated wastewater effluent	N/A	N/A	Various	

(a) Ultra-low flow toilets only evaluated in *2011 Region C Water Plan*

This memorandum has two purposes:

- To document the criteria for recommending appropriate packages of strategies for each Water User Group (WUG).
- To document assumptions made in projecting water savings and opinions of probable cost for these measures.
- To provide updates on categorization and utilization of specific water conservation measures in the *2011 Region C Water Plan*.

Sections 2 and 3 include conservation measures mandated by federal laws (collected and called minimum requirements). Sections 4 through 8 include measures from the basic conservation package. Sections 9 through 12 include measures from the expanded conservation package. Sections 13 and 14 include non-municipal conservation measures. Savings from efficient steam electric power plants are included in updated demands for the non-municipal WUG. Chapter 6 of the *2011 Region C Water Plan* includes more detailed descriptions of each package.

Reuse of treated wastewater effluent was considered on a case-by-case basis, and savings and costs are documented elsewhere in the plan. Summaries of the potential water savings and cost per 1,000 gallons of water saved for each municipal conservation strategy are presented in Tables 1.2 and 1.3. The water savings represent regional totals and the costs are regional average costs. Water savings and costs may differ for individual water user groups.

Table 1.2: Summary of Municipal Water Savings by Conservation Strategy

Strategy	Implementation Date	Conservation Package	Water Savings (acre-feet per year)					
			2010	2020	2030	2040	2050	2060
Low Flow Plumbing Fixtures ^(a)	2010	Minimum	0	4,077	12,019	20,595	28,925	36,819
Implement New Federal Clothes Washer Standards	2010	Minimum	6,697	27,089	38,612	44,587	50,061	55,945
Minimum Package Subtotal			6,697	31,166	50,632	65,183	78,986	92,764
Public and School Education	2010	Basic	19,402	38,245	52,968	70,322	90,402	114,741
Impact of Increasing Water Prices	2010	Basic	5,157	12,224	20,876	31,255	43,536	58,483
Water System Audit	2010	Basic	2,163	7,585	12,307	14,298	16,033	17,198
Water Conservation Pricing Structure	2010	Basic	530	3,278	6,284	7,311	8,035	8,359
Water Waste Prohibition		Basic	367	1,990	3,866	4,650	5,188	5,573
Basic Package Subtotal			27,618	63,321	96,301	127,835	163,195	204,354
Residential Customer Audit	2010	Expanded	306	4,391	5,660	6,421	7,114	7,791
Landscape Irrigation Restrictions	2010	Expanded	4,474	5,481	6,515	7,445	8,183	8,815
ICI Water Audit	2020	Expanded	120	199	2,315	4,510	5,022	5,681
Coin-Op Water-Efficient Clothes Washer Rebate	2020	Expanded	122	767	1,717	1,922	2,143	2,329
Expanded Conservation Package Subtotal			5,021	10,839	16,207	20,297	22,462	24,617
Overall Total			39,336	105,326	163,140	213,315	264,643	321,735

(a) Only includes additional estimated savings from ultra-low flow toilets as described in Section 2.0. Other low flow fixture savings included in demand estimates.

Table 1.3: Summary of Cost by Municipal Conservation Strategy

Strategy	Implementation Date	Conservation Package	Cost Per 1,000 Gallons of Water Saved					
			2010	2020	2030	2040	2050	2060
Low Flow Plumbing Fixtures	2010	Minimum	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Implement New Federal Clothes Washer Standards	2010	Minimum	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Minimum Package Subtotal			\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Public and School Education	2010	Basic	\$0.82	\$0.77	\$0.63	\$0.54	\$0.47	\$0.40
Impact of Increasing Water Prices	2010	Basic	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Water System Audit	2010	Basic	\$4.13	\$1.69	\$1.16	\$1.14	\$1.11	\$1.13
Water Conservation Pricing Structure	2010	Basic	\$0.40	\$0.07	\$0.00	\$0.00	\$0.00	\$0.00
Water Waste Prohibition		Basic	\$1.95	\$0.90	\$0.54	\$0.50	\$0.50	\$0.51
Basic Package Subtotal			\$0.93	\$0.70	\$0.52	\$0.44	\$0.39	\$0.33
Residential Customer Audit	2010	Expanded	\$2.35	\$2.05	\$1.84	\$1.86	\$1.88	\$1.92
Landscape Irrigation Restrictions	2010	Expanded	\$0.35	\$0.35	\$0.34	\$0.35	\$0.35	\$0.36
ICI Water Audit	2020	Expanded	\$0.89	\$1.04	\$1.05	\$1.06	\$1.09	\$1.10
Coin-Op Water-Efficient Clothes Washer Rebate	2020	Expanded	\$0.49	\$0.32	\$0.24	\$0.23	\$0.22	\$0.22
Expanded Conservation Package Subtotal			\$0.49	\$1.05	\$0.95	\$0.97	\$0.99	\$1.01

2.0 FEDERAL LOW/ULTRA-LOW FLOW PLUMBING FIXTURE RULES

2.1 Applicability

Potential savings from federal low and ultra-low flow plumbing fixtures were evaluated for all municipal WUGs.

2.2 Projected Water Savings

Projected water savings for low flow plumbing fixture rules (in effect since 1994) have been estimated by the Texas Water Development Board (TWDB) and are included in Region C demand projections. These include low flow faucets and toilets (1.6 gallons per flush, gpf). House Bill 2667, implemented September 1, 2009, further reduces the maximum volume per flush of toilets available for sale after January 1, 2014 from 1.6 gpf to 1.28 gpf. The further reduction in water demands from this legislation is not included in the water demand projections. The additional demands were calculated as the gallons per flush of each type of toilet multiplied by the percentage of each type in service. To be conservative the phase-in (for example availability of 1.28 gpf toilets prior to January 1, 2014) of each toilet type was not included in estimating number of toilets. Ranges of gpf for toilets prior to the 1.6 gpf rule vary, so to be conservative a value of 3 gpf was used as an average.

The life of a toilet is approximately 30 years⁽³⁾. The assumed natural replacement rate is normally distributed (one-sided) with standard deviation equal to the toilet life, mean equal to the implementation date, and independent variable equal to the planning year. Figure 2.1 displays the assumed percentages of each type of toilet during the planning periods. The total savings from the implementation of 1.28 gpf toilets was estimated for the entire Region C planning area and not accounted for as specific conservation savings for any single water user.

The total projected 2060 regional water demand is reduced an additional 1% from what it would be without low flow fixtures.

2.3 Additional Data Requirements

No additional data are needed to project water savings from plumbing fixture rules.

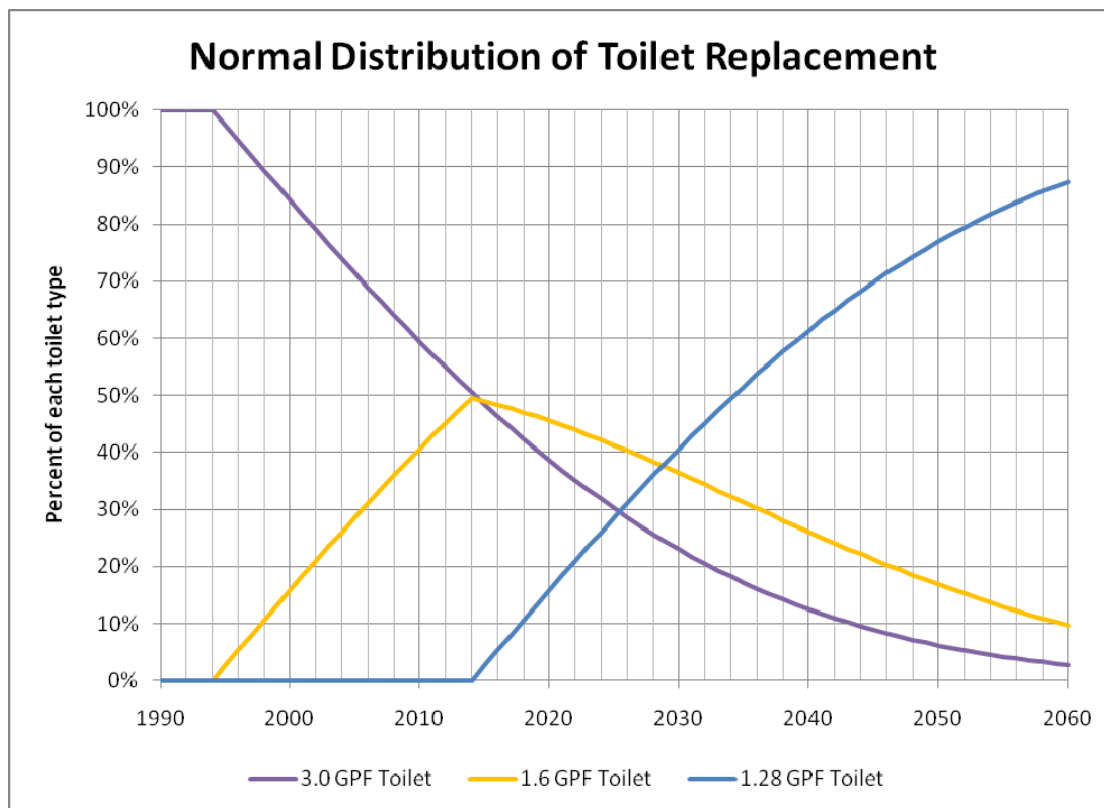
2.4 Reliability

The projected water savings should be realized without action by the WUG. Therefore, the reliability of the potential water savings is relatively high.

2.5 Opinion of Probable Cost

The projected water savings should be realized at no cost to the WUGs.

Figure 2.1



3.0 FEDERAL RESIDENTIAL CLOTHES WASHER STANDARDS

3.1 *Applicability*

Potential savings from federal residential clothes washer standards were evaluated for all municipal WUGs.

3.2 *Potential Water Savings*

For a given WUG, the projected water savings associated with federal residential clothes washer standards is the projected difference in the number of efficient clothes washers with and without the federal standards multiplied by the number of people per single-family housing unit multiplied by the projected per capita savings. The number of people per single-family housing unit was obtained from 2000 Census data, and the projected per capita savings is 5.6 gpcd^(3,4).

The life of a residential clothes washer is approximately 13 years⁽³⁾. The assumed natural replacement rate is normally distributed (one-sided) with standard deviation equal to the clothes washer life, mean equal to the implementation date, and independent variable equal to the planning year.

3.3 *Additional Data Requirements*

No additional data are necessary to project savings from federal residential clothes washer standards.

3.4 *Reliability*

The projected water savings should be realized without action by the WUG. Therefore, the reliability of the potential water savings is relatively high.

3.5 *Opinion of Probable Cost*

The projected water savings should be realized at no cost to the WUGs.

4.0 PUBLIC AND SCHOOL EDUCATION

4.1 *Applicability*

The public and school education program strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- Projected water need,
- Identified sponsor for the public and school education program

4.2 *Projected Water Savings*

Water savings from public and school education are difficult to measure. Public and school education results in indirect savings through enhancement of other water conservation measures and direct savings from changes in customer behavior. In this memorandum, the indirect savings from public education will be attributed to the other water conservation strategies with which they are associated. Therefore, the potential water savings from public and school education will be the direct savings from changes in customer behavior. The projected water savings in a given decade is estimated to be from 1.3 to 3.9 percent of municipal water demand, with savings increasing each decade over the planning period according to Table 2.1. WUGs that implement this program by 2010 are projected to achieve 3.9 percent savings by 2060.

Table 2.1: Projected Percentage Savings by Decade for Public and School Education

2010	2020	2030	2040	2050	2060
1.3%	2.1%	2.5%	3.0%	3.5%	3.9%

It is assumed that the savings from public and school education last one year⁴ and that the program must be renewed each year to maintain and increase the estimated savings.

4.3 *Additional Data Requirements*

No additional data are needed to project water savings from public and school education.

4.4 *Reliability*

Water savings from public and school education are difficult to measure and depend on customer behavior. For these reasons, the reliability of the estimated water savings is low. Public and school education reinforces and builds on previously delivered conservation messages; therefore, it is important that the public and school education program be continued from year to year in order to enhance the reliability of the savings.

4.5 *Opinion of Probable Cost*

Previous planning efforts have budgeted between \$0.50 and \$0.75 per resident per year for public and school education⁽²⁾. The projected savings of 1.3.0 to 3.9 percent of municipal water use is relatively aggressive compared to other planning efforts, justifying a greater level of spending in Region C. The City of Dallas currently spends approximately \$1.00 per resident per year on public and school education. On a per capita basis, it is anticipated that smaller cities would have to spend up to \$3.00 per resident per year to deliver effective water conservation messages.

The opinion of probable annual cost for each WUG to which this measure applies was derived using population projections. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

5.0 IMPACT OF INCREASING WATER PRICES

5.1 *Applicability*

The impact of increasing water prices was evaluated for all municipal WUGs.

5.2 *Potential Water Savings*

The change in water demand from increases in water prices is called the price elasticity of water demand. A price elasticity of -0.20 indicates that a 1.00 percent increase in water rates will cause a -0.20 percent decrease in water usage. Estimation of potential water savings from the price elasticity of water demand requires projection of future treated water prices.

Unfortunately, historical price elasticities depend upon economic and other conditions that may not persist in the future, and no projections of future price elasticities were identified. Therefore, a long-term price elasticity of -0.20 is recommended for projecting the impact of increasing water prices in Region C. It has also been assumed that real water prices will increase by 20 percent over the planning period and that half of the potential impact of increasing water prices will be offset by increasing income.

The projected water savings for each WUG is one half of the long-term price elasticity multiplied by the change in real water price multiplied by the municipal water demand. It was assumed that real water prices will increase linearly during planning period, for a total 20 percent increase by 2060 (Table 5.2). By the end of the planning period, increasing water prices are projected to cause a 2 percent reduction in total water demand.

Table 5.1: Projected Real Water Price Increases During Planning Period

2010	2020	2030	2040	2050	2060
0%	4%	8%	12%	16%	20%

5.3 *Additional Data Requirements and Reliability*

Customer participation is highly reliable for this strategy, since changes in water prices automatically affect all water customers. However, the projected water savings are based on broad, general assumptions, and the reliability of the above projections is low.

The reliability of the above projections could be increased if detailed projections of real treated water prices and real income were available. This would require projections of raw water costs, treatment costs, distribution costs, and administrative costs for each WUG.

5.4 *Opinion of Probable Cost*

The projected water savings should be realized at no cost to the WUGs.

6.0 WATER SYSTEM AUDIT, LEAK DETECTION AND REPAIR, AND PRESSURE CONTROL

6.1 *Applicability*

HB 3338, passed by the 78th Texas Legislature, requires water system audits for retail public utilities. In addition, the feasibility of the system water audit, pressure control, and leak detection strategy was evaluated for publicly-owned municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- Total unaccounted-for water (UFW) in excess of the target level.
- Projected water need, and
- Identified sponsor for this strategy.

6.2 *Potential Water Savings*

For a given WUG, the projected water savings associated with the water system audit, leak detection and repair, and pressure control strategy is the difference between the WUG's actual UFW and the target UFW multiplied by the municipal water demand multiplied by an implementation schedule percentage. The target UFW is 12 percent for most WUGs and 18 percent for WUGs with widespread, rural systems. It has been assumed this strategy will be 33 percent complete by the first decade of implementation and 100 percent by the second decade of implementation. The program should be continued indefinitely to maintain the target UFW.

No water savings were projected for WUGs that have not reported their UFW.

6.3 *Additional Data Requirements*

Available utility profiles have been reviewed for WUGs, and several inconsistencies with the way that WUGs report data have reduced the reliability of the reported data. In different sections, the utility profile switches between units of one thousand gallons and

units of gallons, leading to some confusion in reporting: the reported quantities did not always appear to have the stated units. It is not always clear whether the reported quantities include wholesale water volumes in addition to retail water volumes. The utility profile form requests monthly water diverted (or treated) but some WUGs reported monthly water sales instead. It is not always clear whether multi-family residential water use is included in the residential category or the commercial category. The utility profile form requests “water loss,” but defines it as the difference between water diverted (or treated) and water sold. In reality, this definition applies to “nonrevenue water,” which includes water loss and unbilled authorized consumption. It is not always clear whether utilities reported water loss or nonrevenue water. Some WUGs reported one or more years where the water sold was greater than the water diverted (or treated). Some WUGs also reported total water diverted (or treated) differently on the same profile where this information is requested. Future reporting forms should attempt to address these areas of potential confusion.

6.4 *Reliability*

The projected water savings are based on reported UFW data, which increases the reliability of the estimates. However, UFW as a percentage of total produced and/or purchased water can vary widely from year to year, even if the total system water loss does not change. Therefore, the reliability of the potential water savings is medium.

6.5 *Opinion of Probable Cost*

The cost for a system water audit is highly variable and depends on the size of the water system and the degree of uncertainty present in the estimated losses. The opinion of probable cost for a “desktop” audit, conducted by assembling readily available data and estimating losses for which data are not available, may range from \$5,000 to \$50,000. The opinion of probable cost for an “intensive” audit, where field investigations are conducted to generate additional data with which to refine the desktop audit, may range from \$50,000 to \$500,000 or more. It has been assumed that WUGs will implement the desktop audit.

In addition, a typical cost for leak detection and repair is \$400 per mile of main per year⁽²⁾. Using estimates of the number of miles per main for different populations, an opinion of the probable annual cost for leak detection and repair was generated.

For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

7.0 WATER CONSERVATION PRICING STRUCTURE

7.1 *Applicability*

The water conservation pricing structure strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- Projected water need,
- No water conservation pricing structure, and
- Identified sponsor for the water conservation pricing structure.

7.2 *Potential Water Savings*

The projected water savings for each WUG is a percentage of municipal water demand multiplied by an implementation schedule percentage. Selection of water conservation pricing structures is a highly WUG-specific task requiring a separate rate study. For purposes of projecting conservation savings, it was assumed that implementation of a water conservation pricing structure would save 1.5 percent of total water demand for each municipal WUG. No savings were projected if the current water pricing structure is unknown.

The assumed implementation schedule percentages are 50 percent in the first decade of implementation and 100 percent by the second decade of implementation.

7.3 *Additional Data Requirements*

The current water pricing structure is known for WUGs that comprise 86 percent of 2060 municipal water demand. For a complete estimate of potential water savings, it is necessary to identify the existing water pricing structure for the remaining WUGs.

7.4 *Reliability*

Customer participation is highly reliable for this strategy, since changes to the pricing structure automatically affect all water customers. However, it is not possible to predict the water conservation pricing structure that each WUG would adopt, so the reliability of the savings estimate is low.

7.5 *Opinion of Probable Cost*

It has been assumed that the probable cost to pass an ordinance in a city of up to 25,000 people is \$5,000 and that the cost to pass an ordinance in a city of more than 50,000 people is \$10,000. To obtain an opinion of probable annual costs, probable capital costs were amortized at a 6 percent interest rate for a term of 20 years. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

8.0 **WATER WASTE PROHIBITION**

8.1 *Applicability*

The water waste prohibition strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd.
- Projected water need.
- No water waste prohibition.
- Identified sponsor to implement a water waste prohibition strategy.

Some WUGs are unable to implement this strategy, because they lack ordinance-making authority.

8.2 *Potential Water Savings*

The projected water savings for each WUG is the product of the following parameters:

- Potential water savings
- Municipal water demand
- Percent seasonal water demand
- Percent automatic irrigation
- Compliance rate
- Implementation schedule percentage

The projected savings are based on use of rain sensors that shut off automatic irrigation systems when it is raining or when it has rained recently (depending on the type of sensor). It is estimated that the percentage of watering cycles missed during a drought year is approximately equal to the minimum annual percentage of days with ½-inch rainfall events. The projected water savings from an irrigation water waste prohibition strategy is 3.3 percent of irrigation water use for accounts that have automatic irrigation systems⁽²⁾.

The percentage of customers that have automatic irrigation systems varies considerably across the region and is unknown in most cases. In the July 2004 RCWPG survey, 52 out of 129 total responses provided an estimate of the percentage of customers that have automatic irrigation systems.

It is anticipated that it will take ten years of implementation to realize full compliance with the water waste prohibition. However, anecdotal evidence indicates that there is some fraction of rain sensors that will be out of order. Therefore, “full compliance” is projected to be 90 percent participation.

The estimated potential water savings has been based on a requirement for rain sensors for automatic irrigation systems. As discussed previously, a water waste prohibition may address numerous other sources of waste, but it is not possible to predict what the ordinance for an individual WUG might prohibit. The potential water savings from other sources of water waste have not been estimated.

It is anticipated that the customer will replace the rain sensor at the end of its useful life at his or her own expense to maintain compliance with the water waste prohibition and that the projected water savings will be permanent.

8.3 *Additional Data Requirements*

The status of whether a WUG has implemented a water waste prohibition is known for WUGs that comprise 71 percent of 2060 municipal water demand. Additional information is necessary to project water savings for the remainder of the WUGs.

In addition, the percentage of customer accounts that have automatic irrigation systems is unknown for most WUGs. Additional data would improve the reliability of the assumptions stated in Section 8.2.

8.4 *Reliability*

For an individual automatic irrigation system with a rain sensor in working order, the reliability of the potential water savings should be high. However, for an entire WUG to realize its projected savings, there must be enforcement of the water waste prohibition to ensure that the projected number of rain sensors are installed, and automatic irrigation system owners must keep the rain sensor in working order. In addition, there are uncertainties associated with the estimates of the market penetration of automatic irrigation systems. Due to uncertainties described above, the reliability of the projected savings is medium.

8.5 *Opinion of Probable Cost*

The primary costs for this measure include adoption of an ordinance and enforcement of the ordinance similar to Section 7. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

9.0 COIN-OP CLOTHES WASHER REBATE

9.1 *Applicability*

The coin-op clothes washer rebate strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd.
- Projected water need.
- No coin-op clothes washer rebate strategy.
- Identified sponsor to implement a coin-op clothes washer rebate strategy.

9.2 *Potential Water Savings*

In a given year, the projected water savings for a WUG is the sum of savings from multi-family coin-op clothes washer rebates and Laundromat coin-op clothes washer rebates.

The projected savings from multi-family coin-op clothes washer rebates is the product of the following parameters:

- Number of active multi-family rebates
- Multi-family clothes washer density
- Multi-family population density
- Projected per capita savings
- Percentage of rebates not given to freeriders

Detailed assumptions for water savings are documented in the *2006 Region C Water Plan Appendix M* ⁽²⁾ and have not changed during this planning period.

9.3 *Additional Data Requirements*

No additional data are required to project potential water savings.

9.4 *Reliability*

The per capita savings should be highly reliable because the savings are based on changes in clothes washer design. However, due to significant uncertainty in the final market penetration, the overall reliability of the savings estimate is low to medium.

9.5 *Opinion of Probable Cost*

The opinion of probable cost for a single rebate is \$208, including the rebate, marketing, and overhead. Detailed assumptions for water savings are documented in the *2006 Region C Water Plan Appendix M* ⁽²⁾ and have not changed during this planning period.

10.0 RESIDENTIAL CUSTOMER WATER AUDIT

10.1 *Applicability*

The residential customer water audit strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd.
- Projected water need.
- No residential customer water audit strategy.
- Identified sponsor to implement a residential customer water audit strategy.

10.2 *Potential Water Savings*

A residential customer water audit involves both indoor and outdoor aspects. It is assumed that the auditor will replace showerheads and faucet aerators if they are high-flow devices and will replace toilet flappers if a leaking toilet flapper is discovered during the audit. In addition, the auditor will inspect the irrigation system and its operation and offer suggestions on how to irrigate more efficiently. Audits may result in changed customer behavior.

10.2.1 Indoor Savings

Based on the natural replacement rate and measure life projected for the showerheads and aerators, it is likely that many of the audited customers will already have low-flow showerheads and aerators, even if customers with pre-1995 housing are targeted for the audits. In addition, any savings from replacement of showerheads and faucet aerators would be short-lived because such savings would eventually be realized through natural replacement. No savings have been projected from replacement of showerheads and faucet aerators. In addition, the savings amount from changed behavior is difficult to quantify and has not been estimated.

Detailed assumptions for water savings are documented in the *2006 Region C Water Plan Appendix M* ⁽²⁾ and have not changed during this planning period.

In the absence of a residential customer water audit program, the initial market penetration is zero percent. It is assumed that approximately 20 percent of contacted customers will agree to an indoor water audit. If the WUG targets that the top 25 percent of residential water users for customer water audits (both indoor and irrigation), then a

reasonable final market penetration is 5 percent of all residential customers (20 percent of top 25 percent). Coupled with the measure life of 5 years, this indicates a participation rate of 1 percent of customers per year.

10.2.1 Outdoor Savings

The potential outdoor water savings is approximately 10 percent of irrigation water use for audited single-family customers and 15 percent of irrigation water use for audited multi-family customers. In addition, since high-use customers are targeted for residential customer water audits, it is assumed that these customers will use twice as much water for irrigation as the average customer.

After the initial five-year implementation period, the residential customer water audit program must be continued indefinitely to maintain the projected final market penetration.

10.3 *Additional Data Requirements*

No additional data are required to project the potential water savings from the residential customer water audit program.

10.4 *Reliability*

Although replacement of a leaking toilet flapper repairs the initial leak, the replacement flapper may eventually develop a leak as well. There is also significant uncertainty in the following factors:

- Flapper leakage rate,
- Percentage of leaking toilets for each WUG,
- Savings from the irrigation portion of the audit,
- Customer participation rate,
- Final market penetration, and
- Measure life.

Therefore, the reliability of the potential water savings from residential customer water audits is low.

10.5 *Opinion of Probable Cost*

The opinion of probable cost for a single audit is \$102, including the labor, marketing, materials, and overhead. The cost for a single audit is amortized at 6 percent interest over 5 years, the expected life of the measure. The opinion of probable annual cost is the sum of amortized costs for all audits conducted in the previous 5 years. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

11.0 ICI WATER AUDIT, WATER WASTE REDUCTION, AND SITE-SPECIFIC CONSERVATION PROGRAM

11.1 Applicability

The ICI water audit, water waste reduction, and site-specific conservation program strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd.
- Projected water need.
- No ICI water audit, water waste reduction, and site-specific conservation program.
- Identified sponsor to implement an ICI water audit, water waste reduction, and site-specific conservation program.

11.2 Potential Water Savings

Typical literature values for the potential water savings from an ICI water audit, water waste reduction, and site-specific water conservation program range from 10 to 40 percent of total water usage for audited ICI customers ⁽²⁾. It is projected that the potential savings from this strategy will be 15 percent of total water usage for audited customers that implement the water conservation measures identified in the audit.

It is anticipated that the ICI water audit, water waste reduction, and site-specific water conservation program will reach 0.5 percent of ICI customers each year for 20 years until the final market penetration of 10 percent of ICI customers is achieved. The 20-year implementation period is designed to match the projected life of the water savings. After the initial implementation period, the program must be continued indefinitely to maintain the projected final market penetration.

11.3 Additional Data Requirements

Data regarding the amount of ICI water use was not available for every WUG. For WUGs that have not reported their ICI water use, no potential estimate of savings was made.

11.4 Reliability

The effectiveness of this strategy depends on the degree of participation of ICI customers. In addition, there is significant variability in literature values for potential water savings. Therefore, the reliability of the potential water savings for the ICI water audit, water waste reduction, and site-specific water conservation program is low.

11.5 *Opinion of Probable Cost*

The opinion of probable cost for each audit is \$575. The cost for a single audit is amortized at 6 percent interest over 20 years, the expected life of the measure. The opinion of probable annual cost is the sum of amortized costs for all rebates given in the previous 20 years. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

12.0 **LANDSCAPE IRRIGATION RESTRICTIONS**

12.1 *Applicability*

The landscape irrigation restriction program strategy was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- Projected water need,
- Ability for WUG to create and enforce ordinances,
- Not currently implementing the irrigation restriction program, and
- Identified sponsor for the irrigation restriction program

12.2 *Potential Water Savings*

Irrigation restriction ordinances have been passed for a number of WUGs in Region C, although in varying forms. Some ordinances specify time of day restrictions (no automatic irrigation watering from 10am through 6pm) throughout the year, while some choose warmer months (only implementing from April through October). The exact times allowed throughout a day also vary across the Region. Almost all still allow hand irrigating regardless of time of day or year.

Water savings were estimated at 2.5% of seasonal water demands for each applicable WUG. Seasonal water demands are calculated as the difference between peak summer month usage and winter usage, which is attributable largely to landscape irrigation, although cooling water usage and other factors may also be attributable.

12.3 *Additional Data Requirements*

Additional WUG surveys would help refine the number and type of ordinances currently enforced. True estimates of savings are hard to quantify but could be advanced through comparison of WUGs with similar characteristics (climate, size, seasonal usage) that do and do not have ordinances enforced.

12.4 *Reliability*

Customer participation is related to knowledge of ordinance and ordinance enforcement, which varies by WUG. It is also not possible to predict the exact landscape irrigation restrictions that each WUG would adopt. Finally, amounts of water used in irrigation are dependent on weather patterns which cannot be predicted throughout the planning periods. Due to these unknowns the reliability of the savings estimate is low.

12.5 *Opinion of Probable Cost*

The primary costs for this measure include adoption of an ordinance and enforcement of the ordinance similar to Section 7. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

13.0 MANUFACTURING GENERAL REBATE PROGRAM

13.1 *Applicability*

The manufacturing general rebate program strategy was evaluated for manufacturing WUGs that have a projected water need.

13.2 *Potential Water Savings*

It has been assumed that where the strategy is implemented, the potential water savings for the manufacturing general rebate program is three percent of water sales from a municipal WUG to a manufacturing WUG and that the potential water savings will last for 15 years. These assumptions are consistent with the assumption in the TWDB-sponsored study of conservation potential in Texas¹⁰.

It is anticipated that water savings will be realized at a rate of 0.2 percent per year for 15 years until the full 3 percent of total manufacturing water usage is realized. The 15-year implementation period is designed to match the projected life of the water savings. After the initial implementation period, the manufacturing general rebate program must be continued indefinitely to maintain the projected water savings.

It has also been assumed that the program will be implemented beginning in 2020.

13.3 *Additional Data Requirements*

No additional data are required to estimate potential water savings from a manufacturing general rebate program.

13.4 *Reliability*

The effectiveness of this strategy depends on the degree of participation of manufacturing customers. In addition, the estimate of potential water savings is not based on WUG-specific data. Therefore, the reliability of the potential water savings for the manufacturing general rebate program is low.

13.5 *Opinion of Probable Cost*

The opinion of probable cost for rebates is \$2.30 per gallon per day of savings, including the rebate, marketing, and overhead. The cost for a single rebate is amortized at 6 percent interest over 15 years, the expected life of the measure. The opinion of probable annual cost is the sum of amortized costs for all rebates given in the previous 15 years. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

14.0 GOLF COURSE CONSERVATION PROGRAM

14.1 Applicability

The golf course conservation strategy was evaluated for irrigation WUGs that have a projected water need.

14.2 Potential Water Savings

It has been assumed that where the strategy is implemented, the potential water savings for the golf course conservation program is 15 percent of golf course water demand and that the potential water savings will last indefinitely (the golf course will continue to maintain and implement the conservation program at its own expense). In addition, it has been assumed that participation rates will be 0 percent in 2010, 40 percent in 2020, 50 percent in 2030, 60 percent in 2040, 70 percent in 2050, and 80 percent in 2060.

14.3 Additional Data Requirements

No additional data are required to estimate potential water savings from a golf course conservation program.

14.4 Reliability

The effectiveness of this strategy depends on the degree of participation of golf courses. In addition, the estimate of potential water savings is not based on course-specific data. Therefore, the reliability of the potential water savings for the golf course conservation program is low.

14.5 Opinion of Probable Cost

Implementation alternatives include voluntary implementation for self-supplied golf courses, rebates for courses supplied by a municipal WUG, and ordinances if supplied by a city. The opinion of probable cost assumes that a municipal WUG offers a rebate to a golf course to implement a conservation program.

The opinion of probable cost for rebates is \$2.30 per gallon per day of savings, including the rebate, marketing, and overhead. The cost for a single rebate is amortized at 6 percent interest over 20 years. The opinion of probable annual cost is the sum of amortized costs for all rebates given in the previous 20 years. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

15.0 REFERENCES

1. Freese and Nichols, Inc., Alan Plummer Associates, Inc., CP&Y, Inc., and Cooksey Communications, Inc.: *2011 Region C Water Plan*, prepared for the Region C Water Planning Group, Fort Worth, April 2010.
2. Freese and Nichols, Inc., Alan Plummer Associates, Inc., Chiang, Patel & Yerby, Inc., and Cooksey Communications, Inc.: *2006 Region C Water Plan*, prepared for the Region C Water Planning Group, Fort Worth, July 2006.
3. GDS Associates, Inc.: *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas*, prepared for the Texas Water Development Board, May 2002.
4. Texas Water Development Board: *Water Conservation Implementation Task Force Water Conservation Best Management Practices Guide*, Report 362, Austin, November 2004.