

**APPENDIX K**

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



**Estimation of Savings and Costs for Recommended Water Conservation Strategies in Region C**

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**1.0 INTRODUCTION**

The *2016 Region C Water Plan* recommends a Water Conservation Package for municipal water user groups (WUGs) and additional strategies for manufacturing and irrigation WUGs (Table K.1).

**Table K.1: Recommended Water Conservation Strategies**

| <b>Recommended Strategies</b>        | <b>Water Conservation Measures</b>                                | <b>User Group Type</b> | <b>Memo Section</b> |
|--------------------------------------|---|------------------------|---------------------|
| Municipal Water Conservation Package | Low-flow plumbing fixture rules <sup>(a)</sup>                    | Municipal              | 2.0                 |
|                                      | Efficient new residential clothes washer standards <sup>(a)</sup> | Municipal              | 3.0                 |
|                                      | Efficient new residential dishwasher standards <sup>(a)</sup>     | Municipal              | 4.0                 |
|                                      | Enhanced public and school education                              | Municipal              | 5.0                 |
|                                      | Price elasticity/rate structure impacts                           | Municipal              | 6.0                 |
|                                      | Enhanced water loss control program                               | Municipal              | 7.0                 |
|                                      | Water waste prohibition   | Municipal              | 8.0                 |
|                                      | Time-of-day irrigation restrictions                               | Municipal              | 9.0                 |
|                                      | Reuse of treated wastewater effluent                              | Municipal and others   | 10.0                |
| Non-Municipal                        | Manufacturing general rebate                                      | Manufacturing          | 11.0                |
|                                      | Golf course conservation  | Irrigation             | 12.0                |

<sup>(a)</sup> These measures are implicit in the water demand projections.

This memorandum has two purposes:

- To document the criteria for recommending strategies in the Water Conservation Package for a WUG, and
- To document assumptions made in projecting water savings and opinions of probable cost for these strategies.

Sections 2 through 4 include conservation measures mandated by state or federal laws. The remainder of the measures in the municipal Water Conservation Package are included

in Sections 5 through 10. Sections 11 and 12 include non-municipal conservation measures.

Summaries of the potential water savings and cost per thousand gallons of water saved for each municipal conservation measure are presented in Tables K.2 and K.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.

## **2.0 LOW FLOW PLUMBING FIXTURE RULES**

### *2.1. Applicability*

Potential savings from state low flow plumbing fixture rules were evaluated for all municipal WUGs. The Water Saving Performance Standards for Plumbing Act, implemented by Texas in 1992, restricted flowrates of plumbing fixtures manufactured after January 1, 1994 to 1.6 gallons per flush (gpf) for toilets and 2.5 gallons per minute for showerheads. House Bill 2667, implemented September 1, 2009, further restricted toilet flowrates to 1.28 gpf by January 1, 2014.

### *2.2 Projected Water Savings*

The Texas Water Development Board (TWDB) projected water savings from the gradual conversion to 1.6 gpf toilets and 2.5 gpm showerheads at 10.5 gallons per capita per day (gpcd) for toilets and 5.5 gpcd for showerheads <sup>(1)</sup>. The TWDB projected the additional water savings from conversion to 1.28 gpf toilets at 1.63 gpcd.

For a given WUG, the initial number of inefficient toilets is based on the 1995 population. The TWDB assumes that 2 percent of this initial number will be replaced each year. Some of the projected water savings has already occurred as residents and businesses replace toilets and showerheads. For a given WUG, the percentage of the population that has installed low-flow plumbing fixtures depends on the 1995 population, the natural fixture replacement rate, and population growth since 1995 <sup>(1)</sup>. Based on these factors the TWDB estimated future water savings for each municipal WUG from the low flow plumbing fixture rules.

To project future water demands, the TWDB started with a dry-year per capita water use estimate (typically based on 2011 usage) and subtracted projected water savings from three state/federal regulatory measures:

- Low-flow plumbing fixture rules (this section),
- Efficient new residential clothes washer rules (Section 3.0), and
- Efficient new residential dishwasher rules (Section 4.0).

Although the savings from each measure are not broken out separately, the savings from all three measures in a given decade is the difference in the dry-year per capita water use and the projected per capita water demand multiplied by the projected population (Table K.2) The projected 2020 regional municipal water demand is reduced by 4.7 percent from what it would be without these three regulatory measures, and the projected 2070 regional municipal water demand is reduced by 8.7 percent.

**Table K.2: Summary of Projected Municipal Water Savings by Conservation Measure**

| Measure   | Water Savings (acre-feet per year) |                |                |                |                |                |
|---|------------------------------------|----------------|----------------|----------------|----------------|----------------|
|   | 2020                               | 2030           | 2040           | 2050           | 2060           | 2070           |
| Low Flow Plumbing Fixture Rules <sup>(a)</sup>                    | 73,670                             | 117,130        | 156,899        | 190,599        | 219,168        | 247,409        |
| Efficient New Residential Clothes Washer Standards <sup>(a)</sup> |                                    |                |                |                |                |                |
| Efficient New Residential Dishwasher Standards <sup>(a)</sup>     |                                    |                |                |                |                |                |
| <b>Water Savings Implicit in Water Demand Projections</b>         | <b>73,670</b>                      | <b>117,130</b> | <b>156,899</b> | <b>190,599</b> | <b>219,168</b> | <b>247,409</b> |
| Enhanced Public and School Education                              | 12,720                             | 21,704         | 31,089         | 34,290         | 37,258         | 39,974         |
| Price Elasticity/Rate Structure Impacts                           | 4,927                              | 11,145         | 18,911         | 28,214         | 39,153         | 51,822         |
| Enhanced Water Loss Control Program                               | 19,138                             | 20,435         | 2,072          | 2,605          | 3,413          | 4,277          |
| Time-of-Day Irrigation Restriction                                | 60                                 | 165            | 193            | 222            | 260            | 286            |
| Water Waste Prohibition   | 135                                | 325            | 383            | 471            | 646            | 830            |
| Other <sup>(b)</sup>  | 11,041                             | 24,994         | 35,025         | 36,844         | 35,868         | 33,919         |
| <b>Water Savings Over and Above Water Demand Projections</b>      | <b>48,021</b>                      | <b>78,768</b>  | <b>87,673</b>  | <b>102,646</b> | <b>116,598</b> | <b>131,108</b> |
| <b>Total Water Savings</b>  | <b>110,496</b>                     | <b>184,701</b> | <b>244,566</b> | <b>293,245</b> | <b>335,759</b> | <b>378,516</b> |

(a) Water savings estimated by Texas Water Development Board

(b) "Other" water conservation includes water savings from two sources:

(1) According to their water conservation plans, 15 WUGs have implemented significant measures in addition to the Water Conservation Package. These conservation measures have been implemented recently and were not reflected in the historical water data that were used to project water demands. These measures were evaluated on a WUG-specific basis.

(2) Conservation water savings estimates over and above the Water Conservation Package that were submitted by WUGs or their consultants.

**Table K.3: Summary of Cost by Municipal Conservation Measure**

| Measure  | Cost Per Thousand Gallons of Water Saved |               |               |               |               |               |
|--|--|---------------|---------------|---------------|---------------|---------------|
|  | 2020                                     | 2030          | 2040          | 2050          | 2060          | 2070          |
| Low Flow Plumbing Fixture Rules                            | \$0.00                                   | \$0.00        | \$0.00        | \$0.00        | \$0.00        | \$0.00        |
| Efficient New Residential Clothes Washer Standards         | \$0.00                                   | \$0.00        | \$0.00        | \$0.00        | \$0.00        | \$0.00        |
| Efficient New Residential Dishwasher Standards             | \$0.00                                   | \$0.00        | \$0.00        | \$0.00        | \$0.00        | \$0.00        |
| <b>Water Costs Implicit in Water Demand Projections</b>    | <b>\$0.00</b>                            | <b>\$0.00</b> | <b>\$0.00</b> | <b>\$0.00</b> | <b>\$0.00</b> | <b>\$0.00</b> |
|  |  |               |               |               |               |               |
| Enhanced Public and School Education                       | \$2.02                                   | \$1.35        | \$0.99        | \$0.98        | \$0.97        | \$0.97        |
| Price Elasticity/Rate Structure Impacts                    | \$0.00                                   | \$0.00        | \$0.00        | \$0.00        | \$0.00        | \$0.00        |
| Enhanced Water Loss Control Program                        | \$3.74                                   | \$3.53        | \$2.54        | \$2.43        | \$2.07        | \$1.88        |
| Time-of-Day Irrigation Restriction                         | \$8.20                                   | \$3.55        | \$3.25        | \$3.19        | \$3.14        | \$3.17        |
| Water Waste Prohibition                                    | \$2.51                                   | \$1.18        | \$1.04        | \$0.87        | \$0.82        | \$0.80        |
| Other  | \$0.61                                   | \$0.42        | \$0.38        | \$0.39        | \$0.39        | \$0.39        |
| <b>Water Costs Over and Above Water Demand Projections</b> | <b>\$2.18</b>                            | <b>\$1.43</b> | <b>\$0.58</b> | <b>\$0.54</b> | <b>\$0.50</b> | <b>\$0.47</b> |
| <b>Total Water Costs</b>                                   | <b>\$0.86</b>                            | <b>\$0.58</b> | <b>\$0.21</b> | <b>\$0.19</b> | <b>\$0.17</b> | <b>\$0.16</b> |

### 2.3 *Additional Data Requirements*

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

### 2.4 *Reliability*

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

## 3.0 EFFICIENT NEW RESIDENTIAL CLOTHES WASHER STANDARDS

### 3.1 *Applicability*

Potential savings from federal residential clothes washer standards were evaluated for all municipal WUGs. The federal Department of Energy has set water usage requirements for residential clothes washers by manufacture date (Table K.4).

**Table K.4: Federal New Residential Clothes Washer Standards**

| Type of Clothes Washer | Manufacture Date (on or after) | Water Use Standard <sup>(a)</sup> (gal/ft <sup>3</sup> ) | TWDB Projected Water Savings <sup>(b)</sup> (gpcd) |
|------------------------|--------------------------------|--|--|
| Front-Loading          | January 1, 2011                | WF = 9.5   | 5.23   |
|                        | March 7, 2015                  | MIWF = 4.5   | 6.67   |
| Top-Loading            | January 1, 2011                | WF = 9.5   | 5.23   |
|                        | March 7, 2015                  | MIWF = 8.4   | 5.56   |
|                        | January 1, 2018                | MIWF = 6.5   | 6.13   |

<sup>(a)</sup> For 2011, the water use standard is expressed in terms of water factor (WF). The WF is the total weighted per-cycle water consumption for the cold wash/cold rinse cycle divided by the clothes container capacity. Other water use standards are expressed in terms of maximum integrated water factor (MIWF). The MIWF is the total weighted per-cycle water consumption for all wash cycles divided by the clothes container capacity. The listed standards apply to “standard” sized clothes washers of 1.6 cubic feet and larger.

<sup>(b)</sup> Water savings projections depend on the number of people per household (2.75), the number of loads washed per household per year (300), the proportion of households with clothes washers (75 percent), the percentage of new construction installing a clothes washer (91 percent), the proportion of top-loading machines to front-loading machines (40 percent/60 percent), and the useful life of clothes washers (11 years for a front-loading machine and 14 years for a top-loading machine <sup>(1)</sup>).

### 3.2 *Projected Water Savings*

The TWDB projected water savings from the gradual conversion to more efficient residential clothes washers using the per capita savings projections (Table K.4), the useful life of clothes washers, the regulatory deadlines, and projected populations for each WUG.

As described in Section 2.2, the projected water savings from efficient new residential clothes washer standards are implicit in the TWDB's future water demand projections and comprise a portion of the water savings shown in Table K.2.

### 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 will be realized without action by the WUG, as residents gradually replace inefficient clothes washers. Therefore, the reliability of the potential water savings is relatively high.

### 3.5 *Opinion of Probable Cost*

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

## **4.0 EFFICIENT NEW RESIDENTIAL DISHWASHER STANDARDS**

### 4.1 *Applicability*

Potential savings from federal residential dishwasher standards were evaluated for all municipal WUGs. The federal Department of Energy has set a requirement that "standard" sized residential dishwashers (capacity for 8 place settings) manufactured on or after January 1, 2010, must achieve a water consumption of 6.5 gallons per cycle. This requirement decreases to 5.0 gallons per cycle for dishwashers manufactured on or after May 30, 2013.

### 4.2 *Projected Water Savings*

The TWDB projected water savings of 1.83 gpcd from dishwashers that use 6.5 gallons per cycle and 1.93 gpcd from dishwashers that use 5.0 gallons per cycle <sup>(1)</sup>. As described in Section 2.2, the projected water savings from efficient new residential dishwasher standards are implicit in the TWDB's future water demand projections and comprise a portion of the water savings shown in Table K.1.

### 4.3 *Additional Data Requirements*

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

### 4.4 *Reliability*

The projected water savings will be realized without action by the WUG, as residents gradually replace inefficient dishwashers. Therefore, the reliability of the potential water savings is relatively high.

### 4.5 *Opinion of Probable Cost*

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

## 5.0 ENHANCED PUBLIC AND SCHOOL EDUCATION

Most utilities in Region C have some kind of public and school education program. However, the levels of effort put into these programs, the budgets for these programs, and the water savings from these programs are highly variable. Although this measure does not define how a utility should conduct its public and school education program, it assumes that participating utilities will operate their programs at a high (or “enhanced”) level, committing resources as necessary to achieve significant water savings.

### 5.1. *Applicability*

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

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

### 5.2 *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 measures 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. Given the significant amount of public education on water conservation that has already taken place in Region C, the projected water savings in a given decade is estimated to be from 1 to 2 percent of municipal water demand, with savings increasing each decade over the planning period according to Table K.5. WUGs that implement this program by 2020 are projected to achieve 2 percent savings by 2070.

**Table K.5: Projected Percentage Savings by Decade for Enhanced Public and School Education**

| 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|------|------|------|------|------|------|
| 1.0% | 1.5% | 2.0% | 2.0% | 2.0% | 2.0% |

It is assumed that the savings from public and school education last one year <sup>(2)</sup> and that the program must be renewed each year to maintain and increase the estimated savings.

### 5.3 *Additional Data Requirements*

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

### 5.4 *Reliability*

Water savings from enhanced 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. Enhanced public and school education reinforces and builds on previously delivered conservation messages; therefore, it is important that the enhanced public and

school education program be continued from year to year in order to increase the reliability of the savings.

### 5.5 *Opinion of Probable Cost*

Actual spending per resident can be difficult to track, because media markets overlap many cities. For example, in 2010, the City of Dallas spent about \$1.65 million on its public awareness program and its environmental education initiative. Based on the retail customer population, this corresponds to \$1.37 per resident. However, the associated media buys also reached wholesale customers. When the wholesale customer population is taken into account, the per capita spending was \$0.65.

As another example, the City of Fort Worth currently spends about \$0.19 per retail resident for public and school education. The Tarrant Regional Water District also spends about \$0.84 per wholesale resident (including Fort Worth residents) for its public awareness program. Therefore, different entities are funding and conducting public and school education programs costing a total of about \$1.03 per Fort Worth resident.

Based on this information, the cost of enhanced public and school education is expected to be about \$1.00 per resident for the largest WUGs. It is anticipated that smaller cities would have to spend up to \$3.00 per resident per year to deliver effective water conservation messages <sup>(3)</sup>.

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.

These costs have been associated with the WUGs that benefit from the programs, regardless of whether the funding comes from the WUG itself or from a wholesale supplier.

## **6.0 PRICE ELASTICITY/RATE STRUCTURE IMPACTS**

### 6.1 *Applicability*

The impact of real increases in water prices was evaluated for all municipal WUGs. Although many WUGs in Region C already have conservation-oriented rate structures, this measure is also assumed to account for rate structure changes.

### 6.2 *Projected Water Savings*

The change in water demand due to a real increase in the water price is called the price elasticity of water demand. A price elasticity of -0.20 indicates that a 1.0 percent increase in water rates will cause a -0.2 percent change 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 <sup>(3)</sup>. 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 2070 (Table K.6). By the end of the planning period, increasing water prices are projected to cause a 2 percent reduction in total water demand.

**Table K.6: Projected Real Water Price Increases During Planning Period**

| 2020 | 2030 | 2040  | 2050  | 2060  | 2070 |
|------|------|-------|-------|-------|------|
| 3.3% | 6.7% | 10.0% | 13.3% | 16.6% | 20%  |

### 6.3 *Additional Data Requirements and Reliability*

Customer participation is highly reliable for this measure, 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 medium.

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.

### 6.4 *Opinion of Probable Cost*

The projected water savings due to real increases in water price will be realized at no cost to the WUGs.

## **7.0 ENHANCED WATER LOSS CONTROL PROGRAM**

Most utilities in Region C have some kind of water loss control program. However, the levels of effort put into these programs, the budgets for these programs, and the water savings from these programs are highly variable. Although this measure does not define how a utility should conduct its water loss control program, it assumes that participating utilities will operate their programs at a high (or “enhanced”) level, committing resources as necessary to achieve significant water savings.

The enhanced water loss control program consists of:

- Water audits, pressure control, and leak detection and repair (including Automated Metering infrastructure), and
- Water main replacement

### 7.1 *Applicability*

Retail public utilities that supply potable water to more than 3,300 connections or receive financial assistance from the TWDB must file a system water loss audit with the TWDB by May 1 each year. Other retail public utilities that supply potable water must file a system water loss audit with the TWDB every five years (the next due date is May 1, 2016) <sup>(4)</sup>. In

addition, the feasibility of water audits, pressure control, and leak detection and repair was evaluated for publicly-owned municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- Total water loss in excess of the target level.
- A projected water need, and
- An identified sponsor for this measure.

Water main replacement was evaluated for every WUG.

## 7.2 *Projected Water Savings*

For a given WUG, the projected water savings associated with water audits, pressure control, and leak detection and repair is the difference between the WUG's actual water loss percentage and the target water loss percentage multiplied by the municipal water demand multiplied by an implementation schedule percentage. The target water loss is 12 percent for urban/suburban WUGs and 18 percent for WUGs with widespread, rural systems. It has been assumed this measure will be 33 percent complete by the first decade of implementation and 100 percent complete by the second decade of implementation. The program should be continued indefinitely to maintain the target water loss. No water savings were projected from these measures for WUGs that have not reported their water loss.

Water savings from main replacement was estimated to be 0.5 percent of total water demand for each WUG. For each WUG, main replacement was assumed to take place in 2020, and the main replacements are projected to save water for 20 years.

## 7.3 *Additional Data Requirements*

Some WUGs did not report their water loss to the TWDB. In addition, some water loss accounting quantities are difficult to estimate (e.g., fire fighting, main flushing, etc.). As more utilities report and refine their system water audit data, the overall estimate of potential water savings from this measure should be refined.

In addition, there is little information available regarding the concentration of leakage within Region C water systems (e.g., "80 percentage of the leakage occurs within 20 percent of the system").

## 7.4 *Reliability*

The projected water savings are based on reported water loss data, which increases the reliability of the estimates. However, water loss 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.

## 7.5 *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 cost for leak detection and repair of \$587 per mile of main per year has been assumed. This unit cost was derived from the typical leak detection and repair cost of \$400 per mile of main per year used in the *2006 Region C Water Plan*, with adjustment for inflation. 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.

Since small diameter pipes are prevalent in a water distribution system, the large majority of the main replacements will be small diameter pipes. Costs were calculated assuming an 8-inch diameter for each main replacement, using pipe installation costs from the TWDB’s Unified Costing Model, assuming a multiplier of 1.5 to account for other costs involved in pipe replacement, and assuming a multiplier of 1.03 to inflate the cost from the Unified Costing Model basis (March 2012) to the *2016 Region C Water Plan* basis (September 2013).

In some instances, water user groups provided their own estimate of cost to replace mains that are a significant source of measurable water loss.

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*

Water waste prohibition was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- A projected water need,
- No current water waste prohibition/ordinance, and
- An identified sponsor to implement a water waste prohibition measure.

Some WUGs may be unable to implement this measure, because they lack ordinance-making authority.

### *8.2 Projected Water Savings*

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

- Potential water savings (as a percentage of irrigation water demand<sup>1</sup>)
- Municipal water demand
- Percent seasonal water demand
- Percent automatic irrigation
- Compliance rate

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<sup>1</sup> Irrigation water demand is a percentage of total water demand. The percentage is WUG-specific and is estimated based on historical water use.

- 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 is 3.3 percent of irrigation water use for accounts that have automatic irrigation systems.

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 81 percent of 2070 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.

It has been assumed that the probable cost to pass an ordinance in a city of up to 25,000 people is \$7,334 and that the cost to pass an ordinance in a city of more than 50,000 people is \$14,668. To obtain an opinion of probable annual costs, probable capital costs were amortized at a 5.5 percent interest rate for a term of 20 years, and enforcement costs were assumed to be \$0.37 per resident per year. 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 **TIME-OF-DAY IRRIGATION RESTRICTION**

### 9.1 *Applicability*

The time-of-day irrigation restriction was evaluated for municipal WUGs with the following characteristics:

- Existing or projected total water usage of more than 140 gpcd,
- A projected water need,
- The ability for WUG to create and enforce ordinances,
- No existing time-of-day irrigation restriction, and
- An identified sponsor for the time-of-day irrigation restriction.

### 9.2 *Projected Water Savings*

Time-of-day 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 only the warmer months (e.g., April through October). The exact times allowed throughout a day also vary across the Region. Almost all WUGs still allow hand irrigation regardless of time of day or year.

Sprinkler evaporation losses depend on relative humidity, air temperature, wind speed, nozzle diameter, and nozzle pressure<sup>(5)</sup>. Using long-term, monthly average weather data from the Dallas-Fort Worth International Airport weather station and assuming 5/16-inch nozzle diameter<sup>2</sup> and 50 psi nozzle pressure, annual sprinkler evaporation losses were estimated to be 6.9 percent of irrigation water applied for irrigation between 10am and 6 pm and 4.0 percent if irrigation is restricted to 6pm to 10am. For each WUG, it was assumed that one-third of customers that have automatic irrigation systems would change their irrigation time in response to this restriction. For these customers, the estimated water savings is 2.9 percent of seasonal water demands. Seasonal water demands are calculated as the difference between monthly water usage and winter usage. Seasonal water demands are attributable largely to landscape irrigation, although cooling water usage and other factors may also contribute.

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<sup>2</sup> Sprinkler nozzles are available in diameters ranging from 1/8-inch to 1-inch. A 5/16-inch nozzle diameter is considered to be a “mid-range” diameter.<sup>(5)</sup>

It is anticipated that it will take ten years of implementation to realize full compliance with the time-of-day irrigation restriction. However, some customers will continue to irrigate from 10am to 6pm. Therefore, “full compliance” is projected to be 90 percent participation.

### 9.3 *Additional Data Requirements*

Additional WUG surveys would help refine the number and type of ordinances currently enforced and the percentages of customers that have automatic irrigation systems.

### 9.4 *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. In addition, 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 medium.

### 9.5 *Opinion of Probable Cost*

The primary costs for this measure include adoption of an ordinance and enforcement of the ordinance similar to Section 8. For a given WUG and given year, the probable unit cost was calculated as the probable annual cost divided by projected water savings.

## **10.0 REUSE OF TREATED WASTEWATER EFFLUENT**

Reuse is a significant water conservation measure in Region C. Reuse strategies were evaluated on a case-by-case basis, and reuse water supplies are described in Chapter 5.

## **11.0 MANUFACTURING GENERAL REBATE PROGRAM**

### 11.1 *Applicability*

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

### 11.2 *Potential Water Savings*

It has been assumed that where the manufacturing general rebate is implemented, the potential water savings 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 Texas <sup>(2)</sup>.

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 2030.

### 11.3 *Additional Data Requirements*

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

### 11.4 *Reliability*

The effectiveness of this measure 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.

### 11.5 *Opinion of Probable Cost*

The opinion of probable cost for rebates is \$300 per acre-foot of savings, including the rebate, marketing, and overhead. The cost for a single rebate is amortized at 5.5 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.

## **12.0 GOLF COURSE CONSERVATION PROGRAM**

### 12.1 *Applicability*

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

### 12.2 *Potential Water Savings*

It has been assumed that where the measure 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 20 percent in 2020, 40 percent in 2030, 50 percent in 2040, 60 percent in 2050, 70 percent in 2060, and 80 percent in 2070.

### 12.3 *Additional Data Requirements*

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

### 12.4 *Reliability*

The effectiveness of this measure 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.

## 12.5 *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 \$300 per acre-foot of savings, including the rebate, marketing, and overhead. The cost for a single rebate is amortized at 5.5 percent interest over 15 years, the expected life of the associated 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.

### 13.0 REFERENCES

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