Tarrant Regional Water District

Strategic Water Conservation Plan

January 16, 2013

trwd
Tarrant Regional Water District

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

TBPE Firm Registration No. 13

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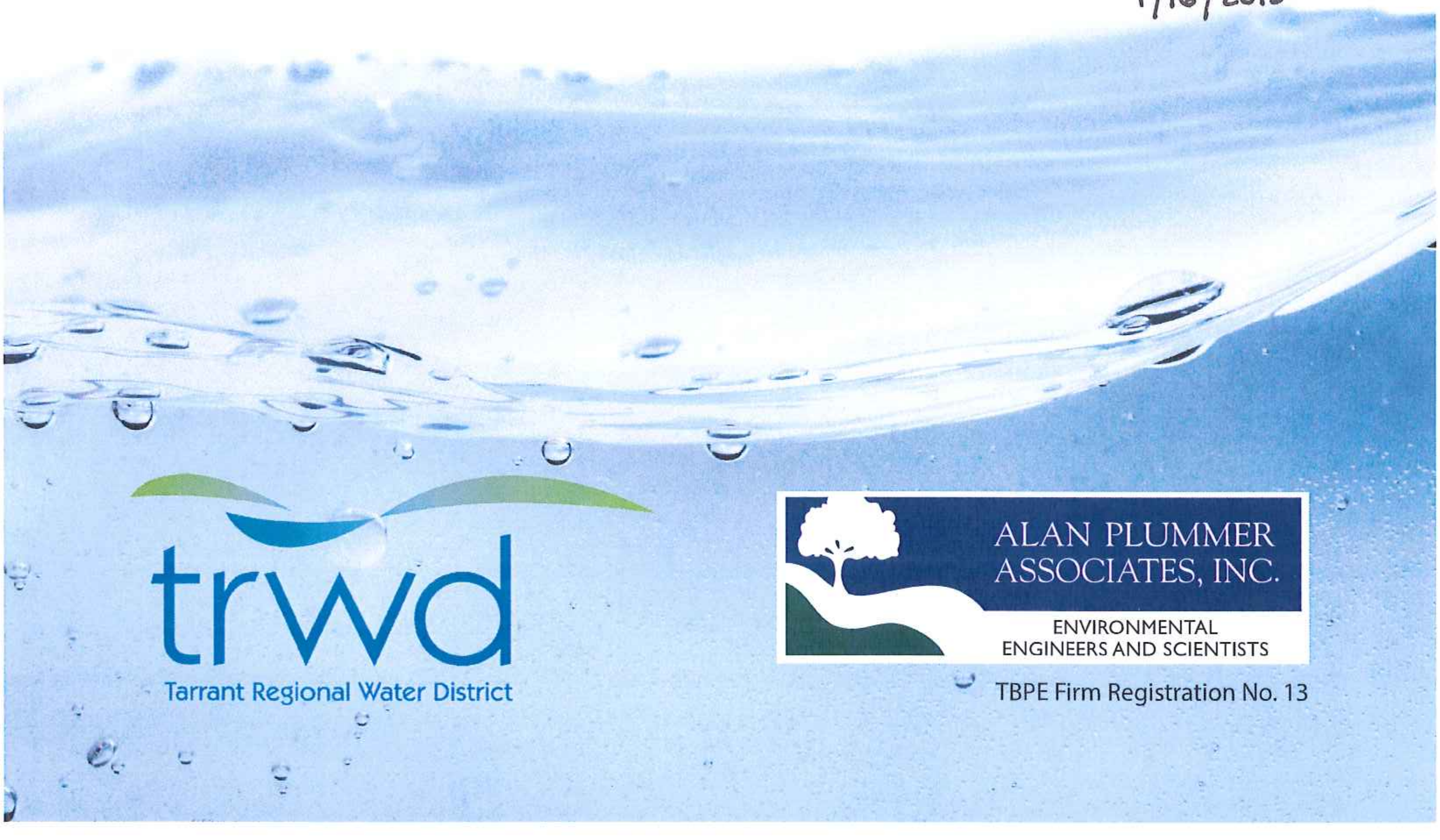

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ES. Executive Summary

Over the next fifty years, total TRWD water demands are projected to double (Ref. 1). Proposed water management strategies for TRWD include water conservation, water reuse projects at Richland-Chambers Reservoir and Cedar Creek Reservoir, participating with other water suppliers to develop Marvin Nichols Reservoir, and participating with other water suppliers to obtain water from Toledo Bend Reservoir and from Oklahoma. The projected capital cost for these projects is $4.73 billion (Ref. 1).

To obtain water from Marvin Nichols Reservoir (to be located in the Sulphur River Basin) by 2030 and Toledo Bend Reservoir (located in the Sabine River Basin) by 2050, the TRWD and other project participants will have to apply for and obtain authorization to transfer water to the Trinity River Basin. Currently, interbasin transfer regulations require applicants to have "developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant" (Ref. 2).

From 2007 through 2011, ongoing water conservation efforts have helped TRWD to save approximately 42.4 billion gallons (130,250 acre-feet) of water, for an average savings of 23.2 million gallons per day (mgd). At the current per capita water demand, these water savings have stretched the existing water supply enough to meet the needs of an additional 132,200 people. This Strategic Water Conservation Plan (Strategic Plan) provides a road map to additional water savings and is an important step toward achieving the "highest practicable levels of water conservation and efficiency." Implementation of this Strategic Plan will extend the life of existing TRWD water supplies and reduce operating costs. Other potential benefits include delaying the need for new water supplies, deferring the associated capital costs, and minimizing associated environmental impacts. This document defines water conservation goals for the five-year planning period from 2013 through 2017 and recommends water conservation measures, budgets, and staffing levels to achieve these goals.[1]

ES.1. Strategic Plan Development Process (Section 1.1)

This document was developed through review of numerous water conservation programs, measures, data, and literature and through input from TRWD staff, TRWD wholesale customer cities, and water conservation staff from other cities.

Water use data from TRWD and its four primary customers (Fort Worth, Arlington, Mansfield, the Trinity River Authority Tarrant County Water Supply Project and their successive customers) were examined to identify strategic areas to target for additional water conservation opportunities. Numerous water conservation measures were evaluated using screening criteria, a benefit-cost analysis, and other means to determine their suitability for implementation during the five-year planning period. New water conservation goals were established, and recommended

[1] In the title of each section of the Executive Summary, the corresponding section in the main report is identified in parentheses.

measures were constructed into a framework plan and presented to TRWD and its customer cities for comment. Feedback was analyzed and used to develop the Strategic Plan.

ES.2. TRWD Primary Customers Water Use Profile (Chapter 4)

To make recommendations that are technically sound and economically feasible, water conservation planners must understand the customer makeup and water use patterns of the service area. Historical water use by the four primary customers and their successive customers was obtained from TRWD and from utility profiles (Figure ES-1). The customer utility profiles contain additional water use information that can be used to further break down historical water use by residential, commercial, industrial, other, and nonrevenue water uses. For the period 2004 to 2008, the customer utility profiles account for 81.5 to 86.9 percent of the water that TRWD delivered to the four primary customers. Because this represents the large majority of water used by the four primary customers, conclusions based on the reported data will be generalized to all TRWD water used by the four primary customers.

Water Sales by Sector (Section 4.2)

The utility profiles report water sales by residential, commercial, industrial, wholesale, and other sectors. For 2004 to 2008, Figure ES-2 shows the weighted average distribution of water sales by customer type for the four primary customers. Residential sales comprise 59.6 to 66.8 percent of retail water sales, commercial sales comprise 24.1 to 31.6 percent, and industrial sales comprise 4.5 to 7.2 percent.

Per-Capita Water Use (Section 4.3)

Total annual water use by the four primary customers is normalized by their populations in Figure ES-3. Some of the variability in annual water use can be attributed to differences in weather from year to year. To better filter out the impact of weather on the annual data, five-year running averages were calculated (Figure ES-3). The five-year running average has declined from 195.8 gpcd in 2002 to 175.8 gpcd in 2011, a decrease of about 1.1 percent per year.

Reported residential water sales are normalized by population in Figure ES-4. Given the available water use data, it is not feasible to separate indoor and outdoor residential water use. The range of residential water sales during the period 2004 to 2008 was about 82 gpcd to 109 gpcd.

Nonrevenue Water and Water Loss (Section 4.4)

Based on the reported data, the calculated average nonrevenue water for the four primary TRWD customers ranged from 12.7 percent to 17.2 percent of total water diversions, depending on the year. Data quality control issues suggest that the actual nonrevenue water percentages are somewhat greater.

Figure ES-1: Water Use by TRWD's Primary Customers and Their Successive Customers

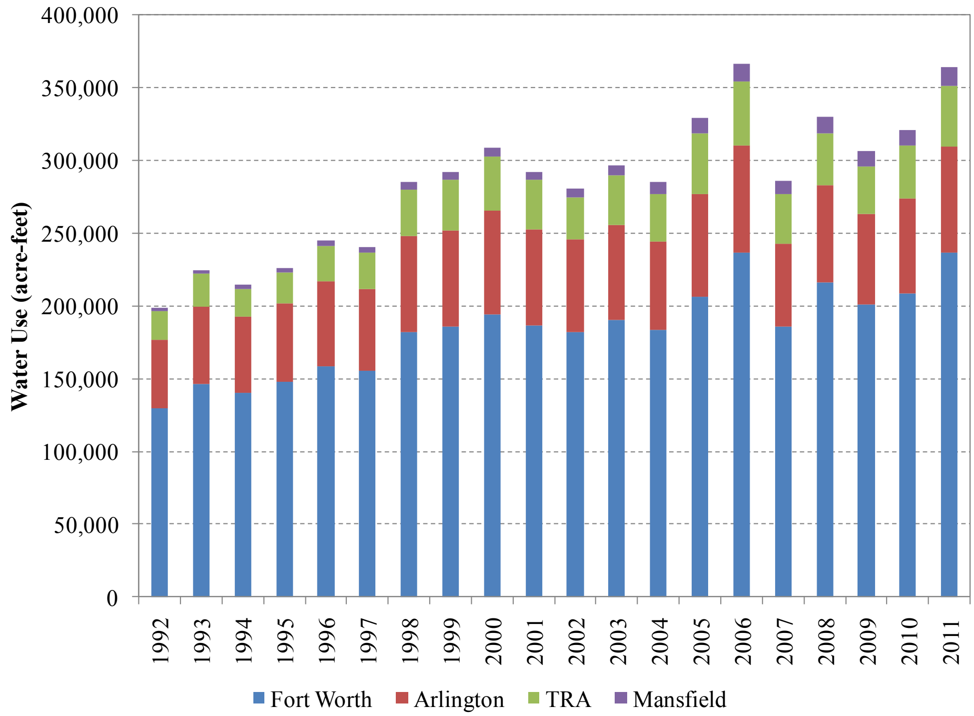


Figure ES-2: Weighted Average Retail Water Sales Distribution by Customer Type for the Four Primary Customers

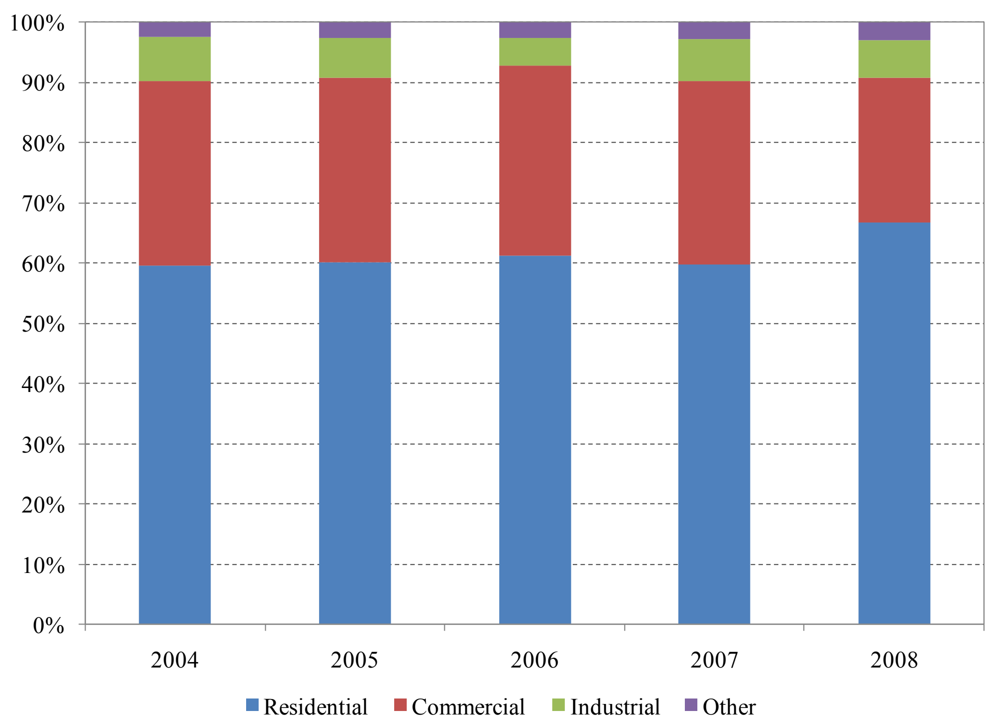


Figure ES-3: Total Water Use Normalized by Population for the Four Primary Customers

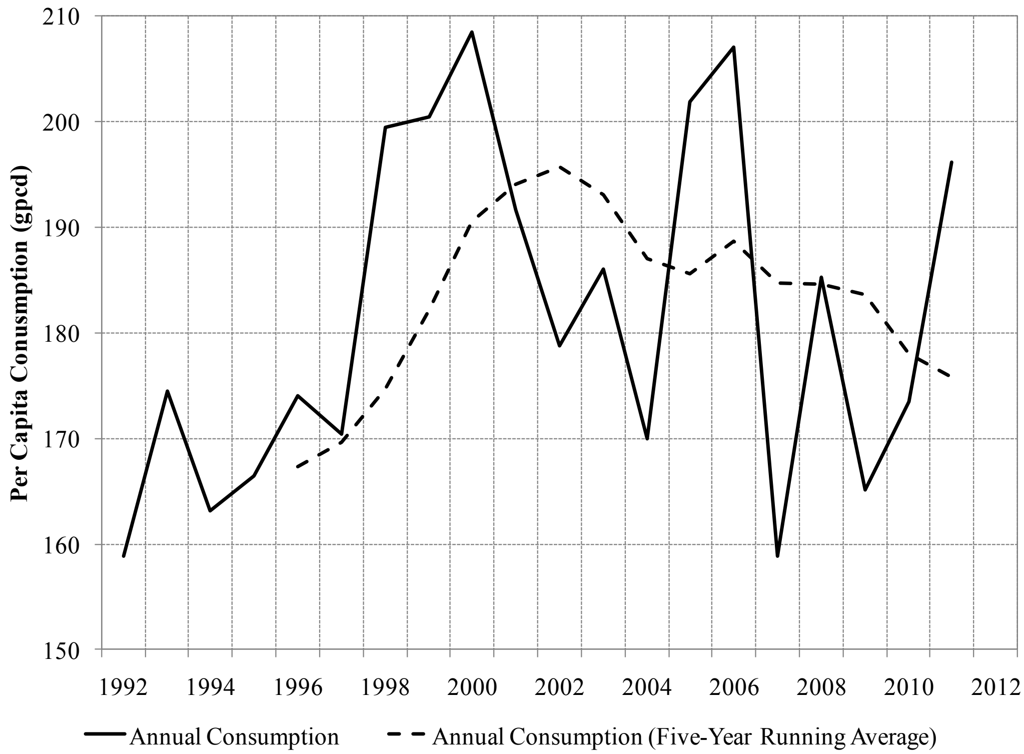
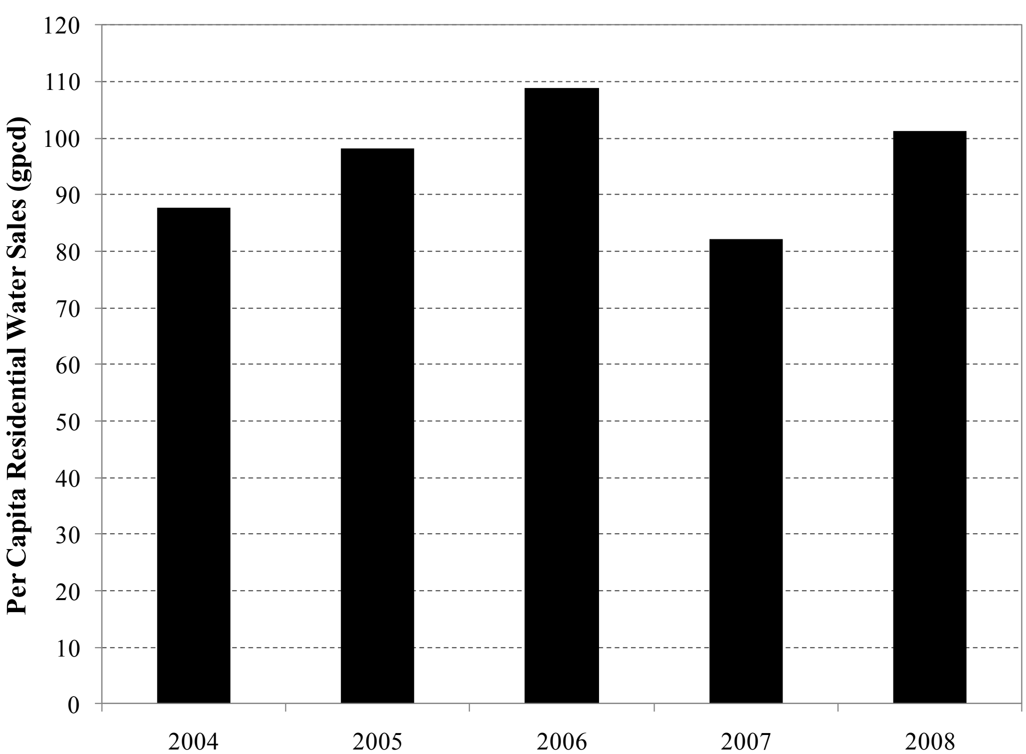


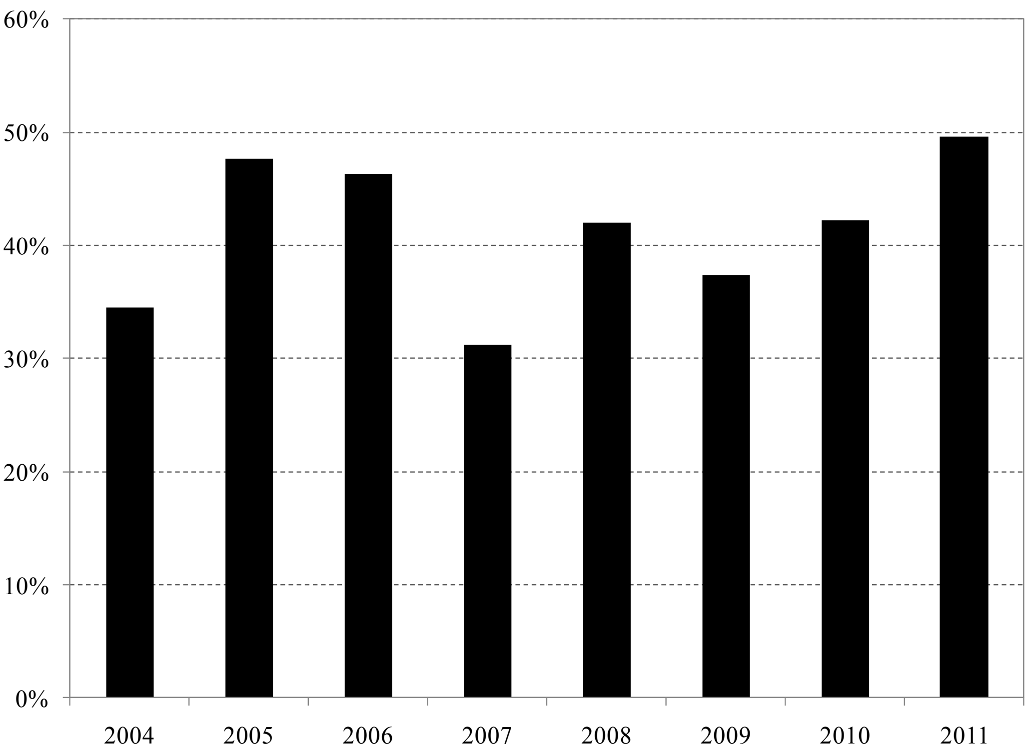
Figure ES-4: Residential Water Sales Normalized by Population for Reporting Customers



Seasonal Water Use (Section 4.5)

On an annual basis, the four primary customers use 31 percent to 50 percent of their water for seasonal uses (Figure ES-5), depending on climatic conditions. Seasonal water uses include lawn irrigation, cooling water, and other water uses that increase in the summer. The customers use more water for seasonal uses during hot, dry conditions.

Figure ES-5: Seasonal Water Use as a Percentage of Total Water Use for the Four Primary Customers



NOTE: Seasonal water uses include lawn irrigation, cooling water, and other water uses that increase in the summer.

ES.3. Identification and Screening of Potential Water Conservation Measures (Chapter 9)

Potential water conservation measures were compiled from various sources, including recommendations by task forces and planning groups, literature sources, and successful regional water conservation programs implemented by other utilities. Potential water conservation measures are presented in Appendix E.

Based on the TRWD water use profile, screening criteria were developed to help determine which new or enhanced water conservation measures would be most effective for the TRWD service area during the next five years. Using these screening criteria, the measures in Table ES-1 were selected for detailed evaluation of probable water savings, benefits, and costs. These measures address a broad range of customer types and water use types.

Table ES-1: Water Conservation Measures Selected for Detailed Evaluation

Measure		Customer Type				Use Type		Measure Type			
		SF	MF	ICI	Municipal/ Utility	Indoor/ Base	Outdoor/ Seasonal	Education/ Outreach	Rebate/ Incentive	Regulation	Other
1	High-efficiency toilet (HET) distribution/incentives	✓	✓	✓		✓			✓		
2	Toilets, natural replacement with HETs	✓	✓	✓		✓				✓	
3	High-efficiency clothes washer (HECW) incentives	✓	✓	✓		✓			✓		
4	Residential clothes washers, natural replacement with HECWs	✓	✓			✓				✓	
5	Pre-rinse spray valve retrofits			✓		✓			✓		
6	ICI customer water audits			✓		✓		✓			
7	Site-specific ICI incentives			✓		✓	✓		✓		
8	Cooling tower incentives			✓			✓		✓		
9	ICI recognition program			✓		✓	✓	✓			
10	Irrigation system evaluations	✓	✓	✓			✓	✓			
11	Irrigation system incentives	✓	✓	✓			✓		✓		
12	Rainwater harvesting incentives	✓	✓	✓			✓		✓		
13	Irrigation limits: maximum 2 times per week	✓	✓	✓			✓	✓		✓	
14	Public education (ET irrigation recommendations)	✓	✓	✓			✓	✓			
15	Golf course conservation and reuse			✓	✓		✓	✓			
16	Model landscape ordinance	✓	✓	✓	✓		✓	✓		✓	
17	Water loss reduction			✓	✓	✓		✓			
18	Water use reduction due to increases in real water price	✓	✓	✓		✓	✓				✓
19	Wholesale customer assistance	✓	✓	✓		✓	✓		✓		
20	Model conservation ordinance	✓	✓	✓	✓	✓	✓	✓		✓	
	NUMBER OF MEASURES	13	13	18	4	12	13	9	8	5	1

SF = Single-family residential
MF = Multi-family residential
ICI = Industrial, commercial, and institutional

ES.4. Detailed Evaluation of Selected Water Conservation Measures (Chapter 10)

The goals of the Strategic Plan are to:

- Develop and implement water conservation programs aimed at:
  - Decreasing per capita water use (gpcd)
  - Reducing seasonal peak demands
  - Reducing water loss and waste
- Target an average one percent per year reduction in the five-year average per capita consumption for the five-year planning period (Figure 10-1).[2] This results in an 8.6 gpcd reduction over five years. This target is exclusive of any credit for indirect reuse diversion volumes (see Section 8.2). This goal is consistent with the recommendations of the statewide Water Conservation Implementation Task Force (Ref. 7) and with TRWD's published 2018 water use goal of 166 gpcd (Table 6-1 and Ref. 3).
- Continue a heightened public awareness of water conservation in the TRWD service area and the North Texas region.
- Continue and enhance conservation practices that will maintain quality of life and allow economic growth and development.
- Continue to include broad-based public and private stakeholder groups in new program development and implementation processes.
- Continue to lead by example by upgrading TRWD facilities with water-efficient fixtures, landscapes, and irrigation systems wherever possible.
- Assist in facilitating regional conservation efforts among TRWD customer cities.
- Establish the foundation for continuation of water savings targets for the following five-year period and succeeding five-year intervals.

The measures listed in Table ES-1 were evaluated based on the following:

- TRWD's water conservation goals for the next five years
- Projected water savings
- Probable benefits
- Probable costs
- Feedback from wholesale customer cities.

[2] Assumes that existing water conservation measures will maintain the existing five-year average per capita water consumption until 2013, when the first recommended water conservation measures from this Strategic Plan will be implemented.

ES.5. Recommended Implementation Plan, 2013 through 2017 (Chapter 11)

Considering how effective TRWD's water conservation program has been over the last several years (Figure ES-3), all of the water conservation measures presently employed by TRWD are recommended for continuation through the planning period. In addition, it will be important to use the multimedia public outreach campaign to educate the public about new measures as they are implemented and to encourage participation.

The recommended implementation schedule for the next five years (Table ES-2 and Figure ES-6) is based on the following prioritization criteria for new water conservation measures:

- Implement the more cost-effective measures early. However, if necessary, delay implementation while working to increase public acceptance.
- Implement measures with higher water savings early.
- Limit the number of programs to be planned/implemented each year based on the capacity of the existing water conservation staff.
- Align strategies that have similarities/synergies.

The following recommendations are given in support of the implementation schedule (Table ES-2):

- As soon as possible, TRWD should develop a model conservation ordinance and encourage customers to adopt and enforce the ordinance.
- TRWD is already working to implement the public education (ET irrigation recommendations) measure. The golf course conservation measure will build on this measure by encouraging golf courses to use the ET irrigation recommendations. Both of these are relatively low-cost measures, and they are also recommended for implementation in 2013.
- TRWD should develop a model ordinance restricting irrigation to a maximum of two times per week and encourage customers to adopt and enforce the ordinance. This measure would make permanent the irrigation restriction that TRWD activated from August 29, 2011 through May 3, 2012 as part of Stage 1 of its Drought Contingency Plan. Although this measure is projected to have substantial water savings, implementation should be delayed until 2014 to allow TRWD to work with its wholesale customers to communicate the benefits of a twice-weekly watering limitation to council and board members, other decision-makers, and the public.
- Although the high-efficiency toilet distribution/incentives measure is the most cost-effective active measure in the long-term, it will require substantial budget increases. Since there is not sufficient time remaining to increase the budget for 2013, it is recommended that the high-efficiency toilet distribution/incentives measure be implemented in 2014.
- TRWD should create an "ICI Device Incentives Menu" to promote use of water-efficient fixtures and equipment by a large number of ICI customers. This menu would begin with implementation of high-efficiency toilet distribution/incentives in 2014 and would

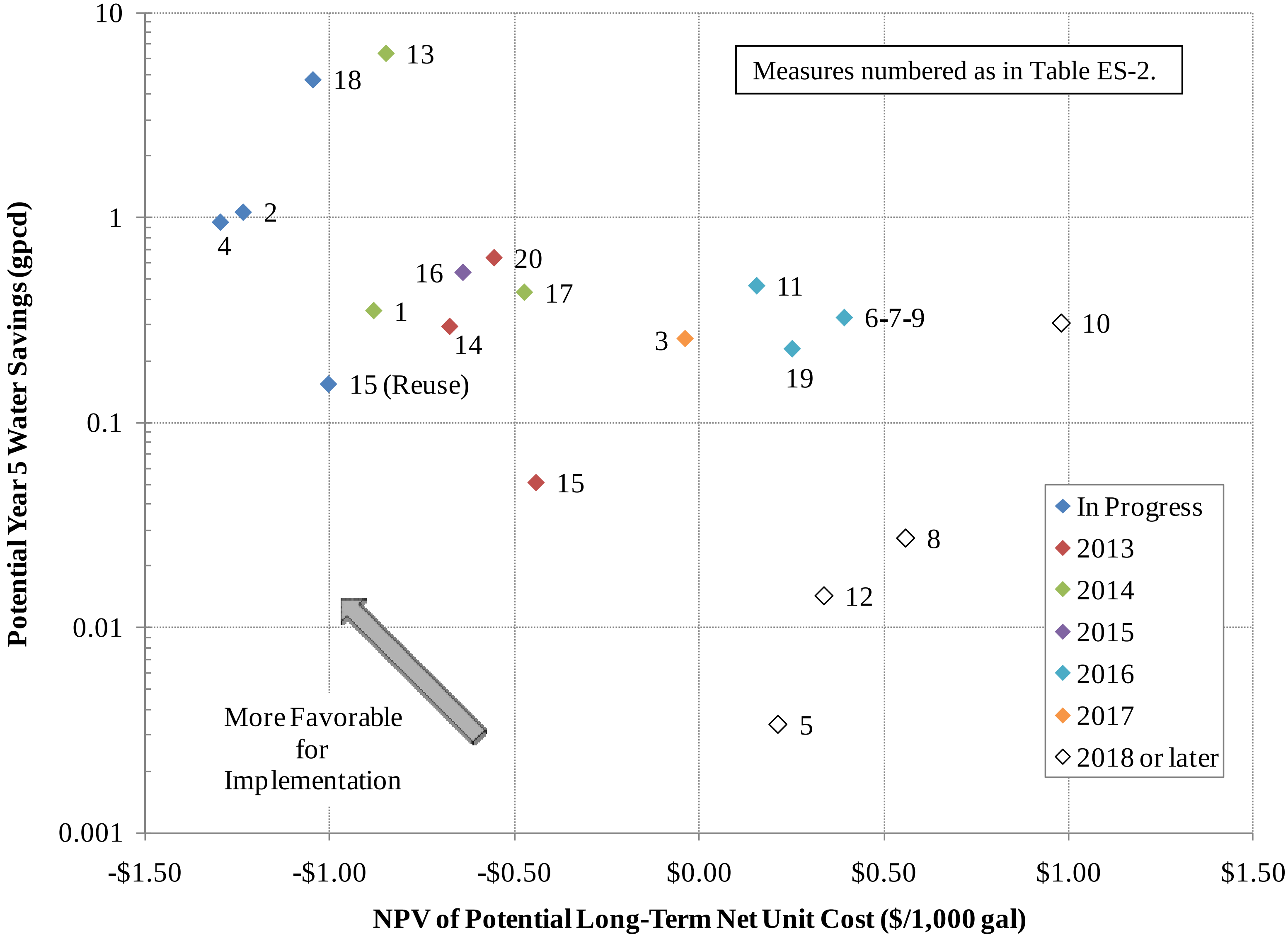
expand in later years to include high-efficiency clothes washer incentives and irrigation system incentives.

Table ES-2: Recommended Implementation Schedule for Evaluated Measures

Measure		Year				
		2013	2014	2015	2016	2017
2	Toilets, natural replacement with HETs					
4	Residential clothes washers, natural replacement with HECWs					
15	Golf course reuse (natural implementation)*					
18	Water use reduction due to increases in real water price					
14	Public education (ET irrigation recommendations)					
20	Model conservation ordinance					
15	Golf course conservation					
13	Irrigation limits: maximum 2 times per week	X				
1	Residential high-efficiency toilet (HET) distribution/incentives	X				
1	*Create ICI device incentives menu:* High-efficiency toilet (HET) distribution/incentives	X				
17	Water loss reduction	X				
16	Model landscape ordinance	X	X			
11	*Add measure to ICI device incentives menu:* Irrigation system incentives			X		
11	Residential irrigation system incentives			X		
19	Wholesale customer assistance			X		
6 7 9	*Site-specific ICI customer program:* ICI customer water audits Site-specific ICI incentives ICI recognition program			X		
3	Residential high-efficiency clothes washer (HECW) incentives				X	
3	*Add measure to ICI device incentives menu:* High-efficiency clothes washer (HECW) incentives				X	
8	*Add measure to ICI device incentives menu:* Cooling tower incentives					X
10	Irrigation system evaluations	Y	Y	Y	Y	X
12	Rainwater harvesting incentives					
5	Pre-rinse spray valve retrofits					

*: Natural conversion of golf course irrigation from raw or potable water to reclaimed water.
X: TRWD staff will perform final planning of measures in the years before implementation.
Y: TRWD will continue its pilot irrigation system evaluation program.

Figure ES-6: Implementation Schedule, Cost-Effectiveness, and Water Savings



- TRWD should also create (by 2016) a "Site-Specific ICI Customer Program" that would provide in-depth assistance to individual ICI customers that desire it. This program would include the ICI customer water audits, site-specific ICI incentives, and ICI customer recognition measures. This program, and the ICI Device Incentives Menu described above, would complement the SmartWater ICI Audits program that Fort Worth implemented in 2010 by expanding audits to other cities and by making it more cost-effective for ICI water users to upgrade equipment. Examples of Fort Worth's success with this program are cited in Section 7.3.
- Since TRWD staff will be busy implementing the irrigation system incentives in 2016, the high-efficiency clothes washer incentives should be delayed until 2017.
- Although implementation of the irrigation system evaluations is not recommended until 2018 (after the five-year planning period), TRWD should begin final planning for this measure in 2017.
- Given the number of programs that TRWD must develop to meet the recommended schedule and the relatively low projected water savings from the pre-rinse spray valve retrofits, rainwater harvesting incentives, and cooling tower incentives, these measures are not recommended for implementation in the next five years.

Projected Water Savings, Benefits, and Costs (Section 11.2)

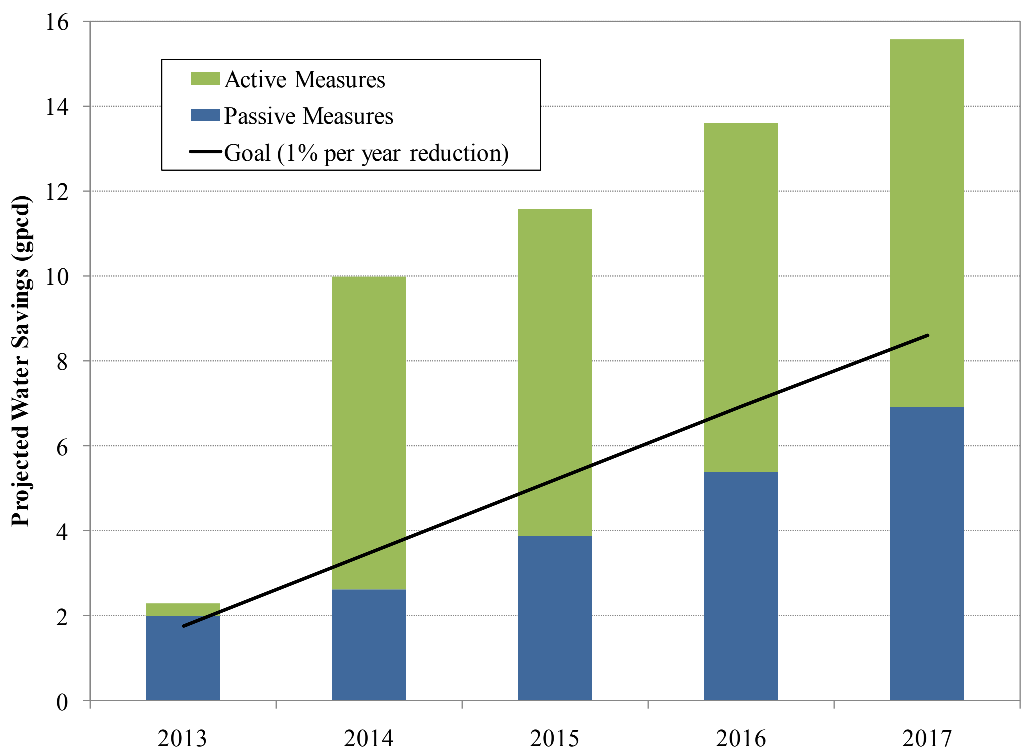
By 2017, the recommended implementation plan is projected to achieve the following water savings, benefits, and costs:

- Annual water savings of 30.1 mgd, which is 56 percent greater than the projected conservation savings (about 19.3 mgd) in the 2011 Region C Water Plan (Ref. 1).
- Annual per-capita water savings of 15.6 gpcd (Figure ES-7).
- Cumulative benefits of about $30.9 million (Figure ES-8).
- Cumulative costs to utilities of about $14.4 million (Figure ES-8).
- Cumulative benefit-cost ratio of about 2.1 (Figure ES-8).

The projected water savings from the implementation plan are in addition to the water savings that have already been achieved (an average of 23.2 mgd from 2007 through 2011). Therefore, it is projected that continuation of TRWD's existing water conservation measures and implementation of the recommended measures will achieve a total water savings of approximately 53.3 mgd compared to 2006 water use. At the projected five-year average per capita water demand (165.1 gpcd), these water savings would stretch the existing water supply enough to meet the needs of an additional 322,800 people by 2017. Placed in a different context, these water savings equal approximately 21 percent of the annual yield that TRWD could potentially obtain from the future Marvin Nichols Reservoir (Ref. 1).

The implementation plan would reduce projected per capita water use and, therefore, could either delay the need for additional water supplies or allow TRWD to downsize its share of future water supply projects. By 2030, the implementation plan could delay the need for additional water supplies by as many as 9 years. As described in Section 10.5, construction of future water supplies is expected to be a cooperative effort between TRWD and other agencies. Since other agencies might not be able to defer construction of new water supply facilities, it has been assumed, for the purpose of evaluating the cost-effectiveness of potential water conservation measures, that TRWD will downsize its share of each planned future water supply according to the projected water conservation savings during a severe drought. Either way, the recommended water conservation implementation plan is cost-effective compared to developing additional water supplies.

Figure ES-7: Projected Per-Capita Water Savings



It is also assumed that Fort Worth and Arlington will continue their existing water conservation measures. Although TRWD will realize additional savings from these measures, additional savings from existing Fort Worth and Arlington measures have not been estimated and are not included in Figure ES-7.

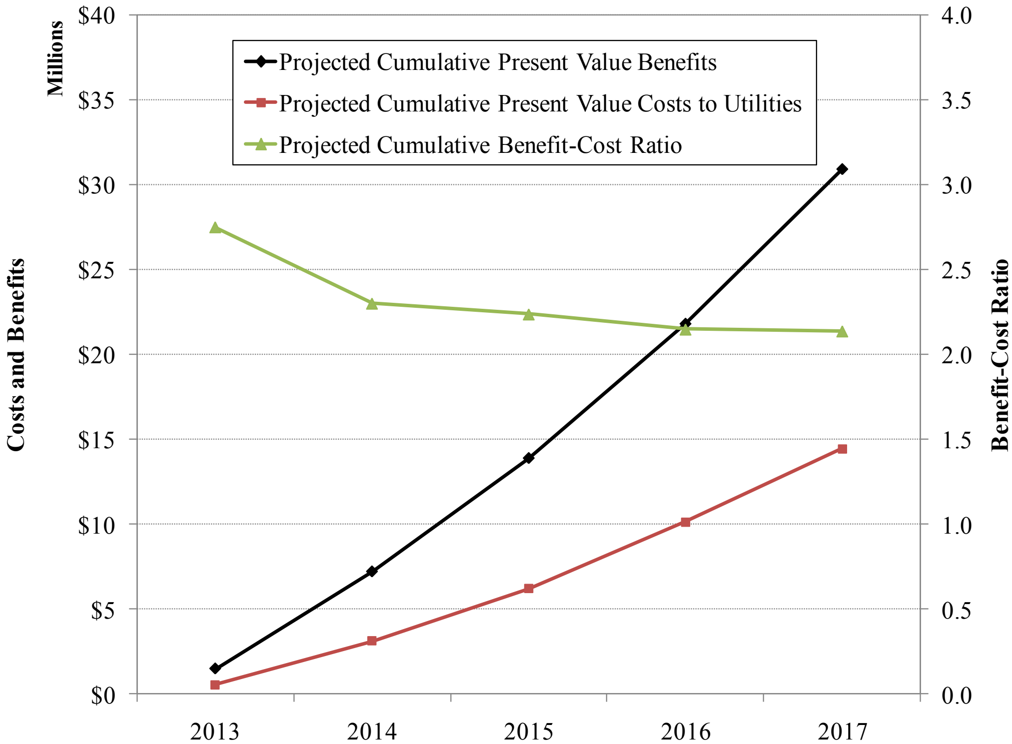
Recommended New Labor Resources (Section 11.3)

TRWD will implement some of the recommended water conservation measures (e.g., the ordinance measures) with existing staff members.[3] The remaining recommended measures will require new labor resources to effectively implement the Strategic Plan. New labor resources

[3] TRWD's customers may have to add staff members to implement some of the measures, particularly for ordinance enforcement.

could consist of additional TRWD staff members and/or retaining contractors. During the final planning stage for each recommended measure, TRWD will decide whether to add staff or retain contractors. Table ES-3 presents the overall new labor resource requirements in terms of full-time equivalent (FTE) positions, summarized by strategy and year. It is anticipated that additional labor resources equivalent to 6 FTEs will be required to effectively implement the recommended measures during the five-year implementation period.

Figure ES-8: Projected Present Value Benefits and Costs to Utilities



The recommended new labor resources have been based on customer participation assumptions and staff time required for similar programs at other utilities. Each of the recommended water conservation measures should be reviewed annually to verify that customer participation and the production capacity of the existing staff continue to warrant the recommended new labor resources.

Recommended TRWD Water Conservation Budgets (Section 11.4)

Recommended TRWD water conservation budgets are presented for the next five years in Table ES-4. TRWD budgets do not include costs borne by the wholesale customers, such as enforcement of regulations. The recommended budgets are designed to give TRWD the flexibility to either add staff or retain contractors to implement the recommended water conservation measures.

Table ES-3: Recommended New Labor Resources

Recommended Water Conservation Measures[a]	Recommended New Labor Resources (FTEs)[b,c]					
	2013	2014	2015	2016	2017	Five-Year Total
Toilet retrofits - Clerical		+1.50				+1.50
Irrigation system incentives - Clerical				+1.00		+1.00
Wholesale customer assistance - Application review, installation/savings verification				+0.25		+0.25
Site-specific ICI customer program - ICI water audits, installation/savings verification				+2.75		+2.75
Clothes washer retrofits - Clerical					+0.50	+0.50
TOTAL	**+0.00**	**+1.50**	**+0.00**	**+4.00**	**+0.50**	**+6.00**

[a] Some recommended water conservation measures/tasks are not shown, because it is assumed that TRWD will implement them using existing staff members.
[b] TRWD can either add staff members or retain contractors to implement these measures.
[c] Does not include staff increases for TRWD customers.

Table ES-4: Recommended TRWD Water Conservation Budget

Water Conservation Measures		Recommended TRWD Water Conservation Budget[a]				
		2013	2014	2015	2016	2017
2	Toilet natural replacement	$0	$0	$0	$0	$0
4	Clothes washer natural replacement	$0	$0	$0	$0	$0
15	Golf course reuse (natural implementation)	$0	$0	$0	$0	$0
18	Water use reduction - price	$0	$0	$0	$0	$0
14	Public education (ET)[c]	$2,000	$2,000	$2,000	$2,000	$2,000
20	Model conservation ordinance[b]	$0	$0	$0	$0	$0
15	Golf course conservation	$7,000	$7,000	$7,000	$8,000	$8,000
13	Irrigation limits 2/week[b]	-[c]	$0	$0	$0	$0
1	Toilet retrofits[d]	-[c]	$1,215,000	$1,237,000	$1,259,000	$1,282,000
17	Water loss reduction	-[c]	$122,000	$43,000	$44,000	$45,000
16	Model landscape ordinance[b]	-[c]	-[c]	$0	$0	$0
11	Irrigation system incentives	-	-	-[c]	$638,000	$666,000
19	Wholesale customer assistance	-	-	-[c]	$237,000	$229,000
6-7-9	Site-specific ICI customer program[d]	-	-	-[c]	$384,000	$395,000
3	Clothes washer retrofits	-	-	-	-[c]	$602,000
10	Irrigation system evaluations[d]	-[e]	-[e]	-[e]	-[e]	-[c,e]
Subtotal		***$9,000***	***$1,346,000***	***$1,289,000***	***$2,572,000***	***$3,229,000***
Continue existing TRWD programs		$1,649,000	$1,679,000	$1,710,000	$1,741,000	$1,773,000
Update Strategic Water Conservation Plan		-	-	-	$380,000	-
Total Water Conservation Budget		**$1,658,000**	**$3,025,000**	**$2,999,000**	**$4,693,000**	**$5,002,000**

[a] Costs inflated at an annual inflation rate of 1.8 percent per year (see Appendix J for discussion).
[b] Existing TRWD staff members will develop the model ordinances and coordinate customer adoption.
[c] Existing TRWD staff members will perform final planning and development of measures the year before implementation.
[d] TRWD will coordinate with existing Fort Worth and Arlington measures. The recommended budgets are for water conservation activities (toilet retrofits, ICI water audits, etc.) beyond those established and implemented by the Fort Worth and Arlington water conservation programs.
[e] Assumes that TRWD will continue its pilot irrigation system evaluation program. The pilot program is included in the "continue existing TRWD programs" line item.

The recommended budgets are the probable amounts that TRWD must spend on each strategy to achieve the projected water savings (Figure ES-7). In addition, TRWD should continue to fund its existing water conservation measures at existing levels (adjusted for inflation). The recommended total water conservation budgets range from $1.66 million in 2013 to $5.00 million in 2017.

Although it is recommended that TRWD proceed with implementation of recycled water projects to increase water efficiency, recycled water planning has been conducted separately from water conservation planning, and no budget recommendations for recycled water projects have been developed as part of the Strategic Plan.

1. Introduction, Objectives, and Goals

The Tarrant Regional Water District (TRWD) supplies raw water to an existing population of approximately 1.8 million people in North Central Texas with a service area that encompasses 5,891 square miles in Jack, Wise, Denton, Parker, Tarrant, Johnson, Ellis, Kaufman, Henderson, Navarro, and Freestone Counties (Figure 1-1). TRWD supplies four primary customers in Tarrant County – Arlington, Fort Worth, Mansfield, and the Trinity River Authority (TRA) – and supplies smaller customers located near its water supply reservoirs.[4] Over the next fifty years, total TRWD water demands are projected to double between 2010 and 2060 (Ref. 1).[5]

Proposed water management strategies for TRWD include water conservation, water reuse projects at Richland-Chambers Reservoir and Cedar Creek Reservoir, participating with other water suppliers to develop Marvin Nichols Reservoir, and participating with other water suppliers to obtain water from Toledo Bend Reservoir and from Oklahoma. The projected capital cost for these projects is $4.73 billion (Ref. 1).

To obtain water from Marvin Nichols Reservoir (to be located in the Sulphur River Basin) by 2030 and Toledo Bend Reservoir (located in the Sabine River Basin) by 2050, the TRWD and other project participants will have to apply for and obtain authorization to transfer water to the Trinity River Basin. Currently, interbasin transfer regulations require applicants to have "developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant" (Ref. 2).

From 2007 through 2011, ongoing water conservation efforts have helped TRWD to save approximately 42.4 billion gallons (130,250 acre-feet) of water, for an average savings of 23.2 million gallons per day (mgd).[6] At the current per capita water demand, these water savings have stretched the existing water supply enough to meet the needs of an additional 132,200 people. This Strategic Water Conservation Plan (Strategic Plan) provides a road map to additional water savings and is an important step toward achieving the "highest practicable levels of water conservation and efficiency." Implementation of this Strategic Plan will extend the life of existing TRWD water supplies and reduce operating costs. Other potential benefits include delaying the need for new water supplies, deferring the associated capital costs, and minimizing associated environmental impacts. This document defines water conservation goals for the five-year planning period from 2013 through 2017 and recommends water conservation measures, budgets, and staffing levels to achieve these goals.

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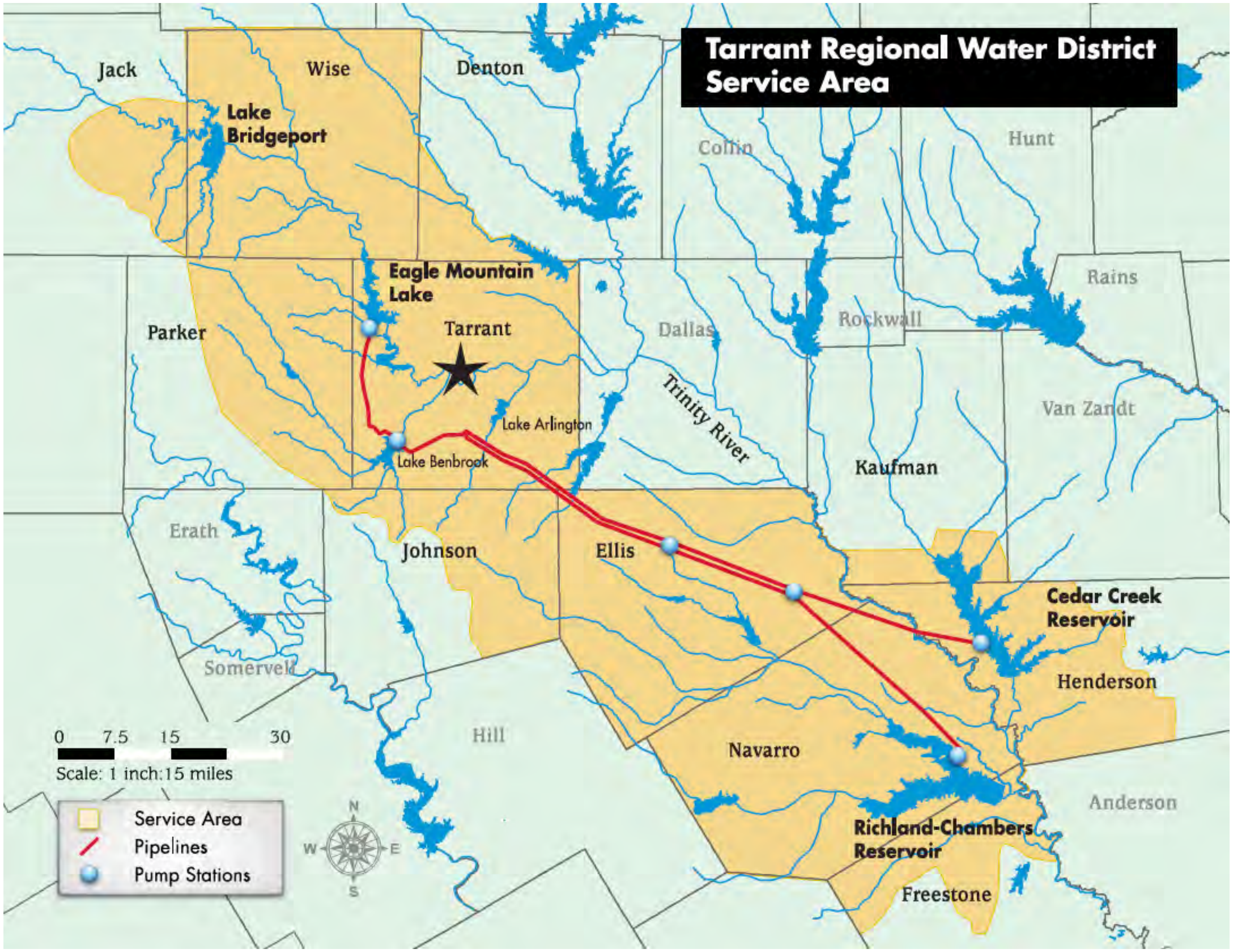
[4] In this report, the phrase "four primary customers" generally refers to Arlington, Fort Worth, Mansfield, and the Trinity River Authority's Tarrant County Water Project and includes their successive wholesale customers.

[5] These demands are based on "drought-of-record" hydrologic conditions and do not represent average demands.

[6] TRWD also implemented Stage 1 drought contingency measures from August 29, 2011 through May 3, 2012 that saved an additional 5.8 billion gallons of water (Appendix I).

Figure 1-1: Tarrant Regional Water District Service Area



Tarrant Regional Water District

Although the principles in the Strategic Plan can be applied to all TRWD customers, the Strategic Plan will target water conservation by the four primary customers and their successive customers. This will address approximately 88 to 93 percent of all TRWD water deliveries.

1.1. Strategic Plan Development Process

This document was developed through review of numerous water conservation programs, measures, data, and literature and through input from TRWD staff, TRWD wholesale customer cities, and water conservation staff from other cities.

The following outline describes the process utilized in the development of the Strategic Plan.

Data Collection and Analysis

TRWD and its wholesale customers provided the following data for use in development of the Strategic Plan:

- Wholesale customer utility profiles
- Wholesale customer water conservation reports.
- TRWD and wholesale customer water conservation plans.
- Daily records of water supplied to the four primary customers.
- Water conservation information distributed to the public.
- Wholesale customer contract provisions.
- Descriptions of existing and planned water conservation programs.
- Historical populations served by the four primary customers.

APAI reviewed the following additional data for use in development of the Strategic Plan:

- Wholesale customer time-of-day irrigation restriction information.
- Historical mandatory water restrictions.
- Information from the 2011 Region C Water Plan (Ref. 1):
  - Historical and planned direct reuse projects.
  - Population projections and water demands.
  - Available water supplies.
  - Recommended water management strategies, including water conservation measures
- Historical land use data.
- Historical U.S. Census data for the four primary customers.
- Historical climate data.

Other data were obtained from various sources.

Coordination with Other Water Conservation Planning Efforts

The consultant team reviewed documents produced by other ongoing water conservation planning efforts, such as the Water Conservation Implementation Task Force (created by the

Texas Legislature in 2003 pursuant to Senate Bill 1094), the Water Conservation Advisory Council (created by the Texas Legislature in 2007 pursuant to Senate Bill 3), and the Region C Water Planning Group.

Review of Water Conservation Programs in Other Large Cities

An evaluation of nine U.S. regional water conservation programs was conducted to learn from their program approaches and results with water-saving technologies, measures, and policies. The nine programs are:

- Contra Costa Water District (Contra Costa County, California)
- Denver Water (Denver, Colorado)
- Lower Colorado River Authority (Austin, Texas)
- Metropolitan North Georgia Water Planning District (Atlanta, Georgia)
- North Texas Municipal Water District (Wylie, Texas)
- Regional Water Providers Consortium (Portland, Oregon)
- South Florida Water Management District (South Florida)
- Southern Nevada Water Authority (Las Vegas, Nevada)
- Western Municipal Water District (Riverside, California)

Review of the TRWD Water Conservation Program

The existing TRWD water conservation program and the TRWD Water Conservation and Drought Contingency Plan (Ref. 3) were reviewed.

Development of Candidate Water Conservation Measures

Numerous water conservation measures were examined and considered during the strategic planning process. These measures were derived from several resources, including recommendations by task forces and planning groups, literature sources, and programs implemented in other cities that have successful water conservation programs.

Evaluation of Water Conservation Measures

Water conservation measures identified from the above resources were compiled into a list as candidate measures. Each candidate strategy was researched and evaluated to determine if it should be recommended for implementation during the five-year planning period. The evaluation included an initial screening of the measures to determine their applicability for use by TRWD and/or its wholesale customers, using screening criteria developed from TRWD's water use profile. Measures passing the initial screening were subjected to a benefit-cost analysis and weighed against feedback from TRWD and its customer cities. A final list of recommended measures was developed and incorporated into the Strategic Plan.

Development of the Strategic Plan

In collaboration with TRWD and its wholesale customers, the consultant team developed the recommended measures into the Strategic Plan, including implementation schedules, budgets, and methods.

1.2. Use of the Strategic Plan

The Strategic Plan provides recommendations and guidance for a balanced plan of water conservation measures to be implemented over the five-year period FY 2013 through FY 2017. The types of water conservation measures, implementation dates, and levels of anticipated funding are designed to achieve TRWD's water conservation goals and targets. The Strategic Plan also establishes a foundation for continued water savings in the future.

The Strategic Plan is intended to be implemented with a "common sense" approach, whereby progress assessments are conducted annually and adjustments are made as necessary to address changing needs and conditions, while achieving the stated goals and targets.

1.3. Long-Term Goals

A successful water conservation program is not self-sustaining. Therefore, proactive efforts must continue beyond the five-year strategic planning horizon to achieve long-term water conservation goals. Continued support by the TRWD Board of Directors, active involvement by wholesale customers and stakeholders, a continuous program of education and public awareness, and on-going re-evaluation of the water conservation program are necessary to meet TRWD's long range water conservation goals and water supply needs.

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2. State of Texas Initiatives and Requirements for Water Conservation

State of Texas water conservation requirements and initiatives include water conservation legislation, the Regional Water Planning process, the Water Conservation Implementation Task Force, and the Water Conservation Advisory Council. Each of these is discussed below.

2.1. Water Conservation Legislation

Significant water conservation legislation in Texas since 2003 is summarized below.

Table 2-1: Summary of Recent Water Conservation Legislation

Year	House/ Senate Bill Number	Description
2003	HB 645	Limited property associations from creating/enforcing rules that undermine water conservation.
	HB 1152	Provided nonprofit water supply corporations with statutory authority to enforce water conservation practices and levy fines.
	HB 2660	Required quantified five-year and ten-year water savings targets for water conservation plans.
	HB 2661	Required TCEQ to develop graywater standards.
	HB 2663	Required TCEQ to establish quantifiable goals for drought contingency plans.
	HB 3338	Required water utilities to perform water audits every five years.
	SB 1094	Created a task force on water conservation to review, evaluate, and recommend levels of water use efficiency and conservation for Texas.
2005	HB 1224	Required the Texas Water Development Board (TWDB) to conduct a study to determine the effects, if any, of take-or-pay contracts on efforts to conserve water.
	HB 1225	Authorized TCEQ to exempt a state water right from cancellation for non-use if the non-use resulted from a water conservation measure that was part of a water conservation plan submitted by the water right holder.
	HB 2428	Required that new commercial pre-rinse spray valves for sale in Texas beginning January 1, 2006, must use no more than 1.6 gallons per minute.
	HB 2430	Required the TWDB to establish a Rainwater Harvesting Evaluation Committee to evaluate the potential for rainwater harvesting in Texas and to recommend minimum water quality guidelines and standards and treatment methods for potable and nonpotable indoor uses of rainwater.

Table 2-1 Continued: Summary of Recent Water Conservation Legislation

2007	HB 4/SB 3	Required the TWDB to develop and implement a statewide water conservation public awareness campaign. Created the Water Conservation Advisory Council. The Advisory Council is discussed in detail in Section 2.4. Required the submission of water conservation plans to the Texas Water Development Board (TWDB) by retail public utilities that provide water service to 3,300 or more connections. Required that each of these entities submit an annual report to the TWDB on the entity's progress in implementing its water conservation plan and requiring enforcement. For structures that are connected to a public water system and have a rainwater harvesting system for indoor use, required that the structure must have cross-connection safeguards and that the rainwater harvesting system may be used only for non-potable indoor purposes. Required the Texas Higher Education Coordinating Board to encourage institutions of higher education to develop curriculum and provide instruction regarding on-site water reclamation system technologies, including rainwater harvesting, condensate collection, or cooling tower blow down. Required that new state buildings (and major renovation projects) use these technologies for landscape watering and nonpotable indoor use where practical and feasible.
	HB 1656	Required municipalities with population of twenty thousand or more to implement a landscape irrigation permitting, inspection and enforcement program that includes minimum standards and specifications for designing, installing, and operating irrigation systems.
2009	HB 2667	Required the following water-saving standards for plumbing fixtures to by 2014: ▪ Shower head output cannot exceed 2.5 gallons of water per minute ▪ Urinals cannot use more than 0.5 gallons of water per flush ▪ Toilets cannot use more than 1.28 gallons of water per flush Allowed local governments to pass an ordinance to opt out of water efficiency requirements if their drainage or sewer system requires more water to operate efficiently. Established standards for waterless urinals.

Table 2-1 Continued: Summary of Recent Water Conservation Legislation

2011	HB 51	Required new school buildings to meet water conservation standards established by the state energy conservation office and to achieve a 15 percent reduction in water use compared to the National Energy Policy Act of 1992 (Table H-1).
	HB 2694	Authorized the TCEQ Executive Director to suspend water rights and/or adjust diversion amounts during a period of drought or other emergency water shortage. In so doing, the Executive Director must take into consideration the efforts of the affected water rights holders to develop and implement their water conservation plans and drought contingency plans.
	HB 3090	Required recipients of financial assistance from the TWDB to submit annual water loss audits to the TWDB beginning in May 2013.
	HB 3372/ SB 1073	Directed the TCEQ and TWDB to develop rules regarding the installation and maintenance of rainwater harvesting systems that are used for indoor potable purposes and connected to a public water supply system. Set notice requirements for connecting a rainwater harvesting system to a public water supply system for use for potable purposes. Limited the liability of public water supply systems for any adverse health effects allegedly caused by the consumption of water collected by a rainwater harvesting system that is connected to a public water supply system and is used for potable purposes.
	HB 3391	Allowed financial institutions to consider making loans for developments that will use harvested rainwater as the sole source of water supply. Required that rainwater harvesting system technology for both potable and nonpotable uses be incorporated into the design and construction of each new state building with a roof of at least 50,000 square feet that is located in an area with an average annual rainfall of at least 20 inches. Encouraged cities and counties to promote rainwater harvesting at residential, commercial, and industrial facilities through incentives such as discounted rain barrels or rebates for water storage facilities. Encouraged school districts to implement rainwater harvesting at district facilities. Established training requirements for city and county staff members whose work relates directly to permits involving rainwater harvesting.

Table 2-1 Continued: Summary of Recent Water Conservation Legislation

<table>
<tr><td rowspan="2">2011 (Cont.)</td><td>HB 3391 (Continued)</td><td>Prohibited a city or county from denying a building permit solely because the facility will implement rainwater harvesting.

Revised the required seller disclosure notice for property to inform the buyer whether there is a rainwater harvesting system connected to the property's public water supply that is able to be used for indoor potable purposes.

Allows a property owners’ association to restrict installation of rainwater harvesting facilities on common property and in property owner front yards. Allows a property owners’ association to require design standards for rainwater harvesting facilities located on the side of a house or other visible location if the standards do not prevent economic installation and if there is a reasonably sufficient area on the property for the installation.</td></tr>
<tr><td>SB 181</td><td>Required Regional Water Planning Groups to include in Regional Water Plans information on projected water use and conservation in the regional water planning area and the implementation of state and regional water plan projects, including water conservation strategies, necessary to meet the state's projected water demands.

Established that:
▪ Tracking water use over time and evaluating the effects of water conservation programs or strategies are vital components of planning for and managing the state's water resources to estimate and meet future water demand requirements.
▪ Gallons per capita per day (gpcd) is not an accurate measure of water use or water conservation because there is no uniform, consistent calculation methodology.
▪ A single gpcd metric should not be used to compare water use between cities and water utilities. Sector-based metrics are needed to provide accurate comparisons.
▪ A uniform gpcd calculation methodology is need to make valid water use comparisons and evaluations of a municipality's or water utility's water conservation programs.
▪ Water use that is not population-dependent should not be measured with a population-based metric.</td></tr>
</table>

Table 2-1 Continued: Summary of Recent Water Conservation Legislation

<table>
<tr><td rowspan="2">2011 (Cont.)</td><td>SB 181 (Continued)</td><td>Directed TCEQ and TWDB to work with the Water Conservation Advisory Council (WCAC) to develop (by January 1, 2013) a uniform, consistent methodology and guidance for calculating water use and conservation by cities and water utilities. This is to include methods for calculating the following:
▪ Total water use, including billed water and nonrevenue water.
▪ Water use by sector.
▪ Total water use in gpcd.
▪ Residential water use in gpcd, including both single-family and multi-family users.
▪ Water use in other sectors normalized by factors other than population or number of customers.
It is also to include guidance determining service populations, including permanent and temporary populations.
Directed the TWDB, in consultation with the TCEQ and the WCAC, to develop (by January 1, 2013) a data collection and reporting program for cities and water utilities with more than 3,300 connections. This program must require an entity to report the most detailed level of water use data currently available to the entity. The TCEQ may not require an entity to report water use data that is more detailed than the entity's billing system is capable of producing but may require that billing systems purchased after September 1, 2011, be capable of reporting detailed water use data.</td></tr>
<tr><td>SB 660</td><td>Required the methodology and guidance for calculating water use and conservation (from SB 181) to be used in water conservation plans.
Established that water use data included in a water conservation plan or required report must be interpreted in the context of variations in local water use; the water use data may not be the only factor considered by the TCEQ in determining the highest practicable level of water conservation and efficiency achievable in the jurisdiction of a municipality or water utility for purposes of Section 11.085(l).</td></tr>
</table>

2.2. Regional Water Planning Process

Pursuant to Senate Bill 1 legislation passed by the 75th Texas Legislature in 1997, the Texas Water Development Board (TWDB) was tasked to address Texas water supply needs with a new fifty-year water plan. The TWDB created sixteen regional water-planning groups and established regulations governing the regional planning efforts. Tarrant Regional Water District's four primary customers are located within Region C. The Region C Water Planning Group (RCWPG) completed the first Region C Water Plan in 2001 (Ref. 4) and updated it in 2006 (Ref. 5) and 2011 (Ref. 1).

The 2011 Region C Water Plan recommended water conservation strategies for 275 municipal water users. For TRWD's four primary customers, the plan recommended two sets of water conservation strategies: the basic package and the expanded package. The basic package, which was recommended for all municipal water users with a projected water need, consisted of the following conservation measures:

- Low-flow plumbing fixture rules (included in the water demand projections)
- Public and school education
- Water use reduction due to increasing water prices
- Water system audit, leak detection and repair, and pressure control
- Federal residential clothes washer standards
- Water conservation pricing structure
- Water waste prohibition

The expanded package, which was recommended for 144 Region C municipal water users, consisted of the following conservation measures:

- Landscape irrigation restrictions
- Coin-operated clothes washer rebate
- Residential customer water audit
- Industrial, commercial, and institutional (ICI) water audit, water waste reduction, and site-specific conservation program
- Reuse of treated wastewater effluent.

The projected water savings for TRWD's four primary customers from the two recommended water conservation packages in the 2011 Region C Water Plan are shown in Table 2-2.

2.3. Water Conservation Implementation Task Force

The Water Conservation Implementation Task Force (Task Force), with members appointed by the TWDB, was created to fulfill the mandate of the legislation incorporated in Section 6 of Senate Bill 1094. The Task Force was assigned several tasks, including identifying, evaluating, and selecting best management practices (BMPs) for municipal, industrial, and agricultural water uses and evaluating the cost and benefits of the selected BMPs.

The Task Force developed TWDB Report 362, *Water Conservation Best Management Practices Guide* (Ref. 6). This guide, released in November 2004, included twenty-two BMPs for municipal water users, fifteen BMPs for industrial water users, and twenty BMPs for agricultural water users. Report 362 serves as a resource for entities that volunteer to implement BMPs that are appropriate for their situation. Applicable BMPs were considered for inclusion in the Strategic Plan.

Table 2-2: Projected Water Conservation Savings for TRWD's Four Primary Customers, 2011 Region C Water Plan

In units of mgd:

Conservation Package	Projected Water Conservation Savings[a,b]					
	2010	2020	2030	2040	2050	2060
Basic	8.51	18.50	27.01	34.47	43.54	54.93
Expanded	2.64	4.23	5.79	6.99	7.94	9.07
TOTAL	11.15	22.73	32.80	41.46	51.48	63.99

In units of gpcd:

Conservation Package	Projected Water Conservation Savings[a,b]					
	2010	2020	2030	2040	2050	2060
Basic	5.20	9.60	11.99	13.33	14.75	16.20
Expanded	1.59	2.11	2.46	2.58	2.58	2.58
TOTAL	6.79	11.71	14.45	15.91	17.32	18.79

[a] Total projected conservation savings multiplied by the ratio of projected water supply from TRWD and net customer water demand (Ref. 1). The remainder of the net customer water demand is projected to be served from other water sources.

[b] Does not include TRWD's Richland-Chambers and Cedar Creek reuse projects.

In addition to Report 362, the Task Force also produced a Report to the 79th Legislature (Ref. 7). This report, also issued in November 2004, recommended a standardized methodology for reporting and using per-capita water use data as follows:

- Total per-capita water use is defined as the total amount of water diverted and/or pumped for potable use divided by the total population. Indirect reuse diversion volumes shall be credited against total diversion volumes for the purpose of calculating per capita water use for targets and goals.
- Residential per capita water use is defined as single-family plus multi-family consumption divided by the total population.

The report to the legislature also set targets and goals to be considered by water providers. For municipal water providers, the report recommended consideration of a minimum annual reduction of one percent in total per-capita water use, based upon a five-year rolling average, until such time as the entity achieves a total per capita water use of 140 gallons per capita per day (gpcd) or less.

The report to the legislature further recommended that the State (through the TWDB) work with manufacturers of water-using equipment, water utilities, water users, and others to reduce overall statewide indoor water use to 50 gpcd through education, research, and funding programs.

2.4. Water Conservation Advisory Council

At the recommendation of the Water Conservation Implementation Task Force, the Texas Legislature (through passage of Senate Bill 3 and House Bill 4 in 2007) created a standing Water Conservation Advisory Council. The Advisory Council is composed of twenty-three members representing each of twenty-three entities or interest groups.

Duties of the Water Conservation Advisory Council include:

- Monitoring trends in water conservation implementation.
- Monitoring new technologies for possible inclusion by the TWDB as best management practices in the Water Conservation Best Management Practices Guide developed by the Water Conservation Implementation Task Force.
- Monitoring the effectiveness of the TWDB's statewide water conservation public awareness program and associated local involvement in implementing the program.
- Developing and implementing a state water management resource library.
- Developing and implementing a public recognition program for water conservation.
- Monitoring the implementation of water conservation strategies by water users included in regional water plans.
- Monitoring target and goal guidelines for water conservation to be considered by the TWDB and TCEQ.
- Conducting a study to evaluate the desirability of requiring the TWDB to (a) designate as certified water conservation training facilities entities and programs that provide assistance to retail public utilities in developing water conservation plans; and (b) give preference to certified water conservation training facilities in making loans or grants for water conservation training and education activities.

No later than December 1 of each even-numbered year, the Council is to submit to the Legislature a report on progress made in water conservation in Texas. The first of these reports, submitted in 2008, contained 11 recommendations (Ref. 8). The recommendations most applicable to TRWD addressed the topic of implementation and measurement of water conservation savings:

- Develop methodology, metrics, and standards for water conservation implementation measurement and reporting.
- Develop specific guidelines for how gallons per capita per day should be determined and how it should be applied to population-dependent water use only.
- Develop reporting guidelines for improved data collection.
- Expand data collection efforts to include all water providers and water use sectors.
- Develop a pilot project for water use data reporting.

- Develop a pilot project for determining population figures appropriate for certain water use metrics.

To address its multiple charges, the Advisory Council operates in six subcommittees, or workgroups. The Metrics & Trends Workgroup is working through details of the recommendations listed above. Agendas and minutes of the Workgroup meetings are available from the Water Conservation Advisory Council web site (Ref. 9).

In the last two years, the Council reports the following progress on these topics (Ref. 10):

- The Council has worked with the TRWD and the TCEQ to evaluate the potential for standardized metrics and water use reporting. Although it has not reached a conclusion, the Council believes that a sector-based "gpcd tool" similar to that used in New Mexico for water use reporting may be appropriate, with some revision for Texas conditions. In 2011, the Council proposes to conduct a voluntary "beta test" of a per capita water use calculation tool with utilities of varying sizes.
- In June 2010, the TWDB approved a research project to develop current and accurate maps of the boundaries of Texas public water providers to help develop more accurate population estimates.
- The Council is continuing to work toward developing uniform metrics for all sectors of water use.

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3. Description of the TRWD Raw Water System

TRWD supplies raw water to its customers using a system of seven major reservoirs: Lake Bridgeport, Eagle Mountain Lake, Cedar Creek Reservoir, Richland-Chambers Reservoir, Lake Benbrook, Lake Worth, and Lake Arlington (Figure 1-1). Currently, TRWD has a total permitted supply of 825,600 ac-ft/yr, but the firm yield of the reservoir system is approximately 563,333 ac-ft/yr (Ref. 3), as shown in Table 3-1.[7,8]

Table 3-1: Firm Yield from TRWD Raw Water Sources

Source	Division	Firm Yield (ac-ft/yr)
Lake Bridgeport/Eagle Mountain Lake	Western	108,500
Cedar Creek Reservoir/Richland-Chambers Reservoir	Eastern	385,000
George W. Shannon Wetlands Water Reuse Project	Eastern	63,000
Lake Benbrook	Other	6,833
Total Available		**563,333**

Due to the location of its reservoirs, TRWD operations are split into two divisions: the Western Division and the Eastern Division. The Western Division includes Lake Bridgeport, Eagle Mountain Lake, and Lake Worth, each located on the West Fork of the Trinity River. The firm yield of the Western Division reservoirs is approximately 108,500 ac-ft/yr. Water flows by gravity from Lake Bridgeport to Eagle Mountain Lake to Lake Worth to industrial customers and to water treatment plants (WTPs) in the city of Fort Worth and neighboring cities.

TRWD serves Fort Worth, Arlington, Mansfield, and TRA with water from its Eastern Division reservoirs (Cedar Creek and Richland-Chambers Reservoirs and the George W. Shannon Wetlands Water Reuse Project), which have a firm yield of approximately 448,000 ac-ft/yr.[7,8] Lake Arlington and Lake Benbrook are primarily operated as terminal storage reservoirs, although Lake Benbrook contributes a firm yield of 6,833 ac-ft/yr (Ref. 3). The Cedar Creek and Richland-Chambers pipelines are connected to Benbrook pipelines and the Eagle Mountain Connection (Figure 1-1). Using these pipelines, TRWD can deliver water to:

- Mansfield,
- Village Creek/Lake Arlington,
- Fort Worth Rolling Hills WTP,
- Lake Benbrook,
- Eagle Mountain Lake, and other customers.

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7 The firm yield is the maximum amount that can be delivered with 100 percent reliability during drought-of-record conditions.

8 The total firm yield includes 63,000 ac-ft/yr from the George W. Shannon Wetlands Water Reuse Project, an indirect reuse project at Richland-Chambers Reservoir. The project began operation in March 2009. The total firm yield does not include 52,500 ac-ft/yr from the proposed indirect reuse project at Cedar Creek Reservoir. Additional information is presented in Section 8.1.

Once the Cedar Creek Reservoir indirect reuse project is fully operational, TRWD will have a total firm yield of 615,833 ac-ft/yr, of which 18.8 percent (115,500 ac-ft/yr) will be comprised of indirect reuse.

The primary customers treat the raw water supplied by TRWD and sell it to retail and wholesale water customers. Existing and potential future wholesale customers are listed in Table 3-2.

Table 3-2: Wholesale Treated Water Customers Served by TRWD Primary Customers

TRWD Primary Customer	Wholesale Treated Water Customers (Refs. 1, 11)	
Fort Worth	Benbrook Water Authority[a]	City of Northlake
	Bethesda Water Supply Corporation	Town of Pantego[b]
	City of Aledo[b]	City of Richland Hills
	City of Burleson	City of River Oaks[a]
	City of Crowley	City of Roanoke
	City of Dalworthington Gardens	City of Saginaw
	City of Edgecliff Village	City of Sansom Park[a]
	City of Everman	City of Southlake
	City of Forest Hill	City of Watauga[c]
	City of Grand Prairie	City of Westlake
	City of Haltom City	City of Westover Hills
	City of Haslet	City of Westworth Village
	City of Hurst	City of White Settlement
	City of Keller	City of Willow Park[b]
	City of Kennedale	Dallas-Fort Worth International Airport
	City of Lake Worth	Trinity River Authority[a]
	Town of Lakeside[b]	Trophy Club Municipal Utility District #1
	City of North Richland Hills	
Arlington	Bethesda Water Supply Corporation[b]	Town of Pantego[b]
	City of Grand Prairie[a, b]	City of Mansfield[a]
Mansfield	City of Grand Prairie [b]	Johnson County Special Utility District
TRA[d]	City of Bedford	City of Grapevine
	City of Colleyville	City of North Richland Hills
	City of Euless	

[a] Customer has emergency contract only and does not take water on a regular basis.
[b] Potential future customer.
[c] Through North Richland Hills.
[d] Tarrant County Water Supply Project only.

4. TRWD Primary Customers Water Use Profile

To make recommendations that are technically sound and economically feasible, water conservation planners must understand the customer makeup and water use patterns of the service area. In this chapter, water use data from TRWD and its four primary customers are used to identify water use patterns.

4.1. Available Water Use Data

Historical annual water use by the four primary customers and their successive customers was obtained from TRWD records of daily deliveries for the period 1992 through 2011 (Figure 4-1) and from customer utility profiles for the period 2004 through 2008.[9] The customer utility profiles contain additional water use information that can be used to further break down historical water use by residential, commercial, industrial, other, and nonrevenue water uses.[10] For the period 2004 to 2008, the customer utility profiles account for 81.5 to 86.9 percent of the water that TRWD delivered to the four primary customers. Because this represents the large majority of water used by the four primary customers, conclusions based on the reported data will be generalized to all TRWD water used by the four primary customers.

4.2. Water Sales by Sector

The utility profiles report water sales by residential, commercial, industrial, wholesale, and other sectors.[11] For 2004 to 2008, Figure 4-2 shows the weighted average distribution of water sales by customer type for the four primary customers. Residential sales comprise 59.6 to 66.8 percent of retail water sales, commercial sales comprise 24.1 to 31.6 percent, and industrial sales comprise 4.5 to 7.2 percent.

4.3. Normalization of Water Use Data

To analyze the efficiency of water use, it is often useful to normalize water use by the factors that most influence the water use. Sample normalization units are shown in Table 4-1 for various types of water use. For example, golf course water use is largely determined by the irrigated acreage of the golf course, so normalizing golf course water use by irrigated acreage (gallons per acre per day, acre-feet per acre per year, etc.) would be meaningful. Other factors, such as the weather, also impact golf course water use. For a given sector, it may be informative to normalize water use in more than one way.

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9 Fort Worth, Arlington, and TRA water usage for 2004 to 2008 was taken from the corresponding utility profiles.

10 Customers that provided utility profiles are shown in Table 7-1.

11 Bethesda WSC is the only utility that reports including multi-family residential sales in commercial sales figures. Fort Worth reclassified multi-family residential sales from commercial to residential in 2006 and 2007. Mansfield reported including multi-family residential connections in the number of commercial connections, but reported multi-family residential water sales under residential water sales.

Figure 4-1: Water Use by TRWD's Primary Customers and Their Successive Customers

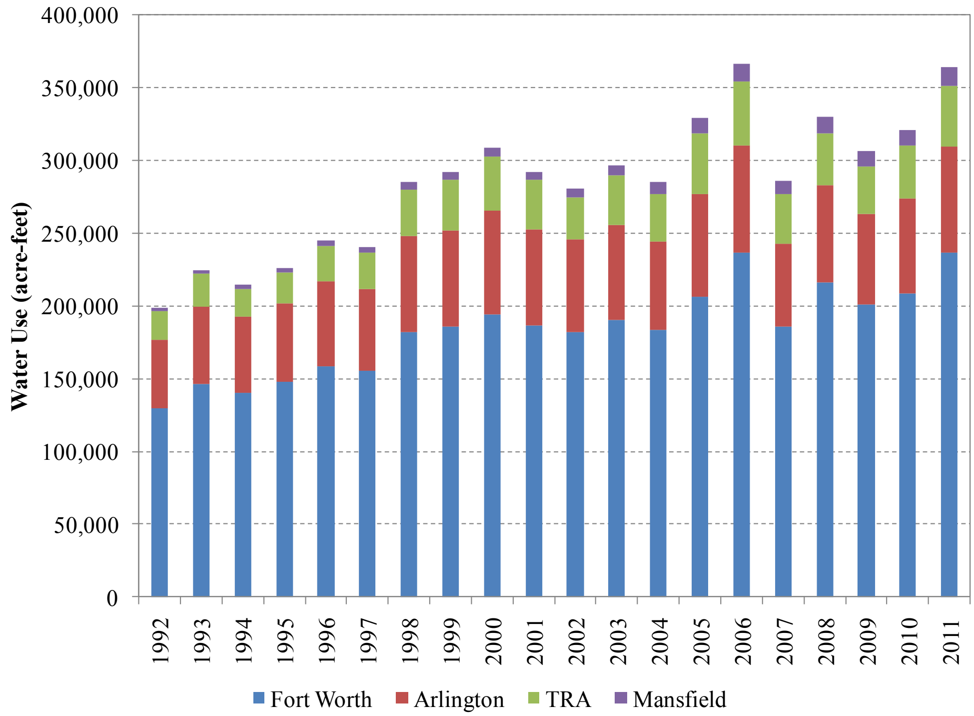


Figure 4-2: Weighted Average Retail Water Sales Distribution by Customer Type for the Four Primary Customers

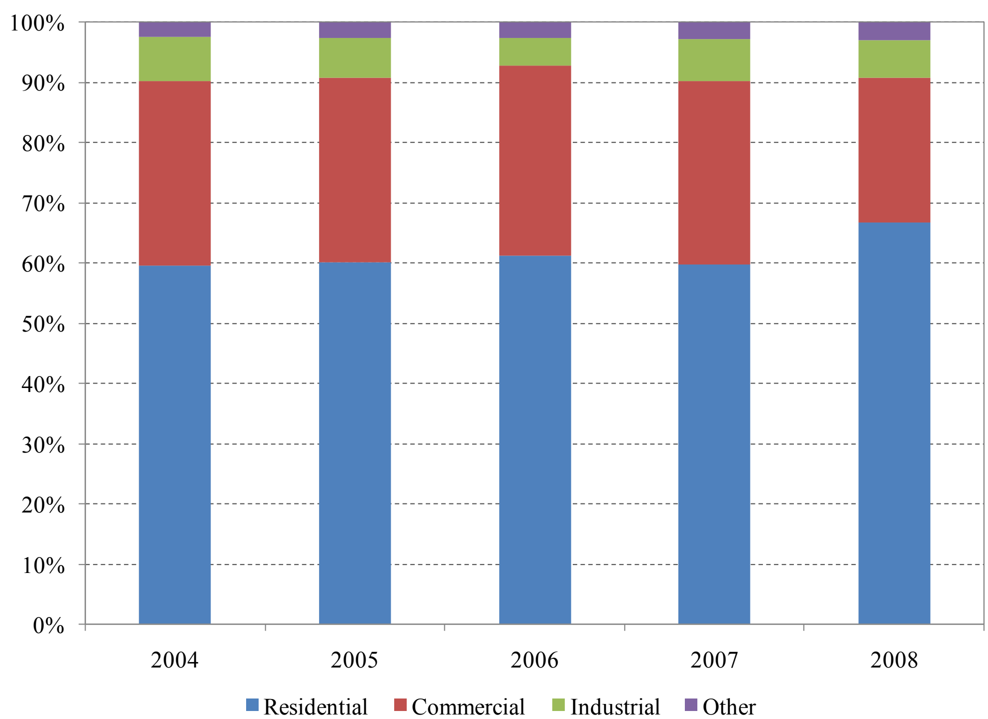


Table 4-1: Potential Normalization Units by Type of Water Use

Water Use Type	Normalization Units
Residential	Resident, dwelling unit
Hotel/Motel	Guest, bed, room
Office Building	Employee, square foot, parking space
Warehouse	Employee, square foot, parking space
Factory/Manufacturer	Employee
Shopping/Mall Centers/Retail	Square foot, parking space
Vehicle Servicing/Washing	Vehicle, washing bay
Automobile Dealers	Vehicle sold, parking space
Parking Lot	Parking space, acre
Restaurant	Meal, seat, table
Bar	Customer, seat, table
Laundry	Clothes washer
Schools	Student
Fire Station	Firefighter, truck
Hospital	Bed
Church	Attendee, member
Park/Golf Courses	Acre, weather variables
Median Strip	Acre, weather variables
Vacant Lot or Raw Land	Acre, weather variables
Cemetery/Agri Business	Acre, weather variables

Traditionally, utilities across the state have normalized their water use by the number of residents in their service area. This may be useful as a way to track water conservation progress within a utility, but it is not necessarily valid for comparison of water use between different utilities. In addition, there is no universally accepted method of calculating per capita water use. For example, some cities exclude "unaccounted-for" or nonrevenue water, while others include this component in their calculations.

Normalizing by the number of residents is appropriate for indoor residential water use, because indoor water uses are relatively similar from residential customer to residential customer and because the volume of indoor water use directly depends on the number of residents. Outdoor residential water use depends less on the number of residents than the number of dwelling units, average lot size, and other factors. Therefore, normalization of total residential water use (indoor and outdoor) by the number of residents may be somewhat less informative. At the other end of the spectrum, normalizing water use at industrial facilities by the number of local residents does not make sense at all, because industrial water use does not depend on the number of residents.

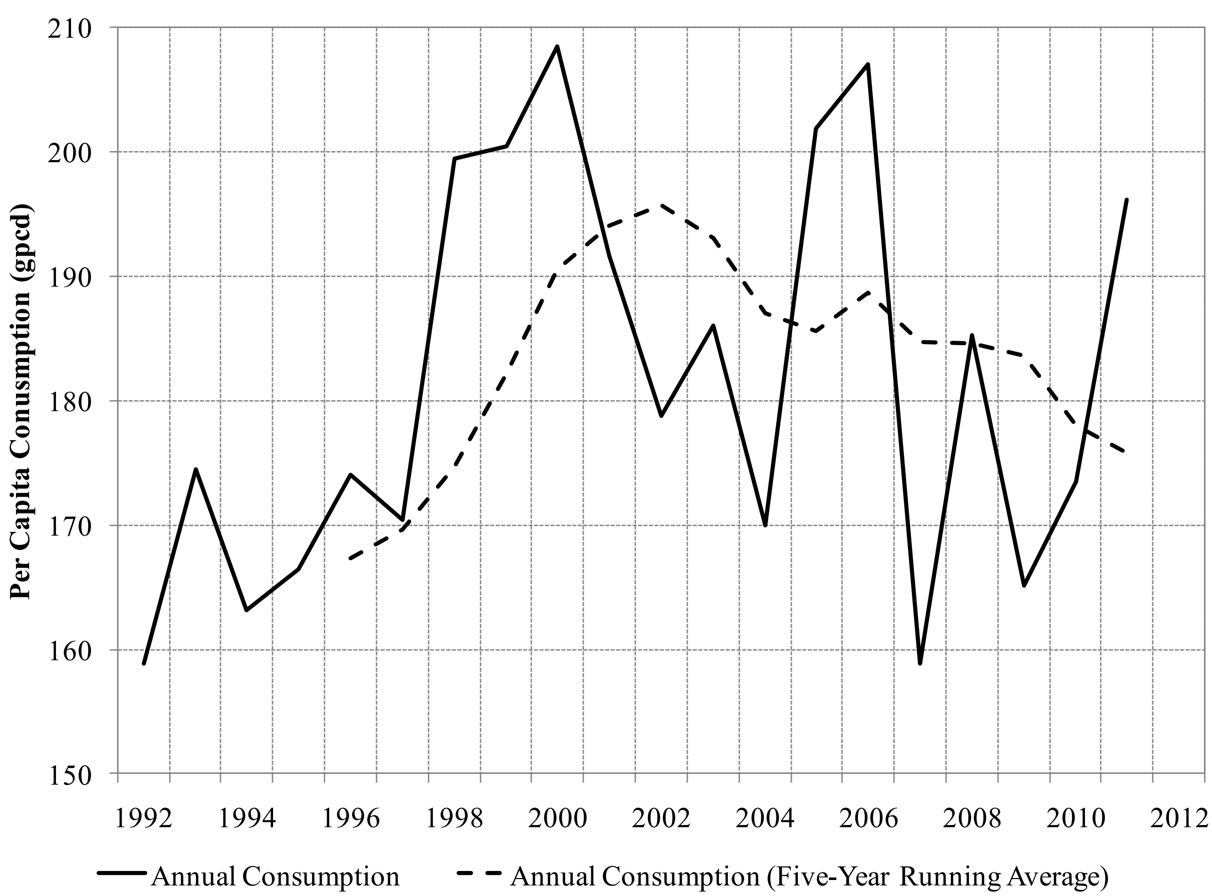
As discussed in Section 2.3, the Water Conservation Implementation Task Force defined total per capita water use as the total amount of water diverted and/or pumped for potable use divided by the total population (Ref. 7). The Task Force also defined residential per capita water use as single-family plus multi-family consumption divided by the total population. These definitions are used below (without credit for indirect reuse) for tracking TRWD water use from year to year.

The Task Force also recommended crediting indirect reuse diversion volumes against total diversion volumes for the purpose of calculating per capita water use for targets and goals. To date, TRWD has not taken credit for indirect reuse in its per capita water use estimates. As discussed in more detail in Section 8.2, TRWD should follow the Task Force recommendation by developing water accounting procedures to track indirect reuse volumes and credit them against per capita water use.

Normalized Total Water Use

Total annual water use by the four primary customers is normalized by their populations in Figure 4-3. Some of the variability in annual water use can be attributed to differences in weather from year to year. To better filter out the impact of weather on the annual data, five-year running averages were calculated (Figure 4-3). The five-year running average has declined from 195.8 gpcd in 2002 to 175.8 gpcd in 2011, a decrease of about 1.1 percent per year. Per capita water use is useful for tracking a utility's water use trends over time. However, per capita water use is not necessarily useful for comparing water use between utilities, since different utilities may have different customer profiles, accounting methods, levels of economic development, etc.

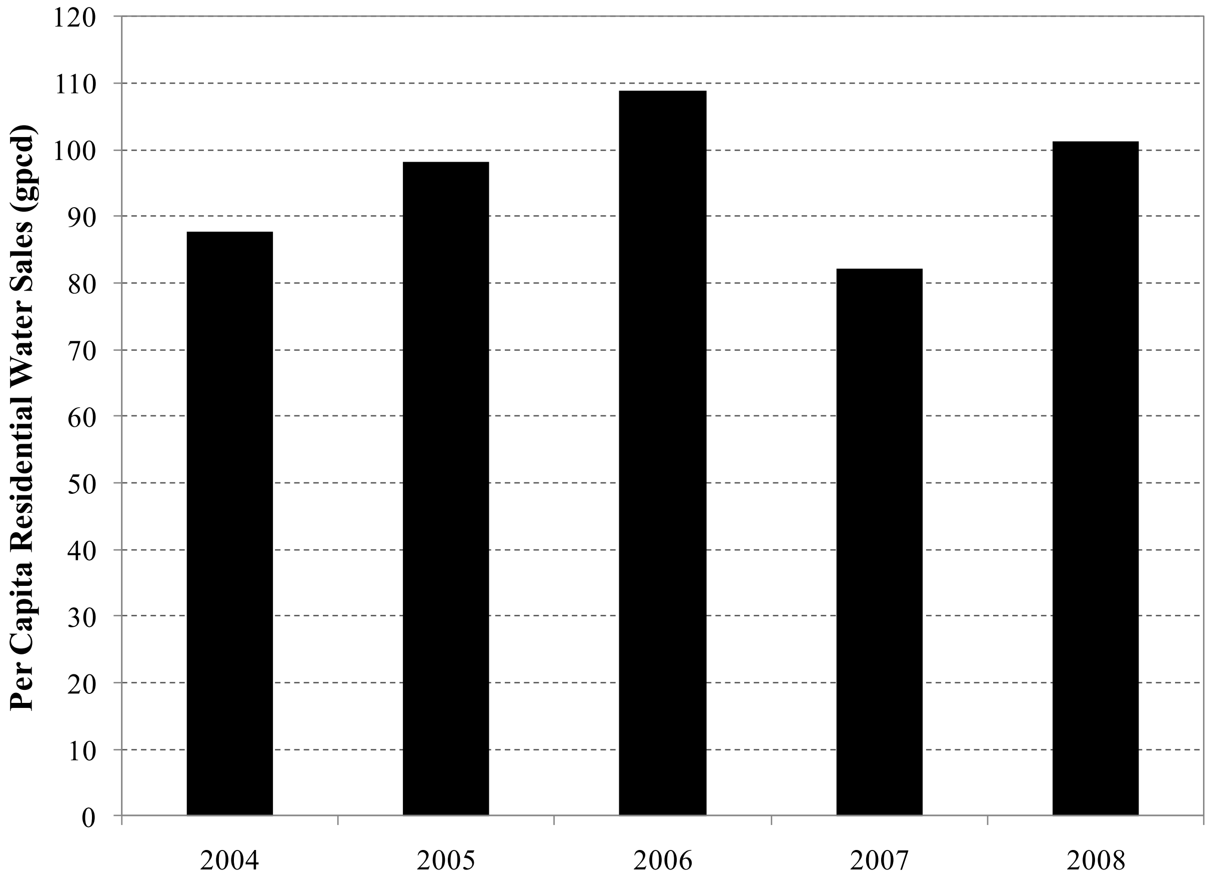
Figure 4-3: Total Water Use Normalized by Population for the Four Primary Customers



Normalized Residential Water Use

Reported residential water sales are normalized by population in Figure 4-4. Given the available water use data, it is not feasible to separate indoor and outdoor residential water use. The range of residential water sales during the period 2004 to 2008 was about 82 gpcd to 109 gpcd.

Figure 4-4: Residential Water Sales Normalized by Population for Reporting Customers



Normalized Commercial and Industrial Water Use

Factors that may be useful in normalizing total commercial and industrial water use include employment, commercial building space, and gross area product. When normalized by employment, reported commercial and industrial water sales in 2008 were 93.2 gallons per employee per day.

For third quarter 2007, total office and industrial space in Fort Worth was 144,812,643 square feet (Ref. 12). Therefore, 2007 commercial and industrial water use in Fort Worth was approximately 0.34 gallons per square foot per day.

The real gross area product for the Fort Worth-Arlington Metropolitan Division (MD) was $76.01 billion in 2007 and $77.57 billion in 2008 (Refs. 13 and 14).[12] Assuming that 37.5 percent of the 2007 water use and 30.2 percent of 2008 water use by the four primary customers was commercial and industrial (Figure 4-2), then the gross area products for 2007 and 2008 were $6.67 per gallon and $7.33 per gallon, respectively. The Fort Worth-Arlington MD includes some areas not served by TRWD, and it would be preferable to normalize by the real gross area product of the TRWD service area, but this real gross area product was not available.

In addition, individual types of commercial and industrial water use may be normalized by the factors in Table 4-1 and compared to literature values. However, commercial and industrial water use was not reported at this level of detail.

4.4. Nonrevenue Water and Water Loss

The utility profile form defines “water loss” as the difference between water diverted (or treated) and water delivered (or sold). However, this quantity is actually “nonrevenue water.” Nonrevenue water is water for which the utility does not receive compensation, including apparent water losses, real water losses, and unbilled authorized consumption.[13]

There are significant data quality control issues with the reported nonrevenue water quantities. Several cities reported one or more years where they sold more water than they diverted (or treated). Short of large meter inaccuracies or meter reads on widely different dates, this is not possible. In addition, few cities reported nonrevenue water that actually equals the difference between water diverted (or treated) and water delivered (or sold). Some utilities may have reported total water loss instead of nonrevenue water. To obtain uniformly reported, credible water loss data, it may be necessary for TRWD to provide additional customer education about water loss and water loss accounting.

Based on the reported data, the calculated average nonrevenue water for the four primary TRWD customers ranged from 12.7 percent to 17.2 percent of total water diversions, depending on the year. The data quality control issues (e.g., negative calculated nonrevenue water) suggest that the actual nonrevenue water percentages are somewhat greater.

4.5. Seasonal Water Use

The study of seasonal water use is an important component of water conservation planning. The capacity of the water treatment and distribution system is based primarily on meeting peak

[12] The Fort Worth Arlington-MD includes Tarrant, Johnson, Parker, and Wise Counties, so it is not limited to the service area of the four primary TRWD customers.

[13] Apparent water loss is the volume of water associated with customer meter under-registering, billing adjustment and waivers, and unauthorized consumption. Apparent loss represents water that was used but for which the utility did not receive compensation. Real loss is the volume of water associated with main breaks and leaks, customer service line breaks and leaks, and storage overflows. Real loss represents water that was physically lost from the water system prior to use. Unbilled authorized consumption consists of water used for firefighting, line flushing, filter backwashing, etc.

demands. If peak demands can be reduced, many upgrades to the system can be delayed or even avoided. In North Central Texas, peak usage occurs in the summer when lawn and landscape irrigation is at a maximum.

Understanding "base" and "seasonal" water use amounts helps in the targeting of water conservation measures. Base water use is:

- Generally associated with indoor water uses or other water uses that remain relatively constant throughout the year;
- Estimated to be the amount of water used on the minimum water use day for a given year; and
- Assumed to be constant throughout each year for each sector.[14]

Seasonal water use is:

- Generally associated with irrigation and cooling water uses and
- Estimated to be all water use greater than the base use.

Seasonal water use statistics can be estimated from TRWD records of daily deliveries to the four primary customers. On the minimum water use day, seasonal water use is at a minimum (although some water is still used for irrigation and cooling). On an annual basis, the four primary customers use 31 percent to 50 percent of their water for seasonal uses (Figure 4-5), depending on climatic conditions. The customers use more water for seasonal uses during hot, dry conditions.

4.6. Peak Day Water Use

Total peak day water use by the four primary customers is normalized by their populations in Figure 4-6. Some of the variability in annual water use can be attributed to differences in weather from year to year. To better filter out the impact of weather on the annual data, five-year running averages were calculated (Figure 4-6). The five-year running average has declined from 368.3 gpcd in 2002 to 318.9 gpcd in 2011, a decrease of about 1.5 percent per year.

[14] Some analysts estimate base water use as the average winter water use (December, January, and February) or the water use in the minimum water use month. However, some irrigation does take place in the winter, particularly during extended dry periods. To better separate seasonal and base water uses, the base water use for each year was estimated from the minimum water use day.

Figure 4-5: Seasonal Water Use as a Percentage of Total Water Use for the Four Primary Customers

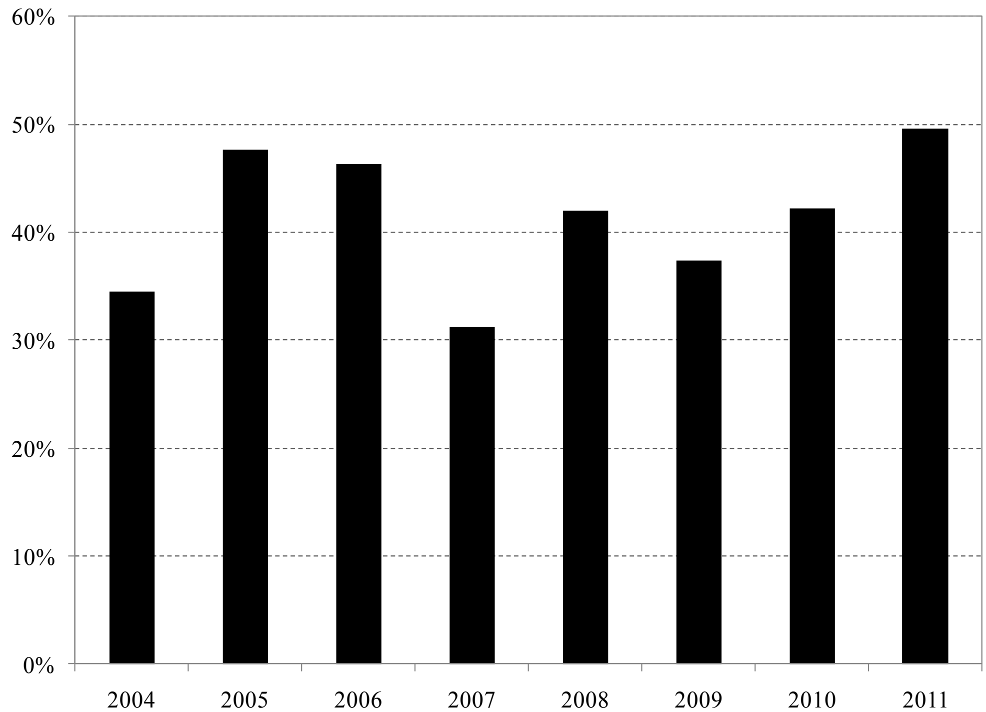
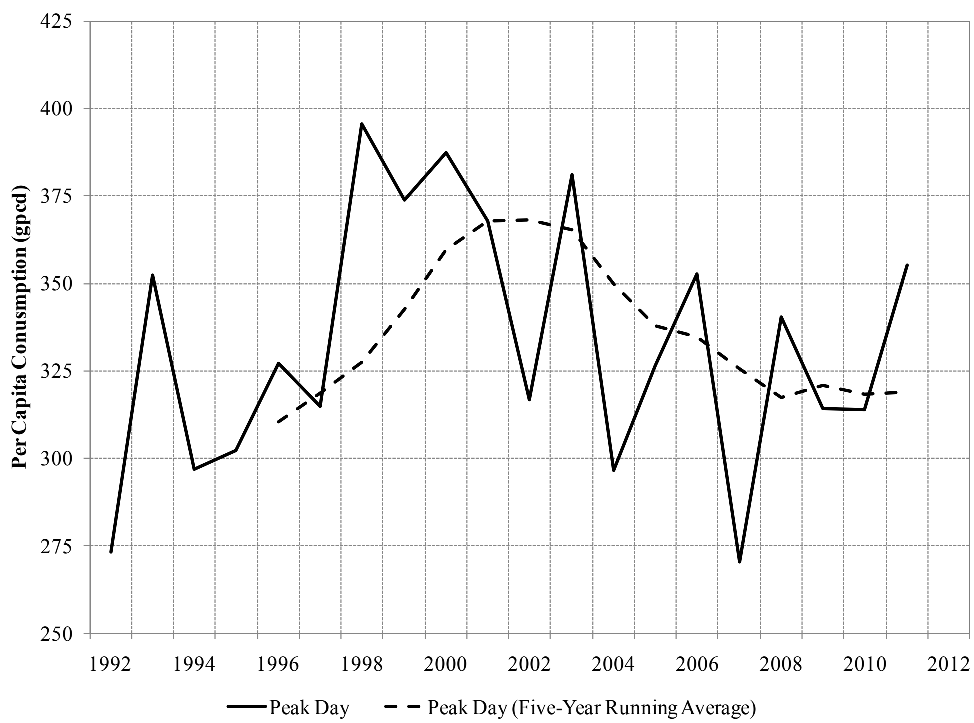


Figure 4-6: Peak Day Water Use Normalized by Population for the Four Primary Customers



4.7. Commuter Population Influence on Water Use

In addition to residential, commercial, and industrial uses and water losses (discussed in later sections), total water use also includes water used by commuters. Some cities experience a large increase in daytime population, while other cities experience a large decrease in daytime population. Commuter population statistics from the 2000 U.S. Census are available for cities with at least 2,500 workers living or working in the city (Table 4-2). Although these statistics represent the best available information, they are rather dated.

Certain cities experience a large inflow of workers (e.g., Fort Worth), while others experience a large outflow of workers (e.g., Arlington). Over the entire service area of TRWD's four primary customers, there appears to be a net negative change in daytime population (-2.8 percent in 2000).

Table 4-2: Commuter Population Statistics, 2000 U.S. Census

Customer	Total Resident Population	Estimated Daytime Population	Estimated Daytime Population Change	Estimated Daytime Population Change (%)
Westlake	207	3,741	3,534	1,707.2
Pantego	2,318	4,873	2,555	110.2
Roanoke	2,810	4,438	1,628	57.9
White Settlement	14,831	22,226	7,395	49.9
Fort Worth	534,694	609,520	74,826	14.0
Lake Worth	4,618	5,174	556	12.0
Southlake	21,519	23,036	1,517	7.0
Richland Hills	8,132	8,418	286	3.5
Grapevine	42,059	41,422	-637	-1.5
Grand Prairie	127,427	120,197	-7,230	-5.7
Hurst	36,273	32,984	-3,289	-9.1
Kennedale	5,850	5,274	-576	-9.8
Burleson	20,976	18,625	-2,351	-11.2
Haltom City	39,018	34,636	-4,382	-11.2
Arlington	332,969	291,419	-41,550	-12.5
Mansfield	28,031	24,325	-3,706	-13.2
Saginaw	12,374	10,391	-1,983	-16.0
Forest Hill	12,949	10,804	-2,145	-16.6
Bedford	47,152	37,587	-9,565	-20.3
Colleyville	19,636	15,621	-4,015	-20.4
River Oaks	6,985	5,498	-1,487	-21.3
Keller	27,345	21,411	-5,934	-21.7
Crowley	7,467	5,795	-1,672	-22.4
North Richland Hills	55,635	42,170	-13,465	-24.2
Benbrook	20,208	14,168	-6,040	-29.9
Euless	46,005	31,691	-14,314	-31.1
Trophy Club	6,350	3,971	-2,379	-37.5
Watauga	21,908	13,464	-8,444	-38.5
TOTAL	1,505,746	1,462,879	-42,867	-2.8

NOTES:

Data obtained from U.S. Census Bureau, 2000 Census, Table PHC-T-40. Estimated Daytime Population and Employment-Residence Ratios: 2000.

These data are twelve years old and may not adequately represent current conditions. Data from the 2010 Census are not yet available.

Data were available for cities with at least 2,500 workers living or working in the city. The totals do not represent the full service area of TRWD's four primary customers.

Populations have not been adjusted to reflect only those served by TRWD and its customers.

5. Population and Water Demand/Supply Forecasts

The ability to plan for the future relies heavily on the ability to project water demand based on changes in population. This chapter summarizes population and water demand projections for TRWD and provides information about recommended future water supply sources.

5.1. Population Projections

Population projections for TRWD's four primary customers were taken from the 2011 Region C Water Plan (Ref. 1) and are summarized in Table 5-1 and Figure 5-1. The population served by TRWD is projected to double in the next fifty years.

Table 5-1: Population Projections for TRWD's Four Primary Customers

Quantity	2010	2020	2030	2040	2050	2060
Total Population[a]	2,032,981	2,445,192	2,847,331	3,260,823	3,695,533	4,167,094
Percentage Served by TRWD[b]	82.3%	84.0%	82.3%	81.2%	80.8%	80.8%
Population Served by TRWD[c]	1,672,146	2,054,901	2,342,926	2,647,846	2,984,918	3,367,329

[a] 2011 Region C Water Plan (Ref. 1).

[b] Projected supply from TRWD divided by net customer water demand. Both quantities calculated from the 2011 Region C Water Plan (Ref. 1). The remainder of the net water demand is projected to be served from other water sources.

[c] Total population multiplied by the percentage served by TRWD.

5.2. Water Demand Projections

Future water demands (Figure 5-2) were projected by multiplying the projected population served by TRWD (Table 5-1) and the current five-year average per capita water demand (175.8 gpcd from Figure 4-3). This scenario represents an average hydrologic year and assumes that current levels of water use and conservation will be maintained in the future.[15]

[15] The projected water demands are less than the Region C water demand projections (Ref. 1), which are intended to represent water demands during drought-of-record conditions. The Region C water demands for TRWD's four primary customers are based on per capita water uses that generally decrease over time from 194 gpcd to 189 gpcd.

Figure 5-1: Projected Populations for TRWD's Four Primary Customers

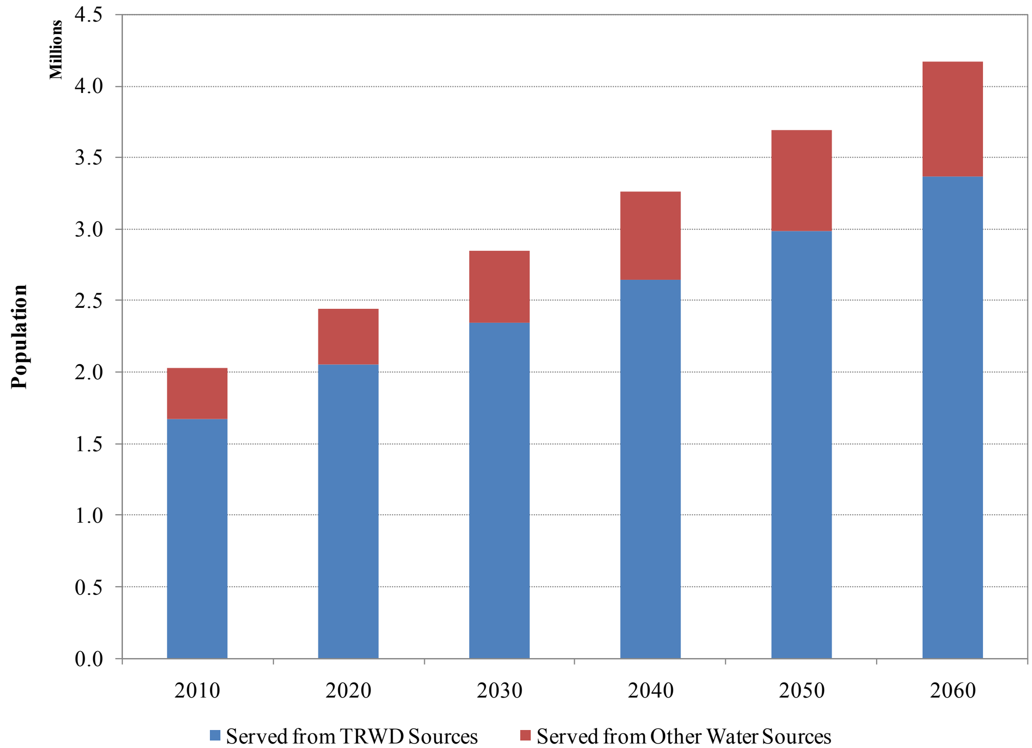
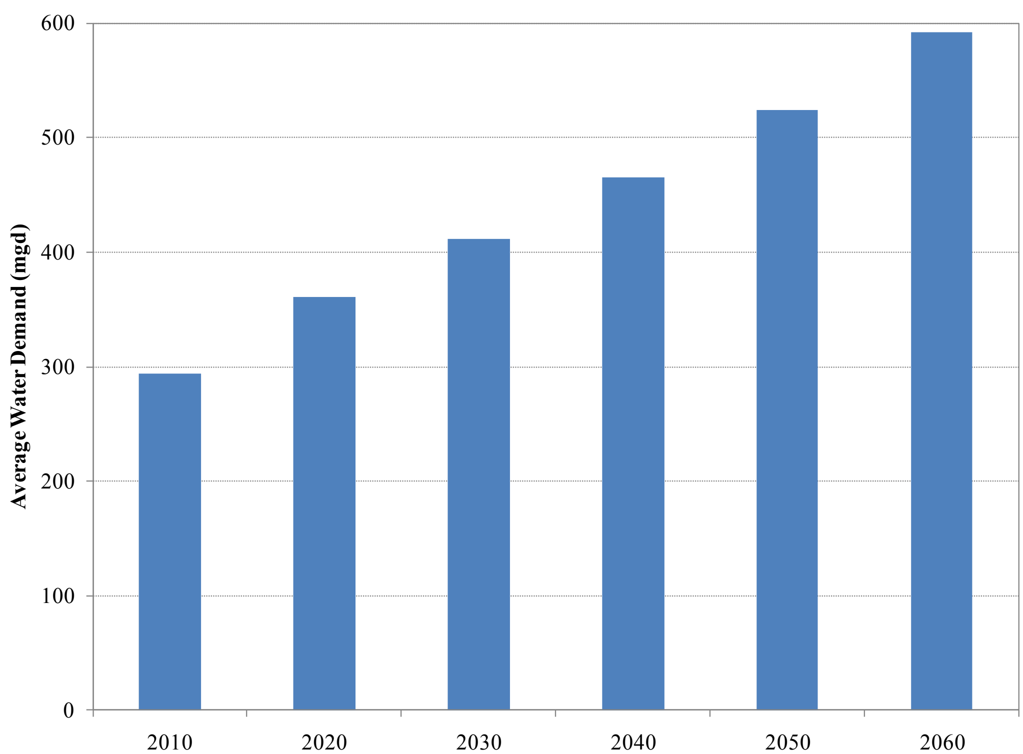


Figure 5-2: Projected Average Day Water Demand on TRWD by Four Primary Customers



5.3. Future Water Supply Sources

The 2011 Region C Water Plan recommends future TRWD water supply sources (Ref. 1). Recommended future water supplies include the following:

- Water conservation. The projected water conservation savings are summarized in Table 2-2 and described in Section 2.2.
- Water reuse by 2018. TRWD would pump return flows from the Trinity River to constructed wetlands, which would serve as a natural water treatment system, and pump the product water into Richland-Chambers and Cedar Creek Reservoirs.
- Integrated pipeline by 2018. In cooperation with Dallas Water Utilities, construct a pipeline to deliver water from Lake Palestine to Dallas and to deliver water from Richland-Chambers and Cedar Creek Reservoirs for TRWD.
- Acquire and connect water supply from the new Marvin Nichols Reservoir by 2030. TRWD would participate in this project with the North Texas Municipal Water District (NTMWD) and the Upper Trinity Regional Water District (UTRWD). Phase 1 would be completed by 2030, and Phase 2 would be completed by 2050.
- Acquire and connect water supply from the existing Toledo Bend Reservoir by 2050. TRWD would participate in this project with the NTMWD.
- Acquire and connect water supply from Oklahoma by 2060. TRWD would participate in this project with the NTMWD and the UTRWD.

Costs for the recommended future water supplies were estimated in the 2011 Region C Water Plan using thirty-year debt financed at an interest rate of six percent per year. During the amortization period, available raw water cost estimates ranged from $0.63 per thousand gallons for water reuse to $3.50 per thousand gallons to acquire a water supply in and connect to Toledo Bend Reservoir. Table 5-2 shows recommended future water supplies.

The 2011 Region C Water Plan also lists Toledo Bend Reservoir (Phase 2), Wright Patman Lake, Lake Tehuacana, and Lake Livingston as alternative future water supplies.

Table 5-2: Future TRWD Water Supplies Recommended in the 2011 Region C Water Plan[a]

Raw Water Supply Strategy	Date to be Developed	Supply (mgd)	Pre-Amortization Unit Cost ($/kgal)	Post-Amortization Unit Cost ($/kgal)
Water Conservation	2010-2060	77.5[b]	n/a	n/a
Water Reuse	2018	94.1	$0.63	$0.18
Integrated Pipeline Project	2018	159.7[c]	$1.36	$0.48
Marvin Nichols Reservoir	2030	249.8	$2.63	$0.74
Toledo Bend Reservoir (Phase 1)	2050	89.2	$3.50	$1.27
Oklahoma	2060	44.6	$2.77	$0.79

[a] From the 2011 Region C Water Plan (Ref. 1). Costs shown in September 2008 dollars and based on thirty-year debt service using a six percent annual interest rate. Does not include treatment or distribution costs. The costs include conveyance of raw water to Tarrant County.

[b] These water conservation savings apply to all TRWD customers, not just the four primary customers and their successive customers.

[c] This is not a new supply for TRWD. The pipeline project will expand TRWD's capacity to convey water made available through other strategies (primarily indirect reuse) from the East Texas reservoirs.

6. Existing TRWD Water Conservation Program

TRWD currently maintains approximately 2.5 staff positions in its water conservation program. These positions include one program manager, one coordinator, and portions of an administrative assistant position and a director position.

Currently, TRWD's water conservation program consists of the following water conservation measures and customer assistance water conservation measures:[16]

- Public Education

- In-House Water Conservation Measures:
  - Practices to Measure and Account for the Amount of Water Diverted
  - Monitoring and Record Management Program for Determining Deliveries, Sales, and Losses
  - Metering and Leak Detection and Repair
  - Indirect Reuse and Recycling of Water
  - In-House Irrigation Policies
  - Annual Water Conservation Implementation Reports

- Customer Assistance Water Conservation Measures:[17]
  - Water Conservation Workshops
  - TRWD Model Water Conservation Plan for TRWD Customers and Model Drought Contingency Plan for TRWD Customers
  - Annual Reports
  - Requirement for Water Conservation Plans by Wholesale Customers

Existing TRWD water conservation program elements and the published goals of the program are reviewed in the following sections. Reuse of treated wastewater effluent, also a water conservation strategy, is discussed in Chapter 8.

6.1. Public Education

TRWD's public education program consists of a public outreach campaign, brochures and conservation literature, school education programs, water-efficient landscaping information, internet initiatives, community group presentations, and special events. Each is described in the following sections.

[16] Unless otherwise documented, descriptions of the TRWD water conservation programs in this chapter are either paraphrased or quoted directly from Ref. 3.

[17] These water conservation measures have been implemented by TRWD to assist its customers. Water conservation measures implemented by TRWD customers are discussed in Chapter 7.

Public Outreach Campaign

In 2007, TRWD initiated an extensive, ongoing multimedia public outreach program to educate direct and indirect customers about conservation practices. The campaign includes television ads on major stations, radio ads during peak traffic periods, billboards on heavily traveled thoroughfares, and other forms of communication. TRWD partnered with Dallas Water Utilities (DWU) on the public outreach campaign theme: "SAVE WATER. Nothing Can Replace It."

Beginning in April 2009, TRWD and DWU combined their public outreach efforts into a single campaign to leverage available budgets and to communicate uniform conservation messages across the entire Dallas-Fort Worth area. Ads have included messages about reducing outdoor watering and waste. TRWD has budgeted $1.25 million for its portion of the combined public outreach campaign.[18]

In May 2010, TRWD received a 2010 Texas Environmental Excellence Award from the Texas Commission on Environmental Quality (TCEQ) for its regional water conservation efforts.

Conservation Brochure

In 2008, TRWD developed an award-winning water conservation brochure that contains water-saving tips for both indoor and outdoor settings. The brochure was made available to customer cities for distribution at public events, libraries, municipal offices, garden centers, and home improvement stores.

School Education Programs

Since 2003, TRWD has provided the "Learning to Be Water Wise" curriculum to the Fort Worth and Arlington Independent School Districts (ISDs) at no cost to the ISDs. In 2007, the City of North Richland Hills partnered with TRWD to provide the program in the Birdville ISD. In 2010, this partnership was expanded to include the City of Bedford and the Hurst-Euless-Bedford ISD. The "Learning to Be Water Wise" curriculum includes student kits and activities to educate 5th grade students on the importance of water and the need for water conservation in their homes and communities. The kits contain water saving devices, which the students are encouraged to install in their own residences.

From 2004 to 2008, the Water District was a sponsor of a regional Newspapers-in-Education program about water. More than a thousand area teachers signed up to receive a free supplement titled "Water: From Here to Eternity and Back Again." The supplement was customized to include topics that specifically related to water issues in North Central Texas.

In 2005, TRWD began offering the "Major Rivers" curriculum to area school districts at no cost to the districts. The Arlington ISD was the first to adopt the program, and the Fort Worth ISD

[18] FY 2012 expenses for development of the Strategic Plan are also included in this budget.

began using it in 2007.[19] “Major Rivers” is a curriculum designed to teach middle school students about Texas water resources, how water is treated and delivered to homes and schools, how to care for water resources, and how to use them wisely. A classroom package includes a teacher's guide with full color overhead transparencies, an introductory video, and full color student workbooks and home information leaflets. For the 2009-10 school year, the Water District ordered teacher kits and replacement packages containing more than 9,000 student activity workbooks.

Since 2005, the Water District has supported the distribution of book covers with a water conservation message to middle schools in Azle, Eagle-Mountain-Saginaw, Decatur, and Birdville ISDs at no cost to the ISDs.

In 2007, TRWD completed an interactive multi-media module to educate students about its wetlands water reuse project. The product can be accessed online at www.trwd.com. The module blends short videos, panoramic photos, and a game to teach school-aged children about wetland ecosystems and the environmental benefits of water recycling projects.

In 2008, TRWD created a student activity workbook to complement the information featured in the online wetland media module. The workbook was provided to 6th graders at All Saints Episcopal School in Fort Worth.

Water Efficient Landscaping

TRWD was one of the original funding partners of the award-winning Texas SmartScape CD ROM.[20] The Water District also provided funding for conversion of Texas SmartScape into an interactive Web site and for regional distribution of the CD version (Ref. 15). Texas SmartScape is an educational tool designed to assist citizens with the design and development of landscaping using Texas native and drought-tolerant plants.

In partnership with the City of Fort Worth, TRWD helped fund the creation of a water conservation demonstration garden located at the Fort Worth Botanic Gardens. The garden is designed to show area residents the environmental and aesthetic benefits of using native and adapted drought-tolerant plants. Information signs that emphasize the responsible use of water resources are being developed.

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[19] Due to changes in curriculum requirements, the Arlington ISD has stopped using the Major Rivers curriculum in its classrooms, but the program remains a vital educational tool for the Fort Worth ISD.

[20] The Texas Smartscape CD-ROM received the following awards:

2002 Texas Commission on Environmental Quality, Environmental Excellence Award, Government (First Place)

2002 American Water Works Association, Watermark Award & Conservation/Reuse Award, Texas Chapter (First Place)

2002 National Association of City and County Health Officials, Award for Excellence in Environmental Health (2nd Place, U.S.)

2001-2002 Keep Texas Beautiful Award, Regional Government (First Place)

Through a grant provided by the Texas Water Development Board (TWDB), TRWD partnered with the City of Arlington to develop a water conservation demonstration garden at the Southwest Branch Library. As a condition for grant funding, TRWD and the city coordinated workshops on ways to design and install water efficient landscapes. The target audience included landscape professionals, builders, and developers. Several more public workshops on water-wise landscaping were conducted in spring 2009.

Internet

TRWD maintains a water conservation web site (www.savetarrantwater.com) to:

- Disseminate water conservation information.
- Spotlight community conservation news and programs.
- Promote local events and public workshops.
- Feature stories and updates about water resources, water reuse, and conservation.
- Dig deeper into the principles of water-wise landscaping.
- Provide in-depth, practical advice on how to save water.
- Discuss water-efficient products and technology.

This web site is also accessible from www.savenorthtexaswater.com, which is designed to forward Dallas-Fort Worth area residents to the water conservation web site operated by their regional water provider.

In 2007, TRWD began producing an online water conservation newsletter, available at its Web site (www.trwd.com). The "Supply Side" newsletter includes information about local water resources, trends in water use, and indoor and outdoor water-saving suggestions.

Community Group Presentations

TRWD has prepared and presented programs to area cities, civic organizations, and other groups concerning the need for water conservation and measures that can be implemented on an individual and corporate level. Presentations have been made to Rotary Clubs, Lions Clubs, Garden Clubs, Tarrant County Master Gardeners, Chambers of Commerce, mayors, city councils, city staffs, and other groups.

Special Events

TRWD sponsors a 2,000-square-foot landscape demonstration garden at Mayfest, a four-day outdoor community festival in Fort Worth. The event gives visitors an opportunity to see the beauty and water-saving benefits of a Texas SmartScape. Master Gardeners from the Tarrant County Extension Office are on hand to educate the public about climate-appropriate landscaping.

TRWD also sponsors four lake and river cleanups annually – two in the spring and two in the fall. These special events provide excellent opportunities to emphasize the importance of protecting and conserving water resources. On average, a total of more than 2,000 volunteers join TRWD each year to clean the watersheds of Eagle Mountain Lake, Lake Bridgeport, the Trinity River, and Cedar Creek Reservoir.

In 2011, TRWD expanded its presence in the Fort Worth community by participating in the Main Streets Arts Festival as the environmental sponsor. The April event attracts more than a quarter million visitors to downtown Fort Worth over four days.

6.2. TRWD In-House Water Conservation Measures

TRWD in-house water conservation measures include practices to measure and account for diverted water; a monitoring and record management program for determining deliveries, sales, and losses; metering and leak detection and repair; indirect reuse and water recycling; landscape and irrigation policies; and annual water conservation implementation reports.

Practices to Measure and Account for Diverted Water

TRWD uses two different methods to measure raw water diversions from its reservoirs. Water is released from Lake Bridgeport through a 42-inch diameter low flow release structure and from Eagle Mountain Lake through a 48-inch diameter gate valve. Each valve is calibrated so that the volumetric flow rate can be calculated based the size of the gate opening and depth of water. TRWD meters its raw water diversions from Cedar Creek and Richland-Chambers Reservoirs and raw water deliveries to Lake Benbrook and Lake Arlington by flow meters that are accurate to within 5 percent. These master meters are calibrated semi-annually and repaired or replaced as needed.

Monitoring and Record Management Program for Determining Deliveries, Sales, and Losses

As a wholesale water supplier, TRWD has instituted a monitoring and record management program to assure that its customers are charged appropriately for their water use. The program includes the following elements:

- Customers with annual demands less than 7,500 acre-feet are required to document their usage in a monthly raw water report. The report includes initiation dates, usage dates, customer name changes and meter status changes.
- TRWD performs scheduled and random readings of customer meters, with no less than three readings taken during a three-month period and a fourth quarter reading taken between September 20 and October 10. In addition, one random reading is performed annually between June 1st and September 30th.
- All meters are documented, and the meter’s serial number is verified and recorded at each reading.
- Customers with an annual demand of 7,500 acre-feet or more must provide TRWD with a daily usage total and a monthly reconciliation of usage. Usage volumes are monitored and recorded daily and verified monthly and annually.

- Customers are required to provide, operate, maintain, and read meters. By contract, meters must be accurate to within 5 percent. TRWD can access the meters at all reasonable times and, upon written request, can have the meters calibrated once per month. In the event a meter is not functioning properly, the customer is required to install a new meter or repair the existing meter within 180 days.
- The Water District has the authority to replace or repair any meter.
- Methods to verify water deliveries include calibration tests, mathematical calculations, and estimates based on historical meter data under similar conditions.
- TRWD reconciles the water deliveries and reservoir diversions into daily mass balances. All of the Water District's reservoir levels and local precipitation are monitored from U.S. Geological Survey (USGS) recording stations. Measured pan evaporations performed by the U. S. Army Corps of Engineers (USACE) are also recorded daily and used in conjunction with the TWDB's evaporation coefficients. Using all of the above data, daily mass balances of each reservoir are performed to estimate natural inflows.

Leak Detection and Repair

The following are elements of TRWD's program to control, detect and repair leaks from its pipeline system:

- All TRWD water transmission pipelines are reinforced concrete cylinder pipe or steel cylinder pipe with an internal protective liner and an external protective coating. Because of the multiple layers of material, these pipelines have very long service lives and are not subject to frequent development of leaks.
- Most joints in TRWD pipelines are designed with bell and spigot joint construction, including a rubber gasket. Some joints are welded. For larger lines, each joint is also sealed with concrete.
- All TRWD water pipelines are constructed in legally defined and identified rights-of-way, properly registered with authorities in each county.
- TRWD personnel routinely inspect TRWD pumping equipment, facilities, and pipelines for leaks or mechanical problems. Aerial surveillance combined with ground observation is used to regularly inspect pipeline routes for breaks and leaks. To minimize waste, repairs are undertaken as soon as practicable.
- TRWD conducts annual inspections of sections of the Cedar Creek and Richland-Chambers pipelines using an advanced technology to assess the condition of pipe segments. The method, which uses remote field eddy current transformer coupling technology (RFEC/TC), is a non-destructive way of detecting broken wires in prestressed concrete pipe. The analysis is cost-effective and highly accurate, which allows TRWD to target individual pipe segments for replacement.
- Pipeline repairs are conducted during the winter when demands are typically at their lowest.
- In summer 2004, TRWD employed the Pressure Pipe Inspection Company's Sahara Leak Detection Technology to inspect a ten-mile section of the Richland-Chambers pipeline

where a number of wet areas had been observed. No leaks were found and shallow groundwater appears to have been the source of the waterlogged soil.

- To minimize leaks caused by pipeline damage during construction, TRWD operates a program for right-of-way identification for construction projects adjacent to TRWD facilities and pipelines.

Indirect Reuse and Water Recycling

Indirect and/or direct reuse is a major part of future water supply plans for North Central Texas. TRWD is taking a lead role in water reuse by recycling return flows. Return flows are a renewable resource – they consist of highly treated water discharged to the Trinity River system by wastewater treatment plants in Fort Worth-Dallas area. A large portion of the return flows originate from reservoirs managed by the Water District.

The first of TRWD's two planned indirect reuse projects began operating in spring 2009. The George W. Shannon Wetlands Water Reuse Project is located adjacent to Richland-Chambers Reservoir. Over the next five years, the Water District plans to recycle enough water from the Trinity River to make up approximately two percent of its raw water supplies.

Another reuse facility is planned for Cedar Creek Reservoir. The wetland treatment systems will be enlarged as water demands increase, up to a maximum size of approximately 2,000 acres in each system. These unique projects will ultimately supplement current yields in both reservoirs by 30 percent – an additional 63,000 ac-ft/yr from Richland-Chambers and an additional 52,500 ac-ft/yr from Cedar Creek. Both wetlands facilities are expected to be fully operational by 2020.

Landscape and Irrigation Policies

TRWD has implemented in-house landscape and irrigation policies, including the following elements:

- Wherever possible, landscapes use native or adapted drought-tolerant plants, trees, and shrubs.
- To minimize evaporative losses, irrigation at TRWD facilities occurs before 10:00 am and after 6:00 pm year-round.
- Irrigation is limited to the amount needed to promote survival and health of plants and lawns. TRWD has eliminated irrigation altogether at some pump station locations.
- Irrigation is avoided on Saturday and Sunday if possible, since these are periods of high water use by the public.
- Irrigation uses untreated source water wherever feasible and reasonable.

Annual Water Conservation Implementation Reports

The TCEQ requires TRWD to complete and submit an annual water conservation implementation report. This report lists various water conservation measures that have been implemented, including the date the strategy was implemented. The report contains the volume of water conserved in the previous year and the status of the five- and ten-year per capita water use goals from the previous water conservation plan.

6.3. TRWD Customer Assistance Water Conservation Measures

TRWD serves as a regional resource for water conservation efforts in its service area, helping direct and indirect customers with their water conservation planning by:

- Holding water conservation workshops for customer staff members.
- Training plumbers in water conservation practices with the GreenPlumbers program.
- Providing model water conservation and drought contingency plans for use by customers in developing their own plans.
- Requiring an annual report on water conservation efforts from customers.
- Requiring entities that enter into, renew, or extend water contracts with TRWD to develop water conservation plans.

Water Conservation Workshops

TRWD coordinates water conservation workshops for staff members of customers (direct and indirect) that receive water from TRWD. The workshops cover TCEQ requirements for water conservation and drought contingency plans, current TRWD water conservation efforts, water supply updates, municipal water conservation programs and best management practices, and related topics.

In 2007, the Water District held a Water Conservation Symposium for its customer cities. The program was designed to show customers measures that they could use to save water, save money, and reduce water demands. Speakers from across the nation were invited to share their experience and expertise. Discussions centered on key elements of successful water conservation programs. The symposium is now an annual event and is jointly coordinated by the region's three major water providers – TRWD, North Texas Municipal Water District, and DWU.

In October 2008, TRWD joined other North Texas water suppliers and the Dallas and Fort Worth Chambers of Commerce to coordinate a Legislative Summit for state and local lawmakers. The event, which focused on water supply and conservation issues impacting North Texas, was repeated for water utility managers and their staff.

GreenPlumbers Program

TRWD is planning to participate in the GreenPlumbers training program developed by GreenPlumbers USA. The GreenPlumbers program, open to all plumbers, provides 32 hours of training in five topics: Climate Care, Caring for Our Water, Solar Hot Water, Water Efficient Technology, and Inspection Report Services (Ref. 16). The classes are designed to provide up-to-date information and advice on the latest technology and energy saving appliances; practical appliances and installation knowledge; environmental impacts of plumbing services, appliances and household practices; consumer information; and energy/water/cost data. Plumbers that have completed these classes are listed on the GreenPlumbers USA web site (Ref. 17).

Pilot Irrigation System Evaluations

TRWD has selected Vepo, LLC's W.I.S.E. Guys staff members to administer and track a pilot irrigation system evaluation program. The pilot program is anticipated to last for two years, with up to 500 irrigation system evaluations per year. Participating cities include Arlington, Bedford, North Richland Hills, Mansfield and Fort Worth.

After the second year, TRWD will evaluate the estimated water savings and costs. Should the pilot program prove cost-effective, TRWD will likely continue the program at a similar level of effort and offer irrigation system evaluations to other cities in Tarrant County on a rotating basis.

TRWD Model Water Conservation and Drought Contingency Plans for TRWD Customers

To assist its customers in the development of their own water conservation and drought contingency plans, TRWD has developed a Model Water Conservation Plan for TRWD Customers and a Model Drought Contingency Plan for TRWD Customers. The model water conservation plan addresses the TCEQ requirements for water conservation plans for municipal use by public water suppliers and includes several provisions that go beyond TCEQ requirements. TRWD is working with its customers to develop water conservation and drought contingency plans that use the model plan as a guide.

Annual Reports

TRWD recently began asking all water customers (direct and indirect) to develop and submit annual conservation reports. To date, Arlington, Bedford, Benbrook Water Authority, Fort Worth, Mansfield, and North Richland Hills have submitted reports (Appendix A). TRWD intends to compile these reports and use them to help generate its own annual water conservation report. TRWD's report will be used to review the effectiveness of its water conservation program.

Requirement for Water Conservation Plans by Wholesale Customers

Since 1989, every TRWD wholesale water contract entered into, renewed, or extended includes a requirement that the wholesale customer and any wholesale customers of that wholesale customer develop and implement a water conservation plan meeting the requirements of Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code. This requirement extends to each successive wholesale customer in the resale of the water. TRWD provides model water conservation and drought contingency plans to all wholesale customers to assist them in developing their own water conservation and drought contingency plans.

6.4. Published Program Goals

As part of the development of its state-mandated water conservation plan (Ref. 3), TRWD adopted five- and ten-year goals for municipal per capita water consumption (Table 6-1) in gallons per capita per day (gpcd). The goals represent a 9.8 gpcd reduction in water use by 2018. Due to the success of its water conservation program, TRWD is on course to meet or surpass the 2013 water use goal of 175 gpcd.

Table 6-1: Five-Year and Ten-Year Municipal Per Capita Water Use Goals for TRWD's Primary Customers

Description	Year	Per Capita Water Use[a] (gpcd)
Current 5-Year Average Per Capita Municipal Use Among TRWD's Primary Customers[b]	2007-2011	175.8
5-Year Goal[c]	2013	175
10-Year Goal[c]	2018	166

[a] From Ref. 3. Based on average climatic conditions.

[b] The "current" 5-year average is the average during the period 2007 through 2011.

[c] Part of the reduction in use is achieved through indirect reuse.

TRWD is a wholesale water supplier and does not directly control the water use of its customers. Some of TRWD's municipal customers are projected to have increasing per capita demands in the future due to urbanization, commercial development, changes in housing types, and growth in employment (Ref. 1).

TRWD does control the operation of its water supply and delivery system. For this system, TRWD adopts the following water conservation and efficiency goals:

- Keep the level of unaccounted water in the system below 5 percent.
- Maintain universal metering of customers, meter calibration, and meter replacement and repair.
- Maintain a program of leak detection and repair.
- Use indirect reuse as a major source of water supply.
- Continue to implement in-house water conservation efforts.
- Raise public awareness of water conservation and encourage responsible public behavior.

6.5. Summary of Conservation Water Savings and Costs

TRWD determines the extent of water conservation by compiling implementation data, monitoring water consumption, modeling water demand, and tracking water conservation costs. Projected conservation water savings and historical water conservation budgets are discussed below.

Water Savings from Water Conservation Measures

TRWD estimates the water savings due to TRWD and customer water conservation efforts as the difference between actual water use and projected water demand if the water conservation program did not exist.[21] To project what TRWD water demand would be in the absence of the water conservation program, TRWD examined factors that influenced historical water use prior to the implementation of the time-of-day watering restrictions (i.e., prior to 2005). As part of this process, TRWD developed and calibrated an annual water demand model based on historical water consumption from 1997 through 2004 (Figure 6-1). Statistically significant predictor variables (i.e., factors that influenced water use) include average soil moisture, total June through September rainfall, number of days with temperatures greater than 100°F, and employment.[22]

The difference between the water demand model projection and actual consumption is assumed to be water savings due to the water conservation program (Figure 6-1). Based on this analysis, TRWD's ongoing water conservation efforts have conserved a total of approximately 41.0 billion gallons (bg) from 2005 through 2011, with the bulk of the savings occurring in the last five years, when a large fraction of the service population was subject to time-of-day watering restrictions (Figure 7-2) and when TRWD implemented its multimedia public outreach campaign.[23]

During the last five years, the projected savings from ongoing water conservation efforts equals:

- An average of 23.2 mgd. At the 2011 rolling average consumption rate (175.8 gpcd from Figure 4-3), 23.2 mgd could supply an additional 132,200 people.
- 26,050 ac-ft/yr, which is about half of the firm yield of the proposed Cedar Creek Reservoir indirect reuse project.

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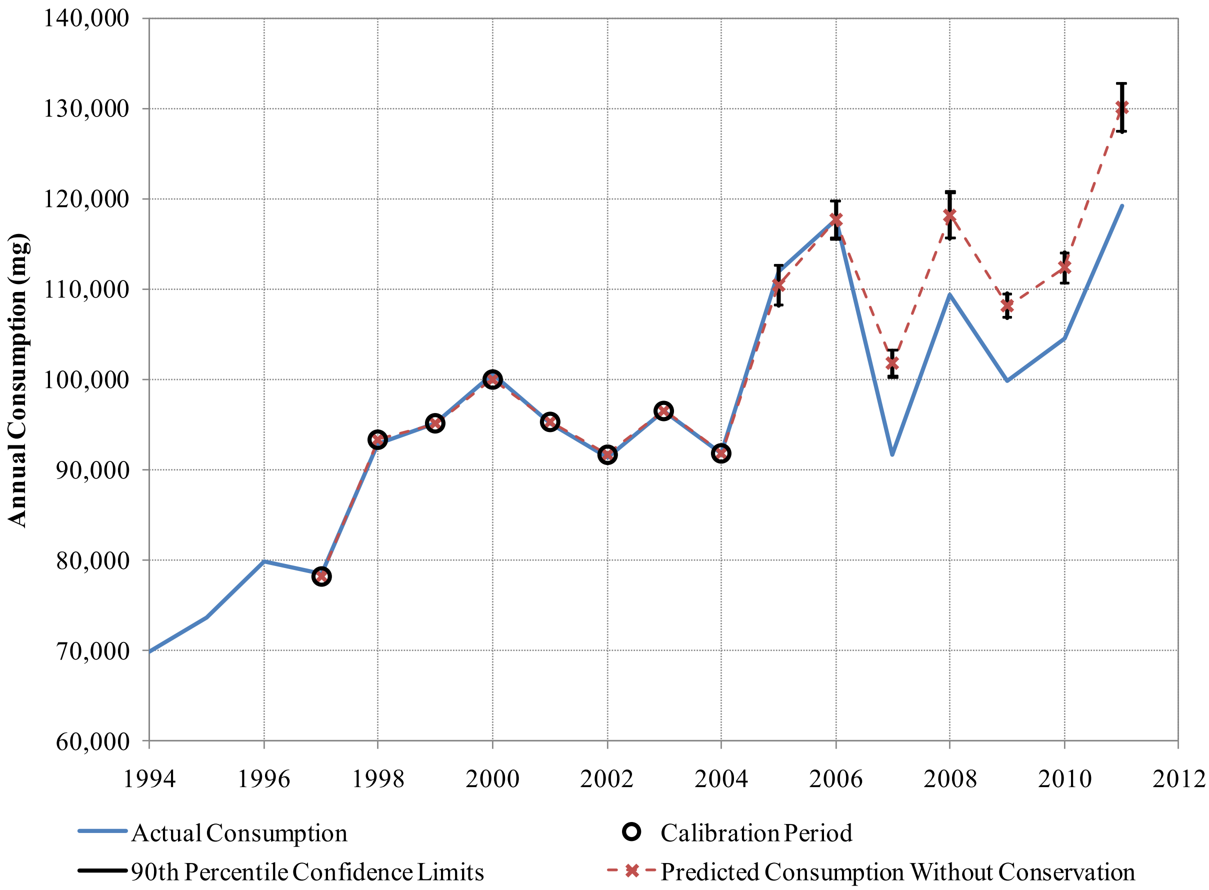
[21] Strictly speaking, the resulting water savings estimate includes the impacts of ongoing water conservation efforts and drought contingency measures. To isolate savings from ongoing water conservation efforts in 2011, when drought contingency measures were implemented, an independent estimate of water savings from the drought contingency measures (presented in Appendix I) was necessary.

[22] Other variables considered include cooling degree days, days since 0.25 inches of rainfall, days since rainfall, heating degree days, maximum temperature, mean dew point, mean temperature, mean wind speed, minimum temperature, total precipitation, population, median family income, real gross area product, unemployment, drought/emergency water use restrictions, time-of-day watering restrictions, TRWD's public outreach campaign, Arlington's fifth tier water rate, and Fort Worth's fourth tier water rate.

[23] TRWD also implemented Stage 1 drought contingency measures from August 29, 2011 through May 3, 2012 that saved an additional 5.8 billion gallons of water (Appendix I).

Figure 6-1: Estimated Consumption without Conservation vs. Actual Consumption



Historical Water Conservation Budgets

TRWD provided historical budget information for its water conservation activities (Table 6-2). These budgets include salaries and benefits of water conservation staff, the public outreach campaign, consulting fees, and community outreach programs. To the extent possible, salaries and benefits have been allocated to individual programs. During the 5-year period from 2008 through 2012, TRWD budgeted approximately $6.9 million for water conservation activities.

TRWD has also budgeted money for leak detection and repair of its pipeline system. This funding is part of the operating and maintenance budget and is not considered an allocation for water conservation activities.

Unit Cost of Water Savings

From 2008 through 2011, TRWD spent approximately $5.081 million on water conservation (Table 6-2) and saved approximately 32.4 billion gallons (Figure 6-1). A simple comparison of these two figures indicates that the unit cost of TRWD water savings from 2008 through 2011 was about $0.16 per thousand gallons. Reducing the demand through water conservation costs much less than supplying the additional water. By comparison, a sampling of recent retail water rates in the TRWD service area (Section 7.1) showed that an account using 25,000 gallons in a month would pay an average rate ranging from $2.91 per thousand gallons to $6.23 per thousand gallons, or 18 to 40 times the cost of water conservation.

Table 6-2: Itemized Historical Water Conservation Budgets

Program	Fiscal Year				
	2008	2009	2010	2011	2012[a]
Unallocated Salaries & Benefits[b]	$222,772	$227,228	$241,028	$243,360	$360,543
Consulting Fees: Strategic Plan			$76,927	$99,335	
Consulting Fees: Public Awareness	$166,441	$183,341	$180,979	$182,166	$180,000
Public Awareness: Advertising, Media[c]	$742,997	$742,336	$687,828	$799,063	$1,250,000
GreenPlumbers Program			$16,000	$1,810	
Community Outreach: School		$41,091	$42,589	$47,131	
Community Outreach: Other		$74,089	$29,349	$33,781	
Total Budget	**$1,132,210**	**$1,268,084**	**$1,274,702**	**$1,406,646**	**$1,790,543**
Regional Symposium[d]	$25,000	$25,000	$25,000	$25,000	$25,000

[a] FY 2012 figures are a general breakdown of items from current budget. For FY 2012, expenses for development of the Strategic Plan, Community Outreach: School, and Community Outreach: Other are covered by the “Public Awareness: Advertising, Media” budget.

[b] Salaries and benefits include 1 full-time coordinator and portions of administrative assistant and director oversight through FY2011. An additional full-time program manager was added in the FY 2012 budget.

[c] In addition to advertising buys, the Public Awareness: Advertising, Media budget also includes the GreenPlumbers program, school education programs, and other community outreach.

[d] The Regional Symposium is one of the successful water conservation strategies adopted to educate water providers in the region. The costs associated with the program are covered by consultant contributions and are not included in the “Total Budget” figure.

7. Primary Customer Existing Water Conservation Measures

In addition to water conservation measures that TRWD has implemented to assist its customers (Chapter 6), TRWD customers have also developed their own water conservation programs. To develop information about the water conservation programs of the TRWD customers, water conservation plans, and water conservation implementation reports. These information sources are summarized in Table 7-1.

Most water conservation plans also include a utility profile that reports recent population and water use data. With the exceptions of DFW International Airport (August 2008), Haltom City (April 2005), and Mansfield (2007), all water conservation plans were current as of spring 2009.[24] Customer water conservation implementation reports are attached in Appendix A and customer water conservation plans are summarized in Appendix B.

All utilities for which information was received report implementation of universal metering, leak detection and repair, public education, and non-promotional rate structures. Some utilities reported irrigation restrictions, reuse of reclaimed water, and other measures, as discussed in the following sections.

7.1. Summary of Water Rates

Of the wholesale customers that reported water rates in their water conservation plans, eleven utilities reported an inclined block rate structure (the unit cost increases as usage increases), and seven utilities reported a flat rate structure (the unit cost remains the same regardless of usage). A comparison of typical monthly residential water bills are shown in Figure 7-1. Water rates are summarized in Appendix C.

7.2. Irrigation Restrictions

Several cities that receive water from TRWD have implemented seasonal and/or year-round time-of-day irrigation restrictions (Table 7-2). The irrigation restrictions typically prohibit irrigation between the hours of 10:00 am and 6:00 pm, with exceptions for hand watering and use of soaker hoses, and typically include a requirement for installation of rain and freeze sensors.

[24] The next deadline for revising the water conservation plans is 2014.

Table 7-1: Conservation Information Obtained from TRWD Customers

Customer	Water Conservation Plan	2004-2008 Utility Profile	Water Conservation Implementation Report
Aledo			
Arlington	April 2009	x	2009
Bedford	May 2009	x	2009
Benbrook	2009	x	2009
Bethesda WSC	March 2009	x	
Burleson	March 2009	x	
Colleyville			
Crowley			
DFW Int'l Airport	August 2008	x	
Dalworthington Gardens			
Edgecliff Village			
Euless	April 2009	x	
Everman			
Forest Hill			
Fort Worth	March 2009	x	2009
Grand Prairie	April 2009	x	
Grapevine	April 2009	x	
Haltom City	April 2005		
Haslet			
Hurst	April 2009	x	
Johnson Co. SUD	2009	x	
Keller	May 2009	x	
Kennedale			
Lake Worth	May 2009	x	
Lakeside			
Mansfield	2007	x	2012
North Richland Hills	2009	x	2009
Northlake	August 2006		
Pantego			
Richland Hills			
River Oaks			
Roanoke			
Saginaw			
Sansom Park			
Southlake	2009	x	
TRA	April 2009	x	
Trophy Club			
Watauga	May 2009	x	
Westlake			
Westover Hills			
Westworth Village			
White Settlement		x	

Figure 7-1: Comparison of Typical Monthly Residential Water Bills

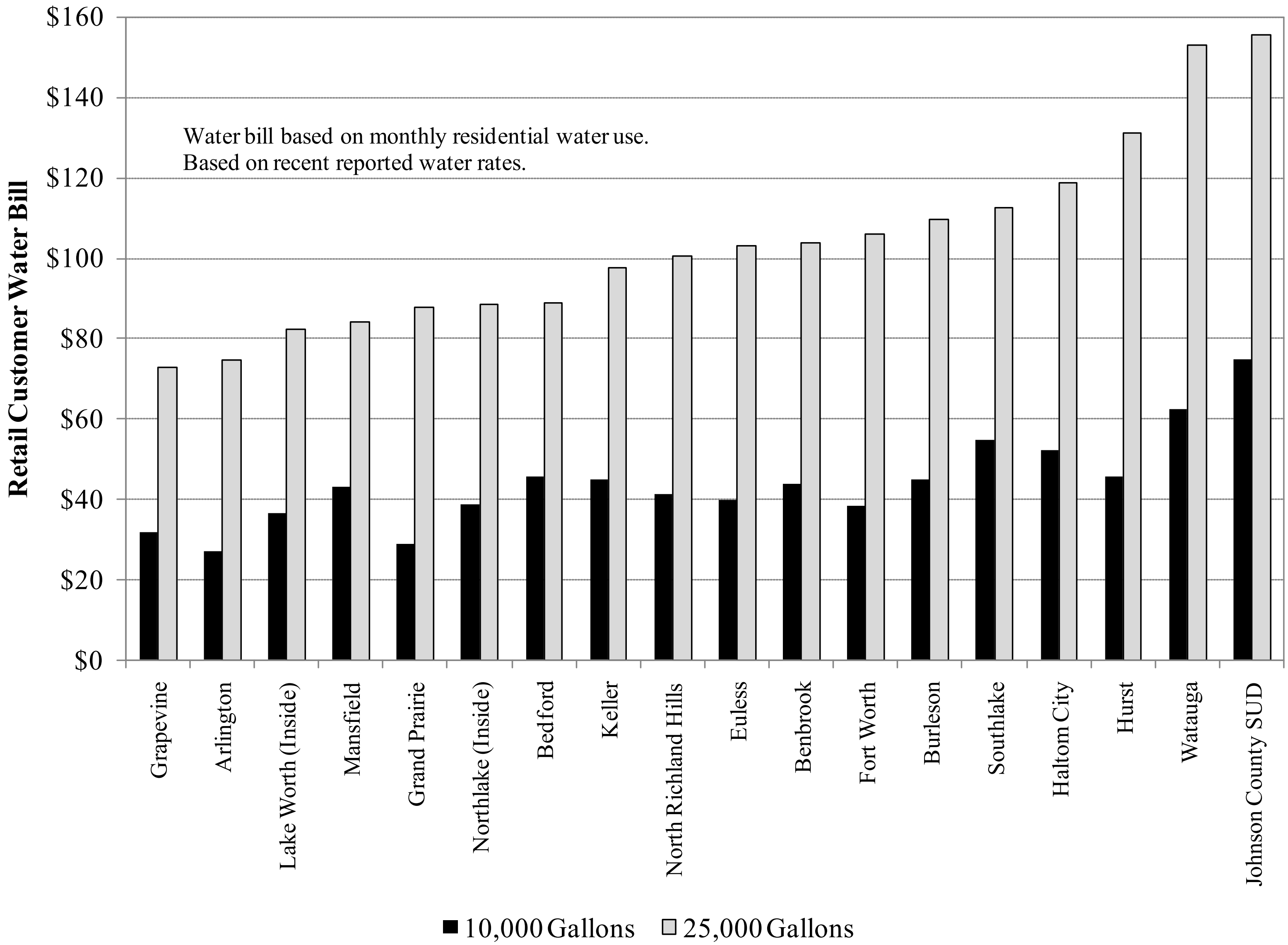
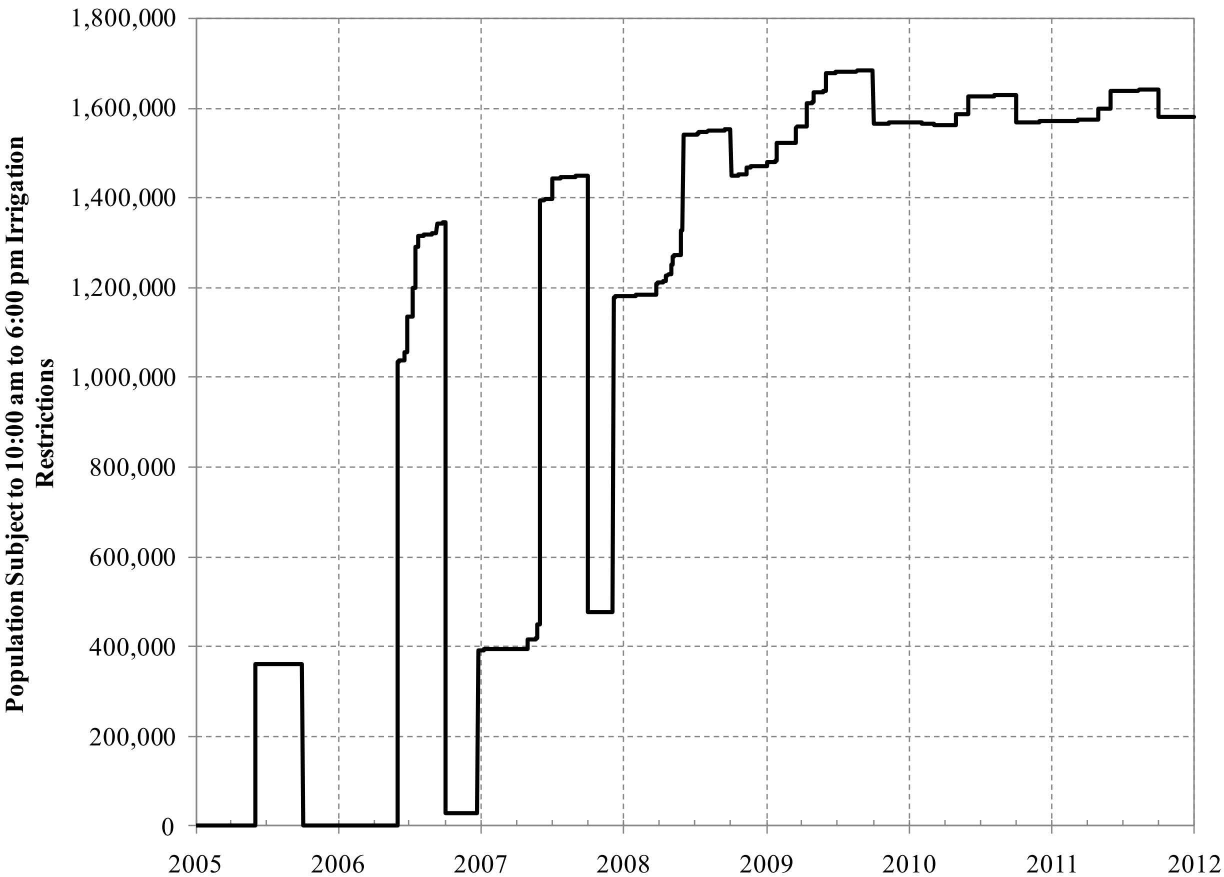


Table 7-2: TRWD Customer Time-of-Day Irrigation Restrictions

Customer	Seasonal Restrictions		Year-Round Restrictions
	Date Implemented	Months in Effect	Date Implemented
Arlington	6/1/2005	Jun – Sep	12/23/2006
Bedford			4/14/2009
Bethesda WSC			Assumed March 17, 2009
Burleson			5/24/2007
Crowley			4/17/2008
Colleyville	9/9/2006	May – Sep	
Dalworthington Gardens			4/17/2008
DFW Airport			Assumed August 2008
Edgecliff Village			4/10/2008
Euless			7/1/2007
Fort Worth	6/1/2006	Jun – Sep	12/5/2007
Grand Prairie	6/1/2009	Apr – Sep	
Grapevine			7/18/2006
Haltom City	6/26/2006	Jun – Sep	1/26/2009
Haslet			
Hurst	6/27/2006	Jun – Sep	
Keller	7/18/2006	Jun – Sep	7/15/2008
Lake Worth			4/14/2009
Mansfield			5/27/2008
Northlake	8/10/2006	Jun – Sep	
North Richland Hills	7/10/2006	Jun – Sep	10/1/2008
Richland Hills			Unknown
Saginaw	6/20/2006	Jun – Sep	5/6/2008
Southlake	7/18/2006	Jun – Sep	6/17/2008
Watauga	7/24/2006	Jun – Sep	3/24/2008
Westover Hills			Unknown
Westworth Village			7/8/2008
White Settlement			11/11/2008

Most of the cities in Table 7-2 implemented seasonal restrictions in 2005 or 2006, with the most popular restricted months being June through September. Many cities modified the time-of-day irrigation restrictions to apply year-round, although some maintain seasonal restrictions. In later years, cities that have implemented restrictions have mostly applied them year-round. It is estimated that almost 1.6 million people (or about 88 percent of the service area) are subject to time-of-day irrigation restrictions on a year-round basis (Figure 7-2), with almost 60,000 more people (or another 3 percent of the service area) subject to seasonal time-of-day irrigation restrictions.

Figure 7-2: Estimated Population Subject to Time-of-Day Irrigation Restrictions



7.3. Selected Other Existing Customer Water Conservation Measures

Several other notable customer water conservation measures are described below.

Fort Worth

In 2010, Fort Worth initiated the SmartWater ICI Audit program. A contractor, Water Management, Inc. (WMI), conducts free water audits of industrial, commercial, and institutional (ICI) facilities to help customers identify ways to save water. WMI reviews historical water use and other available information, meets with facility personnel to discuss water uses, tours the facility to evaluate water uses, and prepares an evaluation and audit report containing recommended water efficiency measures. Through fiscal year 2011, the city has completed 42 facility audits at museums, hotels, patient care/assisted living facilities, an aerospace manufacturer, hospitals, a dairy, high school/college campuses, and office facilities.

In November 2011, Fort Worth recognized three ICI customers with SmartWater Conservation Partner Awards. Based on the results of their ICI customer water audits, these customers implemented improvements to their cooling towers, irrigation systems, and lavatory fixtures that are expected to save about 24 million gallons annually. The awardees were:

- Lockheed Martin Aeronautics: Installed pH control systems for cooling towers, optimized cooling tower operations, and retrofitted more than 1,100 lavatory faucets from 1.5 gallon per minute (gpm) aerators to 0.5 gpm aerators for an estimated annual savings of 21.9 million gallons per year (MG/yr).
- Amon Carter Museum of American Art: Optimized cooling tower operations and upgraded irrigation of 90 percent of existing shrub beds to subsurface irrigation for an estimated savings of 1.33 MG/yr.
- Performing Arts Center Fort Worth, Inc.: Optimized cooling tower operations, installed new cooling tower meters, retrofitted 81 toilet fixtures from 4.5 gallons per flush (gpf) to 1.6 gpf, and retrofitted faucets with 0.5 gpm aerators for an estimated savings of 0.88 MG/yr.

In 2009, Fort Worth initiated the following programs:

- The SmartFlush toilet retrofit program is projected to save more than 2.1 billion gallons over 25 years at a unit cost of $0.33 per thousand gallons (Ref. 18). Fort Worth has budgeted $755,840 for the SmartFlush program in FY 2010 and anticipates replacing approximately 7,000 toilets per year.
    - Fort Worth residential water customers that own or rent a home built prior to 1994 and have existing high-flow toilets (more than 3 gallons per flush) are eligible to receive up to 2 high-efficiency (1.28 gallons per flush) toilets. Elderly or low-income customers may be eligible for free installation.
    - Provides high-efficiency toilets to Fort Worth commercial water customers with large numbers of existing high-flow toilets (hotels, apartments, etc.)
- The Smart Irrigation Program offers free irrigation system evaluations.

In 2008, Fort Worth's SpraySmart program used a contractor to install low-flow (1.28 gallons per minute) pre-rinse spray valves (PRSVs) at food service facilities (Ref. 19). Now the SpraySmart program provides PRSVs on request.

In 2008, Fort Worth added a fourth tier (usage over 22,442 gallons in a month) to its residential water rates. Arlington added a fifth tier (usage of 30,000 gallons or more in a month) to its residential water rates in 2007. Currently, the rates for these tiers are approximately 20 percent greater than the rates for the next lower tier.

Arlington

In 2009, Arlington initiated residential high-efficiency toilet and low-flow showerhead replacement programs. Arlington residential water customers that own or rent a home built prior to 1992 and have existing high-flow toilets (more than 1.6 gallons per flush) are eligible to receive up to 2 high-efficiency (1.28 gallons per flush) toilets.[25] At the same time, these customers can exchange up to 2 older showerheads for low-flow showerheads. Arlington

[25] Until 2011, residents could only receive one high-efficiency toilet through this program.

anticipates replacing approximately 600 toilets per year and a commensurate number of showerheads.

Arlington recently purchased about $75,000 worth of leak detection equipment to help city staff identify leaks more quickly. The city will use this equipment in a pilot leak detection program.

Other Customers

DFW International Airport collects storm water runoff in Trigg Lake and uses this water for irrigation at the Bear Creek Golf Course.

Several TRWD customers, including Fort Worth, Arlington, Euless, D/FW International Airport, TRA, Grapevine, and Trophy Club MUD #1 have implemented or are working to implement projects to reuse treated wastewater effluent. These projects are discussed in Chapter 8.

7.4. Selected Planned Measures

Planned measures for Arlington and Fort Worth were identified from their water conservation plans. Arlington plans to implement a faucet aerator replacement program, a pressure reducing valve replacement or rebate program, and free residential irrigation system evaluations (Ref. 20).

Fort Worth developed a 10-Year Water Conservation Master Plan in June 2007 (Ref. 21). Measures recommended in this plan are summarized in Table 7-3. The projected water savings from implementing the 10-Year Plan are more than 30 mgd.

7.5. Published Customer Water Conservation Goals

Table 7-4 summarizes published water conservation goals (from available water conservation plans) for the four primary TRWD customers and their wholesale customers.

Hurst's goals are significantly greater than their current water use. The goals were apparently set using water supply planning information from the 2006 Region C Water Plan (Ref. 5). Mansfield's current water use is also less than its goals, but the goals have not been updated in the last three years. For unknown reasons, Johnson County SUD's current use is also less than the 5-year goal.

Finally, Southlake's stated goals are so much less than their current water use that it is not clear that the goals are achievable during the stated timeframe. New measures proposed to achieve this water use reduction include testing and repair of two-inch commercial and irrigation meters, monthly water audits, visual inspection of delivery lines, leak detection through monitoring of pressure drops, and institution of a monthly fee to fund a Water Conservation Coordinator position.

Table 7-3: Recommended Measures in the Fort Worth 10-Year Water Conservation Master Plan

Projected Date	Program Description	Program Type	Currently Implemented?
2008	Mandatory two-day-per-week summer watering ordinance effective June 1 – September 30	Peak Demand Reduction	No
2008	Improved rate structures, including tiered irrigation rates and reducing the upper residential tier to continue conservation savings paid by highest user	Peak Demand Reduction	Yes
2008	Selective landscape retrofit	Peak Demand Reduction	No
2008	Water loss control	Internal	Yes
2008	Enforcement of ordinances to improve water conservation	Internal	Yes
2008	Pre-rinse spray valve retrofits	Base Demand Reduction	Yes
2008	Cooling tower water retrofit	Base Demand Reduction	In progress
2009	Residential water audits, including hose shutoffs, irrigation controller setting, and landscape audits for high-use customers	Peak Demand Reduction	Yes
2009	Landscape water management for large users such as athletic fields, commercial plots, and golf courses	Peak Demand Reduction	Yes
2009	Parks Department landscape water management	Internal	In progress
2009	Low-income residential water audit, including showerhead and faucet aerator retrofits	Base Demand Reduction	Yes
2010	Ultra-low-flow toilet/urinal retrofits	Base Demand Reduction	Yes
2011	New water-efficient landscape program with rewards for innovative low water users	Peak Demand Reduction	No
2014	High-efficiency washer replacement	Base Demand Reduction	No
n/a	Water meter replacement program	Other	Yes
n/a	Public outreach programs	Other	Yes
n/a	Increased reuse	Other	In progress
n/a	Certify landscape professionals	Other	No
n/a	Retrofit on resale	Other	No
n/a	ET controllers	Pilot	Yes
n/a	Limit turf and irrigation area	Pilot	No

Table 7-4: Customer Water Conservation Goals

Utility	Plan Date	Current Use (gpcd)	5-Year Goal (gpcd)	10-Year Goal (gpcd)
Arlington[a]	April 2009	161	153	146
Bedford[b]	May 2009	156	148	140
Benbrook WSA[b]	2009	161	156	151
Bethesda WSC[c]	March 2009	126	121	117
Burleson[c]	March 2009	133	130	126
D/FW Int'l Airport	August 2008	n/a[d]	n/a	n/a
Euless[a]	April 2009	146	144	138
Fort Worth[c]	March 2009	192	179	170
Grand Prairie[b]	April 2009	151.5	150	148.5
Grapevine[b]	April 2009	217	210	n/a
Haltom City	April 2005	n/a	n/a	n/a
Hurst[a]	April 2009	153	184	174
Johnson Co. SUD[b]	2009	130	140	130
Keller[a]	May 2009	219	212	207
Lake Worth[c]	May 2009	130	124	118
Mansfield[b]	2007	153	160	155
Northlake	August 2006	n/a	n/a	n/a
North Richland Hills[a]	2009	186	176	166
Southlake[b]	April 2008	306	190	180
Watauga[a]	May 2009	110	105	100

[a] Current use based on a five-year trailing average.

[b] Current use based on 2008.

[c] Current use calculated by another method.

[d] "n/a" means that the utility's plan does not report these data (Haltom City, Northlake) or that the utility does not have residents (D/FW International Airport).

The utilities in Table 7-4 comprise approximately 95 percent of the projected population of the TRWD service area over the next ten years. The population-weighted average water conservation goals for the four primary customers and their customers are less than those from the TRWD water conservation plan (Table 7-5), suggesting that the customers may be amenable to more intensive water conservation.

Table 7-5: Comparison of Water Conservation Goals

Entities	Current Use (gpcd)	5-Year Goal (gpcd)	10-Year Goal (gpcd)
TRWD[a]	184	175	166
Four Primary Customers *et al.*[b]	not estimated	166	158

[a] From the TRWD Water Conservation and Drought Contingency Plan (Ref. 3).

[b] Population-weighted average of water conservation goals from Table 7-4, using population projections from the 2011 Region C Water Plan (Ref. 1).

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8. Recycling/Reuse of Treated Wastewater Effluent

Recycling/reuse of treated wastewater effluent is an important water efficiency strategy. TRWD water reuse projects, their potential impact on water conservation, and other benefits of water reuse are presented in the following sections.

8.1. Existing and Planned Water Reuse Projects

TRWD and its four primary customers have existing and planned reuse projects, as described in the following sections.

TRWD

TRWD has amended two water rights to gain additional permitted water supply based on return flows from TRWD water customers:

- Certificate of Adjudication 08-5035, as amended, which allows diversion of return flows from the Trinity River to the George W. Shannon Wetlands Water Reuse Project (an off-channel wetland impoundment) for water quality polishing, followed by delivery of water into Richland-Chambers Reservoir in an amount sufficient to increase the yield of the reservoir by 63,000 ac-ft/yr. The first phase of the wetlands facility began operation in March 2009. Wetland operations have since been delayed during an expansion that will result in a 1,800-acre wetlands water reuse project. It is anticipated that the expansion will be completed in late 2013.
- Certificate of Adjudication 08-4976, as amended, which allows diversion of return flows from the Trinity River to an off-channel wetland impoundment for water quality polishing, followed by delivery of water into Cedar Creek Reservoir in an amount sufficient to increase the yield of the reservoir by 52,500 ac-ft/yr. The wetlands facility has not yet been constructed. The ultimate surface area will be approximately 2,000 acres.

Four Primary Customers

Fort Worth conveys up to 2 mgd of reclaimed water from its Village Creek Wastewater Treatment Plant (WWTP) to the Links at Waterchase golf course for irrigation.

Fort Worth is developing a project to deliver reclaimed water from the Village Creek WWTP to Arlington, Euless, and D/FW International Airport for non-potable uses. Reclaimed water is currently being delivered to Arlington and Euless. Delivery of water to D/FW International Airport is expected by December 2012.

In addition, Fort Worth plans to implement three more direct reuse projects (Ref. 1):

- Alliance Corridor: In partnership with TRA and Hillwood Corporation, supply reclaimed water from the TRA Denton Creek Regional Wastewater System (DCRWS) for non-potable water uses in the Alliance Airport area.
- Future Direct Reuse: Expand the direct reuse system with additional conveyance and/or treatment facilities to serve non-potable water needs in other parts of Fort Worth.
- Tarrant County Steam Electric Power: Expand the direct reuse system with additional conveyance and/or treatment facilities to serve steam electric power generation needs in Tarrant County.

TRA plans to deliver up to 7,500 ac-ft/yr from DCRWS to Grapevine Lake for subsequent diversion and municipal use in Tarrant County and up to 7,500 ac-ft/yr from DCRWS directly to irrigation users in Denton and Tarrant Counties (Ref. 1).

Grapevine discharges treated effluent from its Peach Street WWTP to Grapevine Lake. Grapevine has contracted with the Dallas County Park Cities MUD to withdraw water from Grapevine Lake for irrigation at Grapevine Municipal Golf Course and Cowboys Golf Club. The contract allows a supply amount up to the lesser of 4 mgd or the amount discharged from the Grapevine WWTP (currently about 3.3 mgd). The contract expires in September 2040, with an automatic 40 year renewal unless terminated.

The Trophy Club MUD #1 conveys reclaimed water from its WWTP to holding ponds at the Trophy Club Country Club, where the water is used for irrigation. There is no contract.

Table 8-1 presents a summary of direct and indirect recycled water projects for TRWD and its four primary customers, along with the projected water supply.

8.2. Water Conservation and Water Reuse

Water reuse projects are intended to help meet future water demands. TRWD anticipates an increase in average raw water demand (four primary customers) from 293.9 mgd in the year 2010 to 591.9 mgd by the year 2060 (Figure 5-2). Once fully implemented, the water reuse projects are projected to supply 23 to 34 percent of this raw water demand (Table 8-1).

Texas Water Code §11.002(8) defines conservation as “the development of water resources; and those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future alternative uses.” Water recycling is a water conservation strategy that reduces demand for new raw water supplies, and this efficiency should be reflected in water use statistics. The Water Conservation Implementation Task Force recommended crediting indirect reuse diversion volumes against total diversion volumes for the purpose of calculating per capita water use for targets and goals (Ref. 7).[26]

[26] Water supplied for direct, non-potable reuse is not included in the total diversion volume, so no adjustments need to be made to account for direct, non-potable reuse projects.

Table 8-1: Summary of Recycled Water Projects for TRWD and its Four Primary Customers

	Status	Type	Project Name	Projected Average Supply[a] (mgd)					
				2010	**2020**	**2030**	**2040**	**2050**	**2060**
[A]	Existing/ Future	Indirect	TRWD Richland-Chambers Reservoir Reuse	8.9	56.2	56.2	56.2	56.2	56.2
[B]	Future	Indirect	TRWD Cedar Creek Reservoir Reuse	0.0	46.8	46.8	46.8	46.8	46.8
[C]	Existing/ Future	Direct	Fort Worth Village Creek	1.4	3.1	3.1	3.1	3.1	3.1
[D]	Future	Direct	Fort Worth Alliance	0.0	1.0	4.2	4.2	4.2	4.2
[E]	Future	Direct	Fort Worth Future	0.0	0.0	3.1	7.1	7.1	7.1
[F]	Future	Direct	Tarrant County Steam Electric Power	0.0	0.0	1.4	2.1	2.1	2.1
[G]	Future	Direct	TRA Tarrant and Denton Counties Irrigation	0.0	6.7	6.7	6.7	6.7	6.7
[H]	Future	Indirect	TRA Tarrant County Municipal	0.0	6.7	6.7	6.7	6.7	6.7
[I]	Existing	Indirect	Grapevine	3.0	3.3	3.5	3.7	3.8	3.9
[J]	Existing	Direct	Trophy Club	0.7	0.7	0.7	0.7	0.7	0.7
[K]	**Projected Total Reuse**			**14.0**	**124.5**	**132.5**	**137.4**	**137.5**	**137.6**
[L]	TRWD Average Water Demand[b]			293.9	361.2	411.8	465.4	524.7	591.9
[M]	**Projected Total Reuse Percentage**			**4.8%**	**34.5%**	**32.2%**	**29.5%**	**26.2%**	**23.2%**
[N]	**Projected Indirect Reuse**			**11.9**	**113.0**	**113.3**	**113.4**	**113.5**	**113.6**
[O]	TRWD Average Water Demand Minus Direct Reuse			291.8	349.7	392.6	441.5	500.7	567.9
[P]	**Projected Indirect Reuse Percentage**			**4.1%**	**32.3%**	**28.8%**	**25.7%**	**22.7%**	**20.0%**

[a] Projected average supplies from Ref. 1.
[b] From Figure 5-2. From four primary customers.

[K] = [A] + [B] + [C] + [D] + [E] + [F] + [G] + [H] + [I] + [J]

[M] = [K]/[L]

[N] = [A] + [B] + [H] + [I]

[O] = [L] – [K] + [N]

[P] = [N]/[O]

To date, TRWD has not taken credit for indirect reuse in its per capita water use estimates. TRWD should follow the Task Force recommendation by developing water accounting procedures to track indirect reuse volumes and crediting them against per capita water use. For example, it is projected (Row [P] in Table 8-1) that 32.3 percent of the TRWD raw water supply in 2020 will consist of recycled water. Assuming that actual indirect reuse volumes confirm this projection, the 2020 TRWD per capita water use should be reduced by 32.3 percent for purposes of comparison to targets and goals.

8.3. Other Benefits

Other benefits of water recycling include:

- Since TRWD provides raw water to many customers, water recycling will broaden regional water efficiency efforts. Also, by implementing water recycling practices, TRWD is leading by example and is encouraging water efficiency practices among its clients and customers and other regional entities.
- Water recycling can help TRWD and its four primary customers avoid or defer costly potable water infrastructure expansion and will defer the need for new raw water supplies. Of the water management strategies for which costs have been developed in the 2011 Region C Water Plan (Ref. 1), the least expensive strategy is indirect water reuse (Table 5-2).
- Direct, non-potable water recycling projects often use water for irrigation and cooling purposes, reducing peak demands for potable water.
- Unlike other raw water sources, the available recycled water supply increases with population growth and increased economic activity.

9. Identification and Screening of Potential Water Conservation Measures

Potential water conservation measures were identified from numerous sources. Screening criteria were developed from the water use profile for TRWD's four primary customers (Chapter 4) to help determine which potential water conservation measures would be most effective during the next five years. TRWD staff and the consultant team screened the potential measures, selecting twenty water conservation measures for detailed evaluation of water savings, costs, benefits, staffing, and implementation issues.

9.1. Identification of Potential Water Conservation Measures

Potential water conservation measures were compiled from various sources, including recommendations by task forces and planning groups, literature sources, and successful regional water conservation programs implemented by other utilities.

Water Conservation Implementation Task Force

The Water Conservation Implementation Task Force (described in detail in Section 2.3) was assigned several tasks, including identifying, evaluating, and selecting best management practices (BMPs) for municipal, industrial, and agricultural water uses and evaluating the cost and benefits of the selected BMPs. The Task Force developed TWDB Report 362, *Water Conservation Best Management Practices Guide* (Ref. 6). This guide, released in November 2004, included twenty-two BMPs for municipal water users, fifteen BMPs for industrial water users, and twenty BMPs for agricultural water users. In the BMP Guide, each BMP's characteristics are detailed in seven subsections of applicability, description, implementation, schedule, scope, documentation, determination of water savings, cost-effectiveness considerations, and references. Municipal and industrial BMPs were considered for inclusion in the Strategic Plan.

Region C Water Planning Group Recommendations

The most recent water conservation recommendations of the Region C Water Planning Group are contained in the 2011 Region C Water Plan (Ref. 1). For TRWD's four primary customers, the plan recommended two sets of water conservation measures: the basic package and the expanded package. The conservation measures and projected water savings associated with each recommended water conservation package are described in detail in Section 2.2. These conservation measures were considered for inclusion in the Strategic Plan.

Literature Reviewed for Water Conservation Measures

Literature on water conservation measures and studies were reviewed to compile a list of measures to screen for consideration in the Strategic Plan. Some of the more extensively reviewed publications are summarized below. A complete list of references is included at the end of the plan.

Amy Vickers, Handbook of Water Use and Conservation (Ref. 22)

The *Handbook of Water Use and Conservation* is an extensive treatise on water conservation measures including discussions of applicability, efficiencies, benefits and costs, and basic steps to audit for incorporation. A number of water efficiency measures described in the handbook were included in the list of potential measures including residential/domestic toilets, urinals, showerheads, faucets, clothes washers, and dishwashers; water-wise landscape, native and low-water turf and plants, practical turf areas, irrigation systems and devices, irrigation scheduling, soil improvements, mulches, efficient landscape maintenance, and water decorations and fountains; and ICI metering and submetering, cleaning and sanitation, process water uses, commercial kitchens and restaurants, laundries and laundromats, swimming pools and zoos, cooling and heating systems, leaks and water losses, and maintenance practices for ICI water efficiency.

Texas Water Development Report 362, Water Conservation Best Management Practices Guide (Ref. 6)

The Water Conservation Implementation Task Force developed TWDB Report 362, *Water Conservation Best Management Practices Guide* (Ref. 6). This guide, released in November 2004, included twenty-two best management practices (BMPs) for municipal water users, fifteen BMPs for industrial water users, and twenty BMPs for agricultural water users. Report 362 provides an evaluation of water savings, costs, and benefits from these BMPs.

California Urban Water Conservation Council, Various Publications

The California Urban Water Conservation Council has produced several studies and reports on water conservation measures including Programmatic BMP: Commercial, Industrial, and Institutional (Ref. 23) and Memorandum of Understanding Regarding Urban Water Conservation in California (Ref. 24).

U.S. Environmental Protection Agency, Water Conservation Plan Guidelines (Ref. 25)

In 1998, the U.S. Environmental Protection Agency published guidelines for water utilities to use in preparing a water conservation plan. This document is organized into basic, intermediate, and advanced guidelines, based on the population served by a water utility, and provides information about the nature and possible use of the measures.

Review of Water Conservation Programs in Other Cities

An evaluation of nine U.S. regional water conservation programs was conducted to learn from their program approaches and results with water-saving technologies, measures, and policies. The nine programs are:

- Contra Costa Water District (Contra Costa County, California)
- Denver Water (Denver, Colorado)
- Lower Colorado River Authority (Austin, Texas)

- Metropolitan North Georgia Water Planning District (Atlanta, Georgia)
- North Texas Municipal Water District (Wylie, Texas)
- Regional Water Providers Consortium (Portland, Oregon)
- South Florida Water Management District (South Florida)
- Southern Nevada Water Authority (Las Vegas, Nevada)
- Western Municipal Water District (Riverside, California)

Findings on program planning, implementation, and management; program effectiveness; stakeholder involvement; and other topics are presented in Appendix D. The agencies that have achieved the most significant long-term water savings share the following characteristics:

- They are more active than the other agencies, operating and funding regional incentive programs in addition to regional public education programs.
- They commit the largest annual conservation budgets and staffs.
- Their conservation measures address a variety of water uses.

Measures implemented by the nine regional water conservation programs were considered as potential conservation measures for TRWD.

Potential Water Conservation Measures

Potential water conservation measures were compiled from various sources discussed previously in this chapter – recommendations by task forces and planning groups, literature sources, and programs implemented in other cities that have successful water conservation programs. The list of potential water conservation measures is presented in Appendix E. This comprehensive list of measures was screened for applicability to TRWD and other factors, as described in Section 9.2.

9.2. Screening of Potential Water Conservation Measures

This section discusses screening of potential water conservation measures to generate a list of measures for which a detailed evaluation will be performed (in Chapter 10).

Screening Criteria

Based on the water use profile developed in Chapter 4 for TRWD's four primary customers, screening criteria were developed to help identify water conservation measures that should be evaluated in greater detail. To the extent feasible, selected measures should:

- Have the potential for:
    - Large water savings.
    - Efficient, low-cost implementation.
    - Public acceptance.
    - Regional cooperation.

  - Cost-sharing with other utilities, government programs, and industry programs.
- Target:
  - High-water-use customers (e.g., the top twenty-five percent of residential customers and the top one to ten percent of ICI customers). Although individual retail customer information was not available for the water use analysis in Chapter 4, the top ICI customers often use water for cooling, industrial and food processing, irrigation, medical and dental equipment, and plumbing fixtures.
  - Outdoor water use.
  - High profile ICI properties for landscape and irrigation-related water conservation measures, such as city parks, golf courses, and large frontage properties with heavy irrigation. Native and drought-tolerant plantings and efficient irrigation methods at these sites offer significant public education benefits.
- Be applicable and practical for TRWD and its four primary customers. Characteristics of individual measures that are favorable or challenging for implementation were developed from the Water Conservation Implementation Task Force's Water Conservation Best Management Practices Guide (Ref. 6) and are presented in Appendix F.
- Be based on proven methods and technologies (as compared to measures that lack reliable water savings data). A water conservation measure under consideration should usually only be adopted into a plan and program if there are solid case examples and other data to support the utility's investment.

Selection of Measures for Detailed Evaluation

Based on the potential water conservation measures and the screening criteria, TRWD staff and the consultant team screened the potential measures, selecting twenty water conservation measures for detailed evaluation of water savings, costs, benefits, staffing, and implementation issues. The measures selected for detailed evaluation are listed in Table 9-1, and the measures are defined in Table 9-2.

Existing Measures Selected for Evaluation of Additional Savings

Two of the selected measures have already been implemented but are projected to lead to additional water savings during the next five years through natural replacement of high-water use fixtures and appliances:

- House Bill 2667 (Table 2-1) phases in a requirement by 2014 that all new toilets for sale in Texas be high-efficiency toilets (HETs) that use a maximum of 1.28 gallons per flush.
- All residential and commercial clothes washers manufactured after January 1, 2011 must have a water factor (WF) ≤ 9.5 gallons per cycle per cubic foot. The Department of Energy has scheduled progressively more restrictive standards on clothes washer water use over the next several years (Figure 9-1).

Table 9-1: Water Conservation Measures Selected for Detailed Evaluation

Measure		Customer Type				Use Type		Measure Type			
		SF	MF	ICI	Municipal/ Utility	Indoor/ Base	Outdoor/ Seasonal	Education/ Outreach	Rebate/ Incentive	Regulation	Other
1	High-efficiency toilet (HET) distribution/incentives	✓	✓	✓		✓			✓		
2	Toilets, natural replacement with HETs	✓	✓	✓		✓				✓	
3	High-efficiency clothes washer (HECW) incentives	✓	✓	✓		✓			✓		
4	Residential clothes washers, natural replacement with HECWs	✓	✓			✓				✓	
5	Pre-rinse spray valve retrofits			✓		✓			✓		
6	ICI customer water audits			✓		✓		✓			
7	Site-specific ICI incentives			✓		✓	✓		✓		
8	Cooling tower incentives			✓			✓		✓		
9	ICI recognition program			✓		✓	✓	✓			
10	Irrigation system evaluations	✓	✓	✓			✓	✓			
11	Irrigation system incentives	✓	✓	✓			✓		✓		
12	Rainwater harvesting incentives	✓	✓	✓			✓		✓		
13	Irrigation limits: maximum 2 times per week	✓	✓	✓			✓	✓		✓	
14	Public education (ET irrigation recommendations)	✓	✓	✓			✓	✓			
15	Golf course conservation and reuse			✓	✓		✓	✓			
16	Model landscape ordinance	✓	✓	✓	✓		✓	✓		✓	
17	Water loss reduction				✓	✓		✓			
18	Water use reduction due to increases in real water price	✓	✓	✓		✓	✓				✓
19	Wholesale customer assistance	✓	✓	✓		✓	✓		✓		
20	Model conservation ordinance	✓	✓	✓	✓	✓	✓	✓		✓	
	NUMBER OF MEASURES	13	13	18	4	12	13	9	8	5	1

SF = Single-family residential
MF = Multi-family residential
ICI = Industrial, commercial, and institutional

Table 9-2: Descriptions of Water Conservation Measures Selected for Detailed Evaluation

	Measure	Description
1	High-efficiency toilet (HET) distribution/incentives	Provide incentives to replace existing residential and commercial toilets that use 3.5 gallons per flush or more with HETs that use 1.28 gallons per flush or less. Use elements of the Fort Worth and Arlington toilet distribution programs.
2	Toilets, natural replacement with HETs	Older toilets use 3.5 gallons per flush (gpf) or better. In 1992, the National Energy Policy Act required that toilets manufactured after January 1, 1994 cannot use more than 1.6 gallons per flush (gpf). In 2009, the Texas Legislature (HB 2667) further required that toilets sold or distributed in Texas by 2014 cannot use more than 1.28 gpf. The natural replacement of inefficient toilets has been occurring and will continue to occur without TRWD action, but TRWD should account for the projected water savings.
3	High-efficiency clothes washer (HECW) incentives	Provide incentives to replace existing residential and commercial clothes washers with HECWs having modified energy factor (MEF) ≥ 2.2 and water factor (WF) ≤ 4.5 gallons/cycle/ft^3. HECWs use up to sixty percent less water than conventional machines. Since clothes washers use hot water, there may be an opportunity to partner with gas and electric utilities. Contra Costa Water District and Denver Water have HECW incentive programs.
4	Residential clothes washers, natural replacement with HECWs	All manufactured residential and commercial clothes washers manufactured after January 1, 2011 must have a water factor (WF) ≤ 9.5 gallons per cycle per cubic foot. The Department of Energy has scheduled progressively more restrictive standards on clothes washer water use over the next several years (Figure 9-1). Natural replacement of inefficient residential clothes washers will occur without TRWD action, but TRWD should account for the projected water savings.
5	Pre-rinse spray valve retrofits	Pre-rinse spray valves (PRSVs) are used in restaurants/food service operations to remove food from dishes and silverware before dishwashing. Replace existing PRSVs that use 3 gallons per minute or more with efficient PRSVs that use 1.6 gallons per minute or less. Use elements of Fort Worth SpraySmart program.

Table 9-2 Continued: Descriptions of Water Conservation Measures Selected for Detailed Evaluation

Measure		Description
6	ICI customer water audits	A TRWD auditor (or contractor) would visit an ICI establishment with facility personnel; review end uses of water; identify potential water-efficiency improvements and potential costs; directly install small, low-cost devices as appropriate; document the audit findings; inform the company of applicable TRWD and/or city water conservation programs; and follow up with the company to track implementation of the recommendations. The ICI customer water audit would be conducted at no cost to the customer. Use elements of the Fort Worth SmartWater Audit Program.
7	Site-specific ICI incentives	Provide site-specific incentives for ICI customers to install water-efficient equipment or recycle water. The incentive would likely rebate a percentage of the cost of the improvements. Candidate water uses could include cooling processes, plumbing fixtures, laundry processing, medical/dental devices, landscape irrigation, rainwater harvesting, etc. Candidate facilities could include office buildings, hotels/motels, restaurants, grocery stores, laundromats, schools, manufacturers, food processing, and parks/golf courses. ICI customers would propose water-efficiency improvements and project the associated water savings and costs. After review of the proposal, TRWD could agree to fund a portion of the cost (up to a maximum amount per customer). The customer would install/upgrade the approved equipment. Upon confirmation of installation, TRWD would rebate a portion of the measure costs. There may be an opportunity to partner with energy utilities and green building organizations. Denver Water and Southern Nevada Water Authority have site-specific ICI incentive programs.
8	Cooling tower incentives	Cooling towers recirculate cooling water for a number of cycles before disposal of the water. Provide incentives for ICI customers to install equipment (makeup and blowdown meters, conductivity controllers, pH controllers, etc.) that lead to 5 cycles or more and reduced cooling water use. Denver Water has a cooling tower incentive program.
9	ICI recognition program	Recognize ICI customers that meet certain water conservation criteria. Recognition could take many forms, including public commendation and using TRWD's water conservation web site to promote the customer's water-saving achievements and offer coupons to the customer's business. South Florida Water Management District and Southern Nevada Water Authority have ICI recognition programs that target hotels/motels, green buildings, new homes, and car washes.

Table 9-2 Continued: Descriptions of Water Conservation Measures Selected for Detailed Evaluation

Measure		Description
10	Irrigation system evaluations	Visit a residence or ICI customer and evaluate the customer's irrigation system. Suggest optimal controller settings and identify the following: • Broken, misaligned, or leaking heads • Pressure and low flow issues • Distribution uniformity issues • Water waste • Other inefficiencies The irrigation system audit would be conducted at no cost to the customer. Use elements of the Fort Worth Smart Irrigation Program.
11	Irrigation system incentives	Provide incentives to residential and ICI customers to retrofit their existing irrigation systems with water-conserving equipment. Qualifying equipment may include rain and freeze sensors, drip irrigation equipment, spray heads with greater distribution uniformity, weather-based irrigation controllers, and other devices. The City of Austin, Contra Costa Water District, Southern Nevada Water Authority, Denver Water, and Western Municipal Water District have irrigation system incentive programs.
12	Rainwater harvesting incentives	Provide incentives to residential and ICI customers to install and use equipment to capture rainfall from rooftops and use the water for non-potable purposes, including irrigation, car-washing, and toilet flushing. The City of Austin offers rainwater harvesting incentives.

Table 9-2 Continued: Descriptions of Water Conservation Measures Selected for Detailed Evaluation

Measure		Description
13	Irrigation limits: maximum 2 times per week	In coordination with the wholesale customers, develop an ordinance that limits irrigation to a maximum of two times per week, year-round, and encourage the customers to adopt the ordinance. A twice-weekly irrigation limitation will reduce over-irrigation but will allow customers to meet plant needs. South Florida Water Management District and Lower Colorado River Authority limit irrigation to two times per week (year-round for SFMWD and summer for LCRA's West Travis County Regional Water System). Denver Water limits irrigation to three times per week but recommends a maximum of two times per week. In 2008, the City of Austin implemented permanent twice-weekly irrigation limits that apply to ICI and multi-family customers year-round and apply to single-family residents in the summer (Ref. 26). In 2012, the City of Austin extended the twice-weekly irrigation limits to be year-round for all customers (Ref. 27). Additional information about twice-weekly irrigation limits is presented in Appendix G.
14	Public education (ET irrigation recommendations)	Based on local rainfall and evapotranspiration data, recommend weekly irrigation amounts. Translate the irrigation amount into watering durations for different types of irrigation equipment. Publicize the recommendations with weekly emails, web site updates, television weather reports, and newspaper features.
15	Golf course conservation and reuse	Recognize golf courses that achieve certain levels of water conservation and publicize their accomplishments. Water conservation achievements may include limiting irrigation to a percentage of plant evapotranspiration requirements, developing water budgets, conducting irrigation system evaluations, tracking and reporting monthly water use, installing an irrigation meter and rain sensors, designating priority areas requiring irrigation, following daily watering times, developing a drought management plan, using reclaimed water, improving soils, native/drought-tolerant landscaping in non-course areas, using zoned irrigation, not watering rough areas, and other measures. The program could also incorporate water quality and wildlife habitat and open space criteria. The San Antonio Water System has a similar golf course conservation program (Golf Fore SA). In the absence of the golf course conservation measure, some existing golf courses have converted from using raw or potable water to using reclaimed water (Section H.15 of Appendix H). This will continue to occur without TRWD action, but TRWD should account for the projected water savings. In the remainder of this report, this is called golf course reuse - natural implementation.

Table 9-2 Continued: Descriptions of Water Conservation Measures Selected for Detailed Evaluation

<table>
<tr><th colspan="2">Measure</th><th>Description</th></tr>
<tr><td>16</td><td>Model landscape ordinance</td><td>In coordination with the wholesale customers, develop a model landscape ordinance and encourage the customers to adopt the ordinance. The model landscape ordinance could include the following elements for new construction:

• Limit on turf areas in all new landscapes. Turf grass requires more water than native grasses and low-water-use plants.
• Requirement for low-water-use landscaping in other areas.
• Minimum soil depths and soil amendments. Soil that retains water increases irrigation efficiency.
• Turf grass summer dormancy capability.
• Other.

In 2002 the City of El Paso limited turf grass in new construction to 50 percent (residential property) or 33.3 percent (commercial property) of the total landscaped area (front and back yards) (Ref. 28).

In 2006, the California Legislature passed the Water Conservation in Landscaping Act, which required cities and counties to adopt landscape ordinances by January 1, 2010. In 2009, the California Department of Water Resources developed a Model Water-Efficient Landscape Ordinance (MWELO) (Ref. 29). Local agencies can either adopt the MWELO or adopt a landscape ordinance that is at least as effective in conserving water.

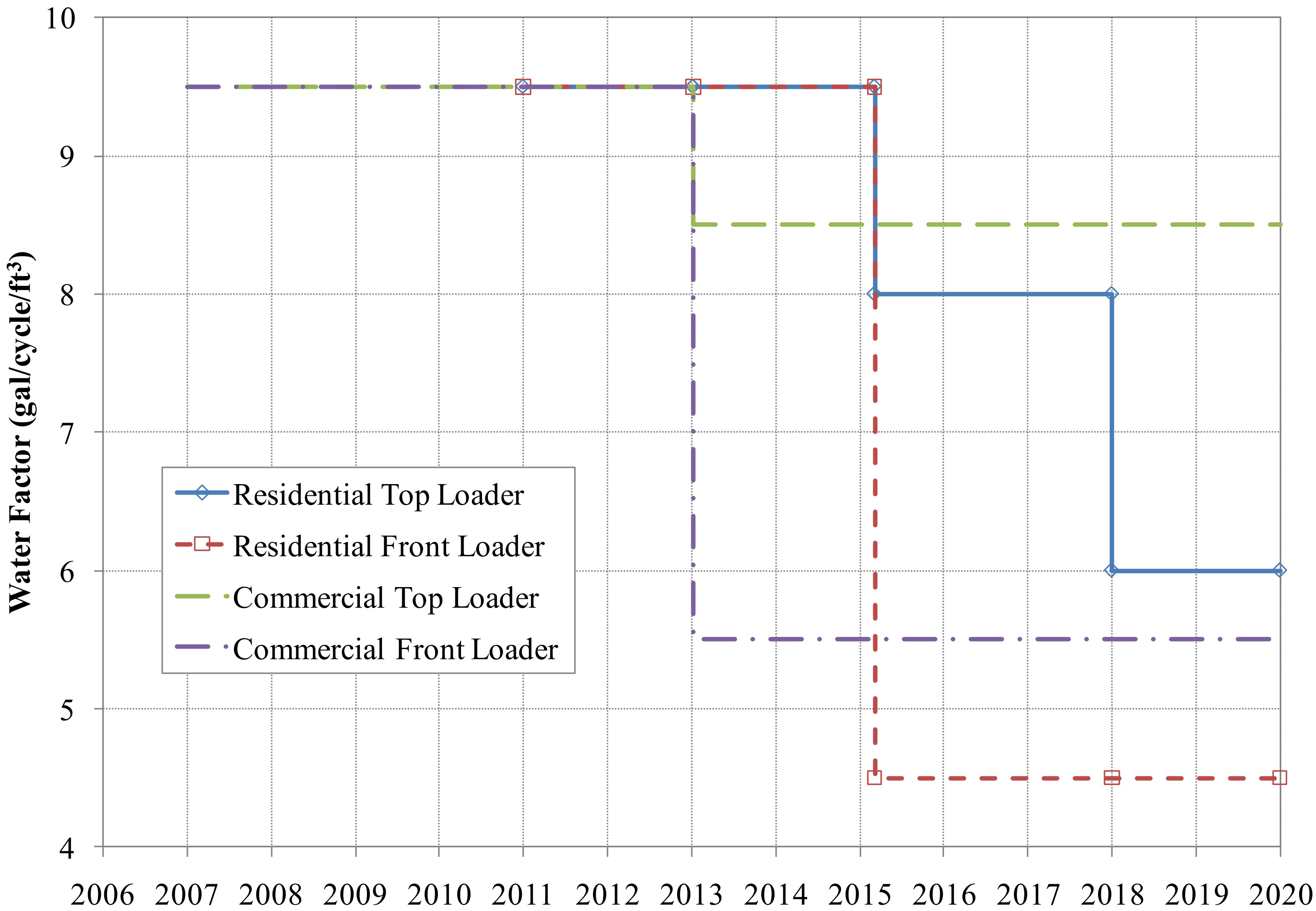
Denver Water requires soil amendments, and Southern Nevada Water Authority customers are subject to turf grass limitations.</td></tr>
<tr><td>17</td><td>Water loss reduction</td><td>To minimize water loss, invite customers to workshops on conducting regular water system audits, developing and tracking performance indicators, improving validation of water loss performance data, conducting active leak detection, and speeding up needed repairs. TRWD would encourage its customers to perform these actions for their water systems and would request periodic water loss reports. South Florida Water Management District, Metropolitan North Georgia Planning District, Contra Costa Water District, and Denver Water have implemented water loss reduction programs.</td></tr>
</table>

Table 9-2 Continued: Descriptions of Water Conservation Measures Selected for Detailed Evaluation

Measure		Description
18	Water use reduction due to increases in real water price	It is anticipated that TRWD's future additional water sources will be more expensive in real terms than its existing water supply. Water use is somewhat elastic, meaning that an increase in the real water price will result in less water use. This reduction in water use will occur without TRWD action, but TRWD should account for the projected water savings.
19	Wholesale customer assistance	Provide incentives for wholesale customers to develop water conservation measures that are tailored for their local service areas. The Lower Colorado River Authority is planning a similar measure.

20	Model water conservation ordinance	In coordination with the wholesale customers, develop a model water conservation ordinance and encourage the customers to adopt the ordinance. Among other requirements, the model ordinance could include:
		
		• Annual irrigation system analysis for athletic fields, golf courses, large users, and large properties.
		• Commercial dining facility requirements:
		    o Serve water only upon request
		    o Positive shutoff on pre-rinse spray wands
		    o Flow restrictors for garbage disposals
		• Minimum number of cycles for cooling tower operation
		    o More stringent standard if potable water is used for makeup water.
		    o Less stringent standard if recycled water is used for makeup water.
		• Condensate collection for new construction
		
		The San Antonio Water System has implemented a water conservation ordinance that contains these and other requirements (Ref. 30).

Figure 9-1: Standard Size Residential and Commercial Clothes Washer Standards



Existing Measures Not Evaluated

In recent years, both the Texas Legislature and the federal government have promulgated significant water conservation legislation. A summary of recent Texas water conservation legislation is presented in Table 2-1. An example of a new federal rule is the new standard for water use in residential dishwashers.[27] With the exception of new toilet and residential clothes washer standards, as discussed above, water savings from recent water conservation legislation have not been evaluated and are not included in the projected water savings in Chapter 10. However, it is expected that TRWD will realize additional, unquantified water savings from the recent legislation.

[27] The federal Energy Independence and Security Act of 2007 specified that "standard size" dishwashers manufactured on or after January 1, 2010 must not have water use of more than 6.5 gallons per cycle.

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10. Detailed Evaluation of Water Conservation Measures

The detailed evaluation of the selected water conservation measures (Table 9-2) considers TRWD's water conservation goals for the next five years and potential five-year water savings, benefits, costs, and feedback from customer cities.[28]

Measures may be combined for ease of implementation (see the recommended implementation plan in Chapter 11), but each selected conservation measure is evaluated individually in this chapter.

10.1. Water Conservation Goals

The goals of the Strategic Plan are to:

- Develop and implement water conservation programs aimed at:
  - Decreasing per capita water use (gpcd)
  - Reducing seasonal peak demands
  - Reducing water loss and waste
- Target an average one percent per year reduction in the five-year average per capita consumption for the five-year planning period (Figure 10-1).[29] This results in an 8.6 gpcd reduction over five years. This target is exclusive of any credit for indirect reuse diversion volumes (see Section 8.2). This goal is consistent with the recommendations of the statewide Water Conservation Implementation Task Force (Ref. 7) and with TRWD's published 2018 water use goal of 166 gpcd (Table 6-1 and Ref. 3).
- Continue a heightened public awareness of water conservation in the TRWD service area and the North Texas region.
- Continue and enhance conservation practices that will maintain quality of life and allow economic growth and development.
- Continue to include broad-based public and private stakeholder groups in new program development and implementation processes.
- Continue to lead by example by upgrading TRWD facilities with water-efficient fixtures, landscapes, and irrigation systems wherever possible.
- Assist in facilitating regional conservation efforts among TRWD customer cities.
- Establish the foundation for continuation of water savings targets for the following five-year period and succeeding five-year intervals.

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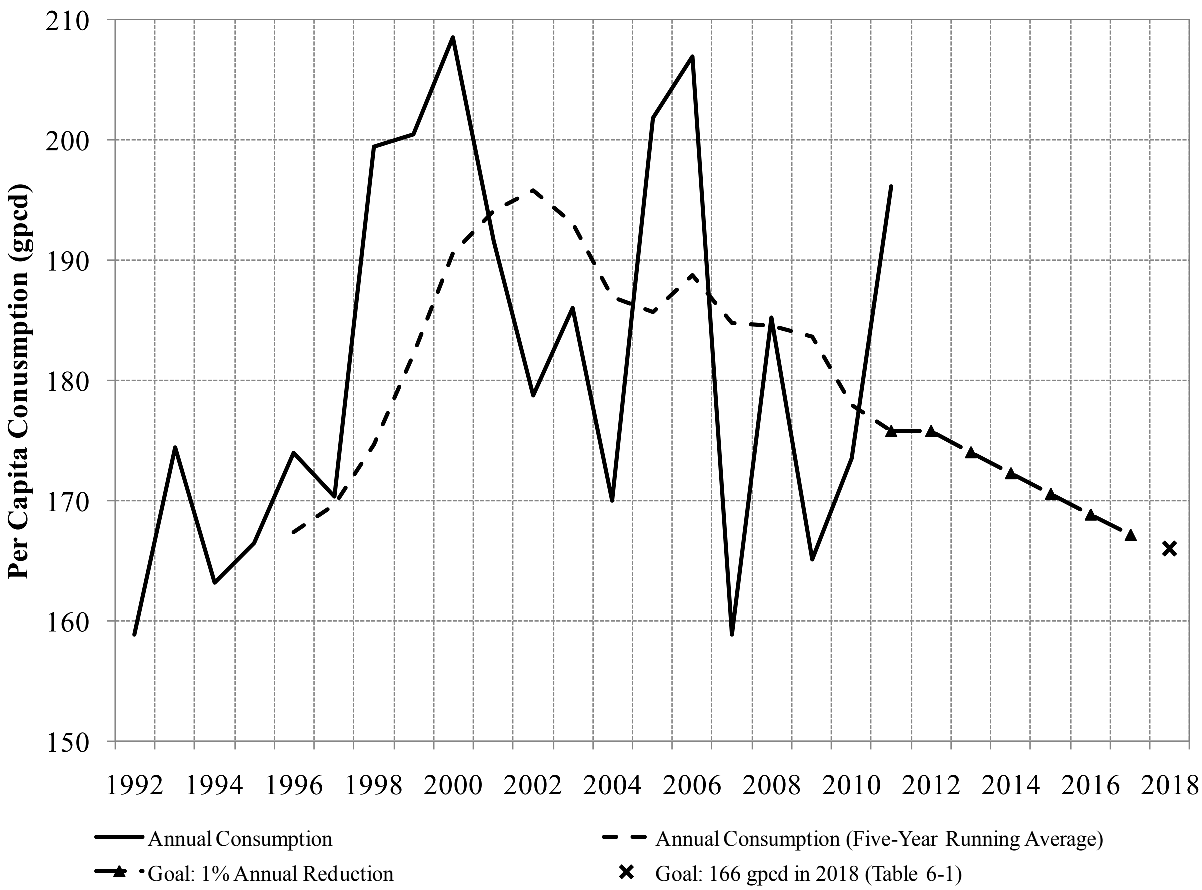
[28] "Evaluated" water conservation measures are the 20 measures that have been selected for detailed evaluation (discussed in Chapter 10). "Recommended" water conservation measures are those that are recommended for implementation during the next five years (discussed in Chapter 11).

[29] Assumes that existing water conservation measures will maintain the existing five-year average per capita water consumption until 2013, when the first recommended water conservation measures from this Strategic Plan will be implemented.

Figure 10-1: Per Capita Water Consumption Goals



10.2. TRWD's Role in the Regional Water Conservation Program

For any given water conservation measure, TRWD's role in the regional water conservation program will affect the potential water savings, benefits, costs, and TRWD staffing requirements. As a wholesale raw water provider with no retail customers, TRWD could act in one or more of the following beneficial roles (* indicates that TRWD is currently active or has been active in a particular role):

- Planner/coordinator for primary customers:
  - Coordinate development of a strategic water conservation plan. (*)
  - Coordinate development of water conservation measures.
  - Coordinate development of water conservation goals.
  - Coordinate development of water conservation ordinances. (*)
  - Conduct regular customer meetings for sharing of water conservation information. (*)

- Technical resource:
  - Based on TRWD staff experience, provide water conservation expertise to the customers as they implement water conservation.
  - Bring experts to symposia and training sessions. (*)
  - Conduct research on water conservation topics that are relevant and important to implementation of future water conservation measures.
- Funding provider:
  - Develop a funding mechanism and provide funding to customers for water conservation measure implementation.
  - Solicit state and federal appropriations and grants.
- Measure operator:
  - Develop and operate public education and recognition programs. (*)
  - Develop and operate rebate/incentive programs.
  - Retain outside contractors to assist with conservation measures where advantageous. (*)

Historically, TRWD has focused its water conservation efforts on public education programs and encouraging customers to adopt time-of-day irrigation limitations. Review of other regional water conservation programs (Appendix D) indicates that the regional water providers that have achieved the most significant long-term water savings operate regional incentive programs in addition to regional public education programs and make the regional water conservation measures available to all customers in the retail and wholesale service areas.

Centralized operation of regional water conservation measures has the following advantages over each customer operating its own measures:

- Conservation measures could be made available to all retail customers, leading to greater participation and greater water savings.
- Customer eligibility and participation requirements would be consistent throughout the service area. This consistency would avoid retail customer confusion and make it easier to educate the public about available water conservation programs.
- Implementation methods would be consistent throughout the service area.
- There could be economies of scale in purchasing water conservation equipment and staffing the water conservation program.
- Tracking of implementation throughout the service area would be easier.

Disadvantages include:

- Forging financial arrangements with the primary customers to fund water conservation measures may present challenges.
- Retail customers may be confused about the relationship of multiple water agencies, particularly for measures that require site visits (e.g., “I buy water from the City of Hurst

– who is the Tarrant Regional Water District, and why are they performing my irrigation system evaluation?").

- Primary customers (and/or their wholesale customers) may perceive a loss of autonomy in addressing water conservation.
- Direct access to retail customer billing records is not currently available. This can make targeting water conservation measures and confirming water savings more difficult.

10.3. Basis for Evaluation

The main purposes of this Strategic Plan are to recommend water conservation measures that TRWD should pursue in the next five years and to present an implementation plan for the recommended measures. The detailed evaluation of water savings, benefits, and costs is intended to show the impacts from five years of implementation of the evaluated strategies. Assumptions include:

- TRWD will directly operate each measure using either TRWD staff or a contractor.
- TRWD and/or its wholesale customers will fund the measures for five years.
- In general, costs for implementing the measures beyond the first five years are not considered. The exception is that the regulatory measures (twice-weekly irrigation limits, model landscape ordinance, and model conservation ordinance) are considered permanent, and the wholesale customers will continue to enforce the resulting regulations indefinitely.
- Measures with effective lives longer than five years (e.g., irrigation system incentives, with a measure life of ten years) will continue to accrue benefits beyond the five years of funding and implementation. In particular, the regulatory measures and the passive measures (natural replacement of toilets, natural replacement of clothes washers, natural conversion of golf course irrigation from raw or potable water to reclaimed water, and water use reduction in response to real price increases) will continue to accrue benefits indefinitely.

In addition, to prevent overlap in the savings, benefits, and costs for the evaluated measures, the following assumptions were made:

- An ICI water audit is performed before a customer is eligible to participate in the ICI site-specific incentives measure.
- The model water conservation ordinance will require all cooling towers to operate at 4 or more cycles of concentration and will require conductivity controllers, makeup water meters, and blowdown meters.
- Cooling tower incentives are only available to existing cooling towers without conductivity controllers. Customers that receive cooling tower incentives are assumed to operate their cooling towers at five cycles of concentration.

10.4. Potential Water Savings from Evaluated Water Conservation Measures

Water savings for each evaluated water conservation measure are projected based on full implementation of each measure during the five-year planning period. Water savings assumptions are presented in Appendix H and supporting information about water savings from twice-weekly irrigation limits during Stage 1 drought response is presented in Appendix I. Participation assumptions and water savings projections are presented in the following sections.

The projected water savings for each measure are based on the experience of other utilities and benchmark data. As such, they are estimates, and actual water savings will vary. Some customers will realize greater water savings, while others will realize less due to a number of variables that affect individual water use.

Program Participation

Program participants are retail customers within the TRWD service area who can reasonably be expected to adopt the water conservation measures. Five-year customer participation targets were set for each of the measures based on a combination of factors, including:

- Participation levels achieved by other water utilities for similar programs,
- Net water savings per account for the strategy,
- Water savings required to meet the revised per capita consumption goal.

For each measure, the projected numbers of new customer participants (Table 10-1) must be achieved to realize the water savings described below. The effective number of participants in each year is shown in Table 10-2. Once implemented, a measure is effective until it passes its effective measure life or until it would have been implemented without an active conservation program (e.g., natural replacement of toilets).

The projected numbers of participants (Table 10-1) are not adjusted for freeriders. Freeriders are customers who participate in an incentive-based water conservation strategy, such as efficient clothes washer or HET rebate programs, but who would have purchased an efficient clothes washer or HET even if a rebate had not been available to defray the cost of the purchase. It is difficult to estimate reliably the number or percentage of freeriders for a given strategy. Program participation rules can be tightened to minimize the impact of freeriders.

Most measures will be available to all customers, but some measures will be specifically targeted at high water users, new construction, or other subgroups with high water savings potential. For example, ICI customer water audits will be available to all ICI customers; however, customers in the top 10 percent of ICI water users will be targeted more aggressively to engage their participation in the program, because their potential for water savings is higher than the average ICI customer. High water-using customers are expected to be interested in participating in the program since their potential for cost savings is also high.

Table 10-1: Projected New Participants

Water Conservation Measures		Sector	Projected New Participants					Units	Target Market
			Year 1	Year 2	Year 3	Year 4	Year 5		
1	Toilet retrofits	SF+MF[a]	10,000	10,000	10,000	10,000	10,000	Toilets	Old toilets
		ICI	1,000	1,000	1,000	1,000	1,000	Toilets	Old toilets
2	Toilet natural replacement	SF+MF	20,207	20,207	20,207	20,207	20,207	Toilets	Old toilets
		ICI	1,339	1,339	1,339	1,339	1,339	Toilets	Old toilets
3	Clothes washer retrofits	SF	3,000	3,000	3,000	3,000	3,000	Clothes washers	Old clothes washers
		MF+ICI	1,000	1,000	1,000	1,000	1,000	Clothes washers	Old clothes washers
4	Clothes washer natural replacement	SF	30,815	30,922	30,587	29,861	28,794	Clothes washers	Old clothes washers
5	Pre-rinse spray valve retrofits	ICI	66	32	15	7	3	PRSVs	Old PRSVs
6	ICI customer water audits	ICI	92	94	96	98	100	Accounts	Top 10%
7	Site-specific ICI incentives	ICI	37	38	38	39	40	Accounts	Top 10%
8	Cooling tower incentives	ICI	42	42	42	42	42	Accounts	Existing cooling towers
9	ICI recognition program	ICI	39	39	39	39	42	Accounts	All
10	Irrigation system evaluations	SF	2,869	2,929	2,990	3,052	3,116	Accounts	Top 25%
		MF+ICI	413	421	430	439	448	Accounts	Top 50%[b]
11	Irrigation system incentives	SF	1,468	1,527	1,589	1,654	1,721	Spray heads	Existing irrigation systems
		SF	5,738	5,858	5,980	6,104	6,232	rain/freeze sensors	Existing irrigation systems
		MF+ICI	106	110	114	119	124	WBICs[c]	Existing irrigation systems
		MF+ICI	826	844	861	879	898	rain/freeze sensors	Existing irrigation systems
12	Rainwater harvesting incentives	SF	93	95	97	99	101	Accounts	New construction
		MF+ICI	7	7	7	7	7	Accounts	New construction
13	Irrigation limits 2/wk	SF+MF+ICI	90%	90%	90%	90%	90%	Accounts	All
14	Public education ET	SF+MF+ICI	12,303	12,559	12,821	13,088	13,360	Accounts	All
15	Golf course conservation	ICI	1	1	1	1	1	Golf courses	Golf courses
15	Golf course reuse (natural implementation)	ICI	2	0	0	0	0	Golf courses	Golf courses
16	Model landscape ordinance	SF+MF+ICI	75%	75%	75%	75%	75%	New landscapes	New landscapes
17	Water loss reduction	Wholesale	25%	25%	25%	25%	25%	Wholesale customers	Wholesale customers
18	Water use reduction – price	SF+MF+ICI	All	All	All	All	All	Customers	All
19	Wholesale customer assistance	Wholesale	5	5	5	5	5	Wholesale customers	Wholesale customers
20	Model conservation ordinance	SF+MF+ICI	50%-75%	50%-75%	50%-75%	50%-75%	50%-75%	Applicable accounts	Large property irrigation systems, dining facilities, all cooling towers, new construction

[a] SF = single-family residential, MF = multi-family residential, and ICI = industrial, commercial, and institutional.

[b] Targeting Top 50% to prevent overlap with large property irrigation analysis in the model conservation ordinance. If the model conservation ordinance is not implemented, this should be revised to target the Top 25% of MF and ICI customers.

[c] WBIC = weather-based irrigation controller.

Table 10-2: Projected Effective Participants

	Water Conservation Measures	Sector	Measure Life (yrs)	Projected Effective Participants[a] Year 1	Year 2	Year 3	Year 4	Year 5	Units
1	Toilet retrofits	SF+MF	25	6,830	13,660	20,490	27,320	34,150	toilets
		ICI	25	794	1,588	2,382	3,176	3,970	toilets
2	Toilet natural replacement	SF+MF	n/a	20,207	40,413	60,620	80,826	101,033	toilets
		ICI	n/a	1,339	2,678	4,016	5,355	6,694	toilets
3	Clothes washer retrofits	SF	13	2,700	5,400	8,100	10,800	13,500	clothes washers
		MF+ICI	8	900	1,800	2,700	3,600	4,500	clothes washers
4	Clothes washer natural replacement	SF	n/a	30,815	61,737	92,324	122,185	150,979	clothes washers
5	Pre-rinse spray valve retrofits	ICI	5	60	72	66	54	42	PRSVs
6	ICI customer water audits	ICI	5	92	186	282	380	480	accounts
7	Site-specific ICI incentives	ICI	5	37	75	113	152	192	accounts
8	Cooling tower incentives	ICI	10	34	67	101	134	168	accounts
9	ICI recognition program	ICI	5	39	78	117	156	198	accounts
10	Irrigation system evaluations	SF	3	2,869	5,798	8,788	8,971	9,158	accounts
		MF+ICI	3	413	834	1,264	1,290	1,317	accounts
11	Irrigation system incentives	SF	10	1,321	2,696	4,126	5,614	7,163	spray heads
		SF	10	5,165	10,437	15,819	21,313	26,921	rain/freeze sensors
		MF+ICI	10	95	194	297	404	516	WBICs[b]
		MF+ICI	10	743	1,503	2,278	3,069	3,877	rain/freeze sensors
12	Rainwater harvesting incentives	SF	15	84	169	257	346	437	accounts
		MF+ICI	15	6	13	19	25	32	accounts
13	Irrigation limits 2/wk	SF+MF+ICI	1	90%	90%	90%	90%	90%	accounts
14	Public education ET	SF+MF+ICI	1	12,303	12,559	12,821	13,088	13,360	accounts
15	Golf course conservation	ICI	1	1	2	3	4	5	golf courses
15	Golf course reuse (natural implementation)	ICI	n/a	2	2	2	2	2	golf courses
16	Model landscape ordinance	SF+MF+ICI	10	75%	75%	75%	75%	75%	new landscapes
17	Water loss reduction	Wholesale	1	25%	25%	25%	25%	25%	wholesale customers
18	Water use reduction – price	SF+MF+ICI	n/a	all	all	all	all	all	customers
19	Wholesale customer assistance	Wholesale	5	5	10	15	20	25	wholesale customers
20	Model conservation ordinance	SF+MF+ICI	1	50%-75%	50%-75%	50%-75%	50%-75%	50%-75%	applicable accounts

[a] The number of effective participants is the sum of new and previous participants minus those that have passed their effective measure life or would have been naturally replaced.

[b] WBIC = weather-based irrigation controller.

Potential Five-Year Water Savings

Assuming that all evaluated measures are implemented and fully funded for a five-year period, the potential five-year water savings are shown in Table 10-3. The potential water savings are based on customer participation, measure life, target customer markets, and water savings assumptions described in Appendix H. The three active measures that are projected to yield the greatest water savings in Year 5 are twice-weekly irrigation limits, wholesale customer water loss reduction, and the model conservation ordinance.

Potential Long-Term Water Savings

Assuming that no additional funding is provided for the evaluated measures after five years, many of the measures will continue to save water beyond the five-year period:

- Incentive measures will continue to provide water savings for the balance of their effective lives.
- Ordinance measures will provide water savings that continue to grow along with the population.

Based on funding all evaluated measures for an initial five-year period, the potential water savings through 2060 are 2,842,871 acre-feet (Table 10-3).

Potential Per Capita Water Savings

When the potential five-year water savings are normalized by population, the potential per capita water savings can be compared to the water use reduction goal (Table 10-4). In the fifth year, the passive measures alone are projected to achieve about 80 percent of the water conservation goal. Fifth year per capita water savings are shown graphically in Figure 10-2.

10.5. Benefit-Cost Analysis

For a water conservation program to be feasible, the net unit cost of the water saved (program unit cost minus program unit benefit) must be less than other water supply alternatives. In this section, the potential benefits and potential costs of the evaluated water conservation measures are quantified and compared.

Potential Benefits

Water conservation has both economic and non-economic benefits. Water conservation:

- Extends the life of existing water supplies and delays the need to develop expensive future water supplies (Table 5-2). Costs associated with developing new water supplies (or purchasing new water) can include capital costs for construction of reservoirs, pumping facilities, pipelines, treatment plants, water storage, and related facilities; costs of obtaining water rights and permits; and variable costs such as power and chemical costs.

Table 10-3: Potential Water Savings from Evaluated Measures

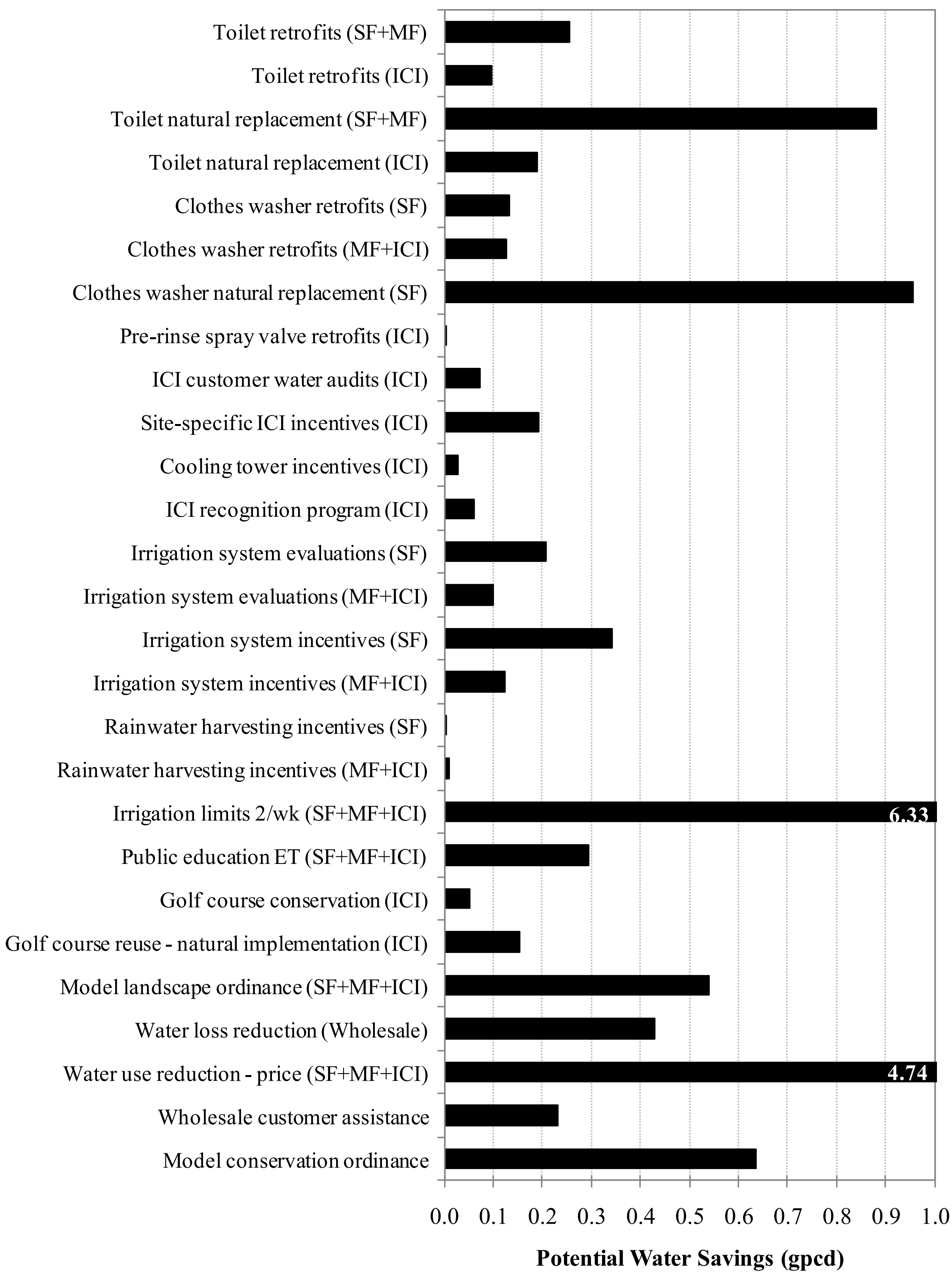
Water Conservation Measures		Sector	Measure Type	Potential Water Savings (mgd)					Potential Long-Term Water Savings[a] (ac-ft)
				Year 1	Year 2	Year 3	Year 4	Year 5	
2	Toilet natural replacement	SF+MF	Passive	0.41	0.73	1.05	1.37	1.70	349,445
		ICI		0.09	0.16	0.23	0.29	0.37	64,248
4	Clothes washer natural replacement	SF		0.49	0.74	0.99	1.42	1.85	398,213
15	Golf course reuse (natural implementation)	ICI		0.30	0.30	0.30	0.30	0.30	16,066
18	Water use reduction - price[b]	SF+MF+ICI		2.27	2.86	4.64	6.81	9.16	761,491
Subtotal Passive Measures				***3.56***	***4.79***	***7.19***	***10.20***	***13.38***	***1,589,464***
1	Toilet retrofits	SF+MF	Active	0.10	0.20	0.30	0.39	0.49	15,365
		ICI		0.04	0.07	0.11	0.15	0.19	5,786
3	Clothes washer retrofits	SF		0.06	0.12	0.18	0.22	0.26	3,649
		MF+ICI		0.07	0.12	0.16	0.21	0.24	2,194
5	Pre-rinse spray valve retrofits	ICI		0.01	0.01	0.01	0.01	0.01	70
6	ICI customer water audits	ICI		0.03	0.06	0.08	0.11	0.14	796
7	Site-specific ICI incentives	ICI		0.07	0.14	0.22	0.29	0.37	2,070
8	Cooling tower incentives	ICI		0.01	0.02	0.03	0.04	0.05	296
9	ICI recognition program	ICI		0.02	0.05	0.07	0.09	0.12	673
10	Irrigation system evaluations	SF		0.13	0.25	0.38	0.39	0.40	2,191
		MF+ICI		0.06	0.12	0.19	0.19	0.19	1,068
11	Irrigation system incentives	SF		0.13	0.25	0.39	0.52	0.66	7,407
		MF+ICI		0.05	0.09	0.14	0.19	0.24	2,679
12	Rainwater harvesting incentives	SF		0.00	0.00	0.01	0.01	0.01	156
		MF+ICI		0.00	0.01	0.01	0.01	0.02	308
13	Irrigation limits 2/wk	SF+MF+ICI		11.26	11.49	11.73	11.98	12.23	869,863
14	Public education ET	SF+MF+ICI		0.52	0.54	0.55	0.56	0.57	3,060
15	Golf course conservation	ICI		0.02	0.04	0.06	0.08	0.10	420
16	Model landscape ordinance	SF+MF+ICI		0.20	0.41	0.61	0.83	1.05	241,726
17	Water loss reduction	Wholesale		0.26	0.52	0.80	0.82	0.83	3,609
19	Wholesale customer assistance	Wholesale		0.09	0.18	0.27	0.36	0.45	2,500
20	Model conservation ordinance	SF+MF+ICI		1.13	1.16	1.18	1.20	1.23	87,523
Subtotal Active Measures				***14.25***	***15.85***	***17.47***	***18.65***	***19.84***	***1,253,407***
Total			**All**	**17.81**	**20.63**	**24.67**	**28.85**	**33.21**	**2,842,871**

[a] Cumulative water savings projected through 2060. Assumes no additional funding after initial five-year period.
[b] Based on TRWD in-district water price projected through 2022. Does not account for unrelated customer rate increases or increases in TRWD's real water price after 2022.

Table 10-4: Potential Per Capita Water Savings from Evaluated Measures

Water Conservation Measures		Sector	Measure Type	Potential Water Savings (gpcd)				
				Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
2	Toilet natural replacement	SF+MF	Passive	0.23	0.40	0.57	0.73	0.88
		ICI		0.05	0.09	0.12	0.16	0.19
4	Clothes washer natural replacement	SF		0.28	0.41	0.53	0.75	0.96
15	Golf course reuse (natural implementation)	ICI		0.17	0.16	0.16	0.16	0.15
18	Water use reduction - price	SF+MF+ICI		1.28	1.58	2.50	3.60	4.74
Subtotal Passive Measures				***2.00***	***2.64***	***3.88***	***5.39***	***6.92***
1	Toilet retrofits	SF+MF	Active	0.06	0.11	0.16	0.21	0.25
		ICI		0.02	0.04	0.06	0.08	0.10
3	Clothes washer retrofits	SF		0.03	0.07	0.10	0.12	0.13
		MF+ICI		0.04	0.06	0.09	0.11	0.13
5	Pre-rinse spray valve retrofits	ICI		0.01	0.01	0.01	0.00	0.00
6	ICI customer water audits	ICI		0.02	0.03	0.04	0.06	0.07
7	Site-specific ICI incentives	ICI		0.04	0.08	0.12	0.15	0.19
8	Cooling tower incentives	ICI		0.01	0.01	0.02	0.02	0.03
9	ICI recognition program	ICI		0.01	0.03	0.04	0.05	0.06
10	Irrigation system evaluations	SF		0.07	0.14	0.21	0.21	0.21
		MF+ICI		0.03	0.07	0.10	0.10	0.10
11	Irrigation system incentives	SF		0.07	0.14	0.21	0.28	0.34
		MF+ICI		0.03	0.05	0.08	0.10	0.12
12	Rainwater harvesting incentives	SF		0.00	0.00	0.00	0.00	0.00
		MF+ICI		0.00	0.00	0.01	0.01	0.01
13	Irrigation limits 2/wk	SF+MF+ICI		6.33	6.33	6.33	6.33	6.33
14	Public education ET	SF+MF+ICI		0.29	0.29	0.29	0.29	0.29
15	Golf course conservation	ICI		0.01	0.02	0.03	0.04	0.05
16	Model landscape ordinance	SF+MF+ICI		0.11	0.22	0.33	0.44	0.54
17	Water loss reduction	Wholesale		0.14	0.29	0.43	0.43	0.43
19	Wholesale customer assistance	Wholesale		0.05	0.10	0.14	0.19	0.23
20	Model conservation ordinance	SF+MF+ICI		0.64	0.64	0.64	0.64	0.64
Subtotal Active Measures				***8.01***	***8.73***	***9.43***	***9.85***	***10.27***
Total			All	**10.01**	**11.36**	**13.31**	**15.25**	**17.19**
Goal			*All*	*1.76*	*3.50*	*5.22*	*6.93*	*8.61*

Figure 10-2: Potential Year 5 Per Capita Water Savings (gpcd)



- Reduces peak supply requirements, extending the life of existing infrastructure. Water system infrastructure is sized to meet peak demands. When peak demands are reduced through water conservation, the need for infrastructure expansion is delayed.
- Defers increases in capital and operating costs for the existing system. Deferral of new water supply development or infrastructure expansion allows the utility to delay the associated capital costs. In addition, increases in variable costs are deferred.
- Positions TRWD to obtain future water rights. The 2011 Region C Water Plan (Ref. 1) recommends future water sources that would involve an interbasin transfer of raw water. An interbasin transfer authorization requires that the applicant "has developed and implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant" (Ref. 2).
- Other benefits include positive environmental effects, improved customer good will, continued growth and economic development, a reduction of TRWD's carbon footprint, and a positive image for TRWD and its customers.

The economic benefits of water conservation are the avoided marginal costs associated with water treatment and distribution, wastewater collection and treatment, and a new raw water supply. Based on figures reported by TRWD and its four primary customers (Appendix J), benefits have been calculated with the following avoided marginal costs:[30]

- Water treatment: $546 per million gallons (mg).
- Wastewater treatment: $337 per mg (for measures that return flow to the wastewater collection system).
- Raw water pumping: Through 2030, a cost of $321 per mg is avoided by pumping less water from Richland-Chambers reservoir.

There are also avoided costs associated with deferral or downsizing of planned future water supplies based on a reduction in water demands through water conservation. Construction of these water supplies is expected to be a cooperative effort between TRWD and other agencies (Section 5.3). Since these agencies might not be able to defer construction of new water supply facilities, it is assumed, for the purpose of evaluating the cost-effectiveness of potential water conservation measures, that TRWD will downsize its share of each planned future water supply, resulting in avoided costs for debt service, raw water pumping, operation and maintenance, and raw water purchases (Table 10-5).

New reservoirs (and raw water transmission facilities with sufficient terminal storage) must be sized to meet annual water demand during a severe drought, when demand is expected to peak. Therefore, the amount by which future water supplies could be downsized depends on projected water conservation savings during a severe drought. However, the potential water conservation savings described in Table 10-3 are based on average water demand. During a severe drought,

[30] 2011 dollars. Avoided costs are assumed to increase at an annual inflation rate of 1.8 percent (the difference between 20-year nominal and real treasury interest rates, Ref. 31).

seasonal water use will be greater than during average water demand periods, and conservation savings from irrigation- and cooling-related conservation measures will be reduced.

Table 10-5: Unit Costs for Planned Future Water Supplies

Planned Future Water Supply	Year	Unit Costs ($/mg)			
		Debt Service	Raw Water Pumping	O&M	Raw Water Purchase
Marvin Nichols Reservoir (Phase 1)	2030	$2,531	$556	$293	$0
Marvin Nichols Reservoir (Phase 2)	2050	$1,452	$556	$166	$0
Toledo Bend Reservoir (Phase 1)	2050	$2,354	$944	$289	$106
Oklahoma Water	2060	$2,109	$401	$280	$158

Planned future water supplies and unit costs taken from Ref. 1. The division of costs for Marvin Nichols Reservoir between Phase 1 and Phase 2 is assumed from the description of the project and the cost estimate in Ref. 1. Unit costs inflated to 2011 dollars.

The 2011 water use data (Figures 4-3 and 4-5) can be used to derive a reasonable estimate of projected water conservation savings during a severe drought. The annual per capita water use (196.1 gpcd) was about 12 percent higher than the five-year running average (175.8 gpcd), and 49.6 percent of the water supplied was used for seasonal purposes. Assuming that the base water use (defined in Section 4.5) remains unchanged during a drought, the 2011 seasonal water use was about 23 percent greater than average. This ratio could be higher for more severe drought conditions. For the purpose of a benefit-cost analysis to estimate the cost-effectiveness of the potential water conservation measures, it is assumed that, during a severe drought, seasonal water use will be about 25 percent greater than average and that irrigation- and cooling-related water conservation savings will be 80 percent (or 1/1.25) of those shown in Table 10-3.[31]

Although there may also be benefits associated with deferring or downsizing improvements to water treatment plants, water distribution systems, wastewater treatment plants, and wastewater collection systems, these benefits are not accounted for.

Finally, some measures (e.g., irrigation system incentives) do not avoid wastewater treatment costs, because irrigation does not return flow to the wastewater system.

The Year 5 potential economic benefit from all evaluated water conservation measures has a present value (PV) of about $10.0 million (Table 10-6). The three active measures that are projected to yield the greatest economic benefit in Year 5 are twice-weekly irrigation limits, the model conservation ordinance, and the model landscape ordinance. Assuming five years of funding for the measures, the potential long-term benefits (based on avoided costs through 2060) are presented in tabular form (Table 10-6) and graphical form (Figure 10-3; note the log scale). The net present value (NPV) of the potential long-term benefit from all evaluated measures is $987.6 million.

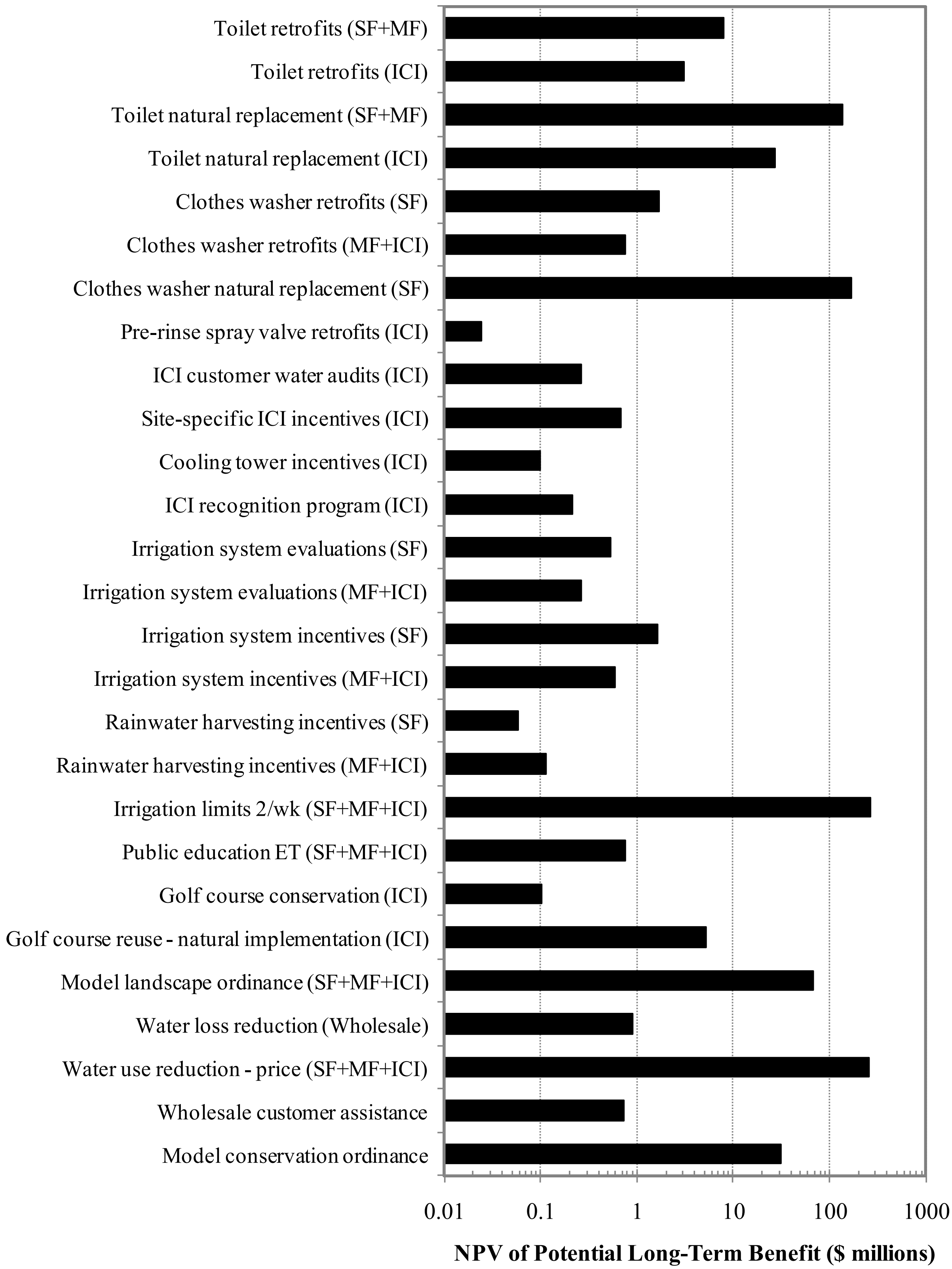
[31] This estimate is only for examining the cost-effectiveness of the various potential water conservation measures and should not be used for design or construction of water supply facilities.

Table 10-6: Potential Economic Benefit from Evaluated Measures

Water Conservation Measures		Sector	Measure Type	Present Value of Potential Annual Benefit					NPV of Potential Long-Term Benefit[a] ($ millions)
				Year 1	Year 2	Year 3	Year 4	Year 5	
2	Toilet natural replacement	SF+MF	Passive	$170,524	$293,205	$409,923	$520,908	$626,364	$139.362
		ICI		$36,599	$62,930	$87,981	$111,801	$134,435	$26.986
4	Clothes washer natural replacement	SF		$203,279	$297,424	$384,862	$538,255	$679,843	$168.170
15	Golf course reuse (natural implementation)	ICI		$89,124	$86,528	$84,008	$81,561	$79,185	$5.162
18	Water use reduction - price[b]	SF+MF+ICI		$830,464	$1,016,332	$1,597,868	$2,280,273	$2,977,585	$258.988
Subtotal Passive Measures				***$1,329,990***	***$1,756,419***	***$2,564,642***	***$3,532,798***	***$4,497,413***	***$598.668***
1	Toilet retrofits	SF+MF	Active	$40,751	$79,128	$115,235	$149,172	$181,034	$8.042
		ICI		$15,346	$29,799	$43,396	$56,176	$68,175	$3.109
3	Clothes washer retrofits	SF		$25,200	$48,590	$69,995	$83,128	$94,553	$1.712
		MF+ICI		$27,290	$46,997	$63,998	$78,098	$89,292	$0.763
5	Pre-rinse spray valve retrofits	ICI		$3,801	$4,435	$3,936	$3,147	$2,390	$0.024
6	ICI customer water audits	ICI		$11,289	$22,158	$32,616	$42,670	$52,330	$0.262
7	Site-specific ICI incentives	ICI		$29,510	$58,075	$84,952	$110,943	$136,057	$0.681
8	Cooling tower incentives	ICI		$4,375	$8,495	$12,372	$16,015	$19,436	$0.097
9	ICI recognition program	ICI		$9,396	$18,245	$26,570	$34,395	$42,383	$0.212
10	Irrigation system evaluations	SF		$37,300	$73,185	$107,695	$106,736	$105,787	$0.534
		MF+ICI		$18,189	$35,666	$52,485	$52,012	$51,557	$0.260
11	Irrigation system incentives	SF		$37,288	$73,415	$108,422	$142,350	$175,229	$1.632
		MF+ICI		$13,637	$26,784	$39,436	$51,624	$63,368	$0.590
12	Rainwater harvesting incentives	SF		$530	$1,040	$1,530	$2,002	$2,455	$0.058
		MF+ICI		$1,092	$2,121	$3,089	$3,999	$4,853	$0.113
13	Irrigation limits 2/wk	SF+MF+ICI		$3,357,763	$3,327,855	$3,298,214	$3,268,837	$3,239,722	$268.632
14	Public education ET	SF+MF+ICI		$156,323	$154,930	$153,550	$152,183	$150,827	$0.768
15	Golf course conservation	ICI		$5,889	$11,435	$16,653	$21,558	$26,162	$0.102
16	Model landscape ordinance	SF+MF+ICI		$59,796	$117,318	$172,637	$225,822	$276,938	$68.185
17	Water loss reduction	Wholesale		$76,170	$150,983	$224,458	$222,458	$220,477	$0.895
19	Wholesale customer assistance	Wholesale		$32,649	$63,396	$92,325	$119,514	$145,041	$0.726
20	Model conservation ordinance	SF+MF+ICI		$415,153	$411,455	$407,790	$404,158	$400,558	$31.577
Subtotal Active Measures				***$4,378,738***	***$4,765,506***	***$5,131,355***	***$5,346,997***	***$5,548,624***	***$388.973***
Total			All	**$5,708,728**	**$6,521,926**	**$7,695,997**	**$8,879,796**	**$10,046,037**	**$987.641**

[a] Net present value of benefit projected through 2060. Assumes no additional funding after initial five-year period.
[b] Based on TRWD in-district water price projected through 2022. Does not account for unrelated customer rate increases or increases in TRWD's real water price after 2022.

Figure 10-3: Net Present Value of Potential Long-Term Benefit



Potential Costs

In the following sections, unit cost assumptions are described, and the potential cost for the evaluated water conservation measures are presented. Conservation strategy costs typically include:

- Marketing and public education materials and campaigns
- Hardware devices
- Incentives for rebate and bill credit programs
- Staff or contractor labor
- Equipment, materials, and training

Cost Assumptions

Cost assumptions for the evaluated active measures are presented in Tables 10-7 and 10-8. Documentation for the unit cost assumptions is provided in Appendix J. The "Incentive/Fixture" amount is the amount of the financial incentive paid to the customer for each measure (e.g., per toilet, per clothes washer, etc.). The "Labor" amount is the labor cost for each measure for either TRWD staff or a contractor to provide the incentive, audit, or recognition.

In this chapter, the total costs borne by TRWD and its wholesale customers are called "costs to utilities." Some costs, such as enforcement of regulations, are borne exclusively by the wholesale customers. Recommended TRWD-only water conservation budgets are presented in Section 11.4.

In addition, it is assumed that TRWD and its wholesale customers will fund the water conservation measures through their operating budgets and that no measures will be financed over time. For example, the full cost of high-efficiency toilets retrofitted in Year 1 will be incurred in Year 1.

A more complicated example is the site-specific ICI incentives and wholesale customer assistance. For these measures, it is assumed that TRWD will set aside the full projected incentive amount in the year that TRWD agrees to provide the incentive but that TRWD will pay the incentive in installments over time, based on actual, proven water savings.

Potential Costs

The potential costs for the evaluated water conservation measures are presented in Table 10-9. The potential costs are based on the participation assumptions (Table 10-1) and the unit cost assumptions (Tables 10-7 and 10-8).

The PV of the potential annual cost to utilities from all evaluated water conservation measures decreases from about $6.2 million in planning and development and first year costs to about $4.9 million in the fifth year of the five-year planning period (Table 10-9). Prior to the first year of implementation ("Year 0"), most measures have planning and development costs that do not

Table 10-7: Cost Assumptions for Evaluated Active Incentive, Audit, and Recognition Measures

Water Conservation Measures		Sector	Unit	Planning & Development Cost[a] ($)	Cost Assumption ($/unit)		
					Incentive/ Fixture	Labor	Combined
1	Toilet retrofits	SF+MF	toilet	$12,951	$86	$7	$93
		ICI	toilet	$12,951	$200	$7	$207
3	Clothes washer retrofits	SF	clothes washer	$12,951	$100	$7	$107
		MF+ICI	clothes washer	$12,951	$210	$7	$217
5	Pre-rinse spray valve retrofits	ICI	PRSV	$12,951	$108	$37	$145
6	ICI customer water audits[b]	ICI	account	$12,951	-	$1,619	$1,619
7	Site-specific ICI incentives[c]	ICI	ac-ft or incentive	$19,427	$300	$809	d
8	Cooling tower incentives	ICI	conductivity controller	$12,951	$500	$243	$843
9	ICI recognition program	ICI	account	$12,951	-	$1,295	$1,295
10	Irrigation system evaluations	SF	account	$12,951	-	$104	$104
		MF+ICI	account	$12,951	-	$234	$234
11	Irrigation system incentives	SF	account (spray heads)	$19,427	$125	$7	$132
		SF	rain/freeze sensor	$2,428	$50	$7	$57
		MF+ICI	WBIC[e]	$19,427	$100	$7	$107
		MF+ICI	rain/freeze sensor	$2,428	$50	$7	$57
12	Rainwater harvesting incentives	SF[f]	account	$12,951	$117	$63	$180
		MF+ICI[g]	account	$12,951	$4,287	$346	$4,633
19	Wholesale customer assistance[c]	Wholesale	ac-ft	$12,951	$300	$113	$413

[a] It is assumed that existing TRWD staff members will plan and develop the water conservation measures. Therefore, planning and development costs are included in the opinions of probable cost to utilities (Table 10-9) but not included in the recommended budgets in Table 11-4.

[b] "-" means the cost is not applicable or the measure will be implemented without cost to the utility or will be performed by existing TRWD staff.

[c] The costs shown are annual costs.

[d] The combined cost is site-specific.

[e] WBIC = weather-based irrigation controller.

[f] Based on a 550 gallon rainwater harvesting system and a 1,750 square foot roof area. The incentive amount depends on the storage and contributing area.

[g] Based on a 15,000 gallon rainwater harvesting system and a 50,000 square foot roof area. The incentive amount depends on the storage and contributing area.

Table 10-8: Cost Assumptions for Other Evaluated Active Measures

Water Conservation Measures		Sector	Unit	Planning & Development Cost[a] ($)	Equipment Cost ($)	Cost Assumption ($/unit)			
						Maintenance	Enforcement	Labor	Other
13	Irrigation limits 2/week[b]	SF+MF+ICI	account	$200,000	-	-	$1.35	-	-
14	Public education ET	SF+MF+ICI	year	$5,921	-	$1,632	-	$16,837	-
15	Golf course conservation	ICI	year	$12,951	-	-	-	$6,476	-
16	Model landscape ordinance	SF+MF+ICI	new landscape[c]	$200,000	-	-	-	$243	-
17	Water loss reduction	Wholesale	year	-	$75,000	-	-	$20,236	$40,000
20	Model conservation ordinance	SF+MF+ICI		$300,000	-	-	See note[d]	-	-

[a] It is assumed that existing TRWD staff members will plan and develop the water conservation measures. Therefore, planning and development costs are included in the opinions of probable cost to utilities (Table 10-9) but not included in the recommended budgets in Table 11-4.

[b] "-" means the cost is not applicable or the measure will be implemented without cost to the utility or will be performed by existing TRWD staff.

[c] It is also assumed that wholesale customers will review plans and inspect installations for each new ICI or multi-family landscape and for each group of 5 new single-family landscapes.

[d] Enforcement cost based on San Antonio Water System enforcement experience and not calculated on a unit basis.

Table 10-9: Opinions of Probable Cost to Utilities for Evaluated Measures

Water Conservation Measures		Sector	Measure Type	Present Value of Potential Annual Cost to Utilities[a]						NPV of Potential Long-Term Cost to Utilities[b] ($ millions)
				Year 0[c]	Year 1	Year 2	Year 3	Year 4	Year 5	
2	Toilet natural replacement	SF+MF	Passive	$0	$0	$0	$0	$0	$0	$0
		ICI		$0	$0	$0	$0	$0	$0	$0
4	Clothes washer natural replacement	SF		$0	$0	$0	$0	$0	$0	$0
15	Golf course reuse (natural implementation)	ICI		$0	$0	$0	$0	$0	$0	$0
18	Water use reduction - price	SF+MF+ICI		$0	$0	$0	$0	$0	$0	$0
Subtotal Passive Measures				***$0***	***$0***	***$0***	***$0***	***$0***	***$0***	***$0***
1	Toilet retrofits	SF+MF	Active	$12,574	$879,995	$854,364	$829,480	$805,320	$781,864	$4.164
		ICI		$12,574	$195,117	$189,434	$183,917	$178,560	$173,359	$0.933
3	Clothes washer retrofits	SF		$12,574	$303,587	$294,745	$286,160	$277,826	$269,734	$1.445
		MF+ICI		$12,574	$204,881	$198,914	$193,120	$187,495	$182,034	$0.979
5	Pre-rinse spray valve retrofits	ICI		$12,574	$9,078	$4,205	$1,948	$902	$418	$0.029
6	ICI customer water audits	ICI		$12,574	$140,389	$139,263	$138,084	$136,855	$135,581	$0.703
7	Site-specific ICI incentives	ICI		$18,861	$141,023	$140,616	$136,520	$136,032	$135,456	$0.709
8	Cooling tower incentives	ICI		$12,574	$29,408	$28,552	$27,720	$26,913	$26,129	$0.151
9	ICI recognition program	ICI		$12,574	$47,610	$46,224	$44,877	$43,570	$45,555	$0.240
10	Irrigation system evaluations	SF		$12,574	$282,581	$280,088	$277,593	$275,097	$272,685	$1.401
		MF+ICI		$12,574	$91,096	$90,156	$89,402	$88,614	$87,797	$0.460
11	Irrigation system incentives	SF		$21,219	$493,404	$492,453	$491,618	$490,882	$490,118	$2.480
		MF+ICI		$21,219	$55,385	$55,110	$54,753	$54,512	$54,286	$0.295
12	Rainwater harvesting incentives	SF		$12,574	$15,768	$15,638	$15,502	$15,361	$15,215	$0.090
		MF+ICI		$12,574	$30,570	$29,680	$28,816	$27,976	$27,161	$0.157
13	Irrigation limits 2/wk	SF+MF+ICI		$194,175	$802,028	$794,884	$787,804	$780,787	$773,833	$28.107
14	Public education ET	SF+MF+ICI		$0	$28,571	$16,901	$16,409	$15,931	$15,467	$0.093
15	Golf course conservation	ICI		$12,574	$6,104	$5,926	$5,754	$5,586	$5,423	$0.041
16	Model landscape ordinance	SF+MF+ICI		$194,175	$728,826	$722,335	$715,901	$709,525	$703,205	$17.777
17	Water loss reduction	Wholesale		$0	$127,473	$55,125	$53,519	$51,960	$50,447	$0.339
19	Wholesale customer assistance	Wholesale		$12,574	$194,798	$189,125	$183,616	$178,268	$173,076	$0.931
20	Model conservation ordinance	SF+MF+ICI		$291,262	$449,598	$445,317	$441,079	$436,882	$432,727	$15.722
Subtotal Active Measures				***$916,946***	***$5,257,294***	***$5,089,055***	***$5,003,592***	***$4,924,854***	***$4,851,570***	***$77.244***
Total			All	**$916,946**	**$5,257,294**	**$5,089,055**	**$5,003,592**	**$4,924,854**	**$4,851,570**	**$77.244**

[a] Costs to TRWD and wholesale customers. Some costs, such as enforcement of regulations, are borne exclusively by the wholesale customers.
[b] Net present value of costs projected through 2060. Assumes no additional funding after initial five-year period.
[c] TRWD final planning and development with existing staff members before implementation.

recur. Other measures (e.g., ICI HET retrofits and pre-rinse spray valve retrofits) have decreasing costs due to assumed decreasing participation. Finally, even for a cost that remains the same over time (in 2011 dollars), the NPV decreases over time due to the discounting involved.[32]

The PV of the potential Year 5 cost to utilities for three measures exceeds $0.5 million per year: residential HET retrofits, the twice-weekly irrigation limits, and the model landscape ordinance.

The NPV of the potential cost for all evaluated measures over a five-year period is $26.0 million. Assuming only five years of funding for the measures, the potential long-term costs (through 2060) are presented in graphical form (Figure 10-4; note the log scale). The NPV of the potential long-term cost for all evaluated measures is $77.2 million.[33] The difference in the potential long-term and short term costs (PV of $51.2 million) stems from continued enforcement of regulations (twice-weekly irrigation limits, the model landscape ordinance, and the model conservation ordinance).

Potential Unit Costs

For each measure, the potential long-term unit cost in dollars per thousand gallons was estimated by dividing the NPV of the potential long-term cost to utilities by the potential long-term water savings (Figure 10-5). For comparative purposes, Figure 10-5 also shows the projected unit costs of several potential future raw water supplies, including the Integrated Pipeline Project, Marvin Nichols Reservoir, Toledo Bend Reservoir (Phase 1), and Lake Tehuacana.[34] Two residential measures (irrigation audit and rainwater harvesting incentives) and three ICI measures (customer water audits, cooling tower incentives, and rainwater harvesting incentives) are projected to cost more than water from the Integrated Pipeline Project. Each evaluated water conservation measure is projected to cost less than water from Marvin Nichols Reservoir.

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[32] Net present values were calculated using a real discount factor of 3.0 percent per year (Refs. 32 and 33).

[33] This figure does not include revenue loss.

[34] Projected unit costs for these future water supplies include debt service. The projected costs are taken from the 2011 Region C Water Plan (Ref. 1) and inflated to 2011 dollars. The projected unit cost for water from Lake Tehuacana has also been adjusted by modifying the Region C estimated yield (56,800 ac-ft/yr, Ref. 1) to the estimated yield from a recent reservoir site protection study (41,900 ac-ft/yr, Ref. 34). The adjusted yield estimate accounts for joint operation of Lake Tehuacana and Richland-Chambers Reservoir and projected environmental flow requirements based on Consensus Criteria for Environmental Flow Needs (Ref. 35).

Figure 10-4: Probable Net Present Value of Long-Term Cost to Utilities

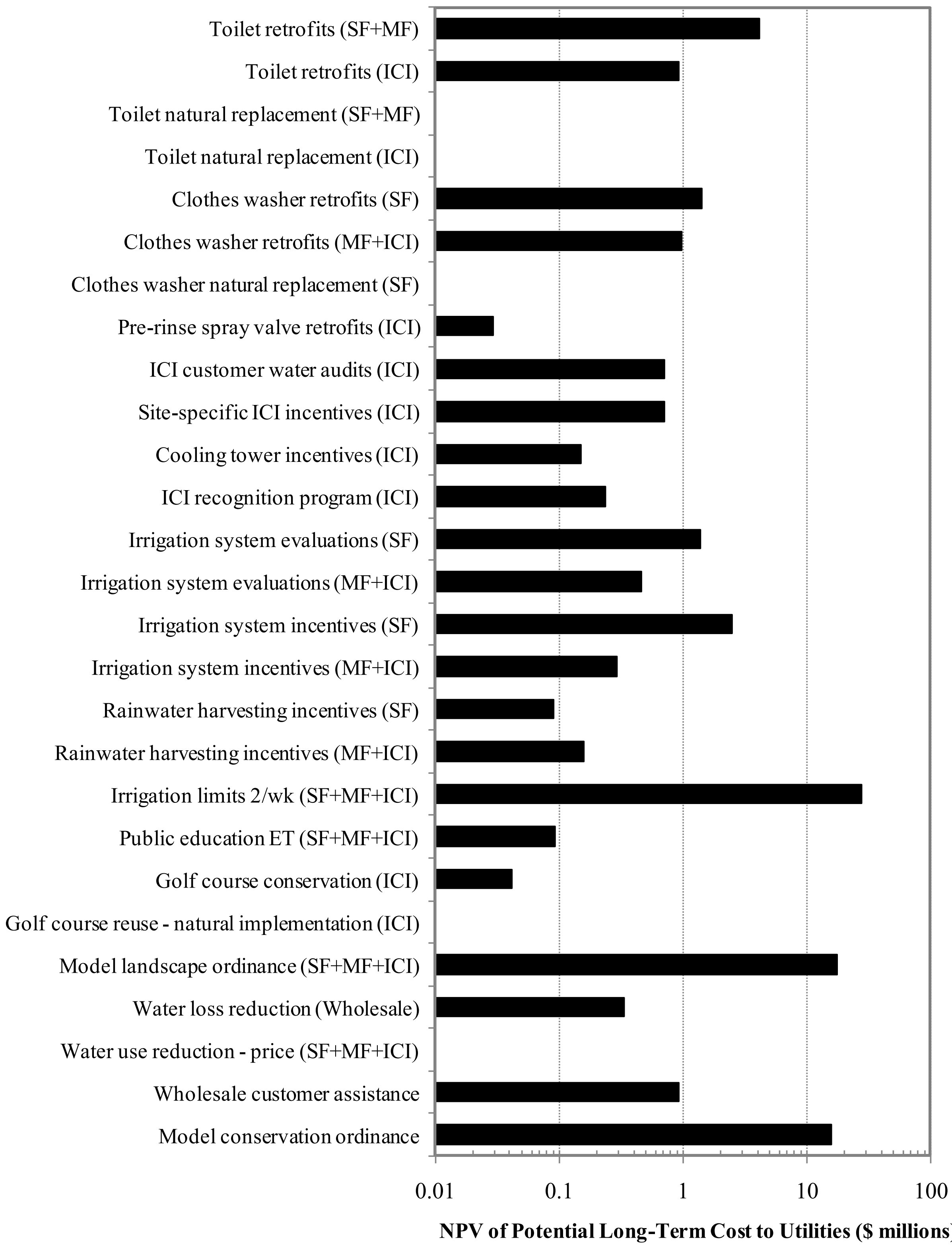
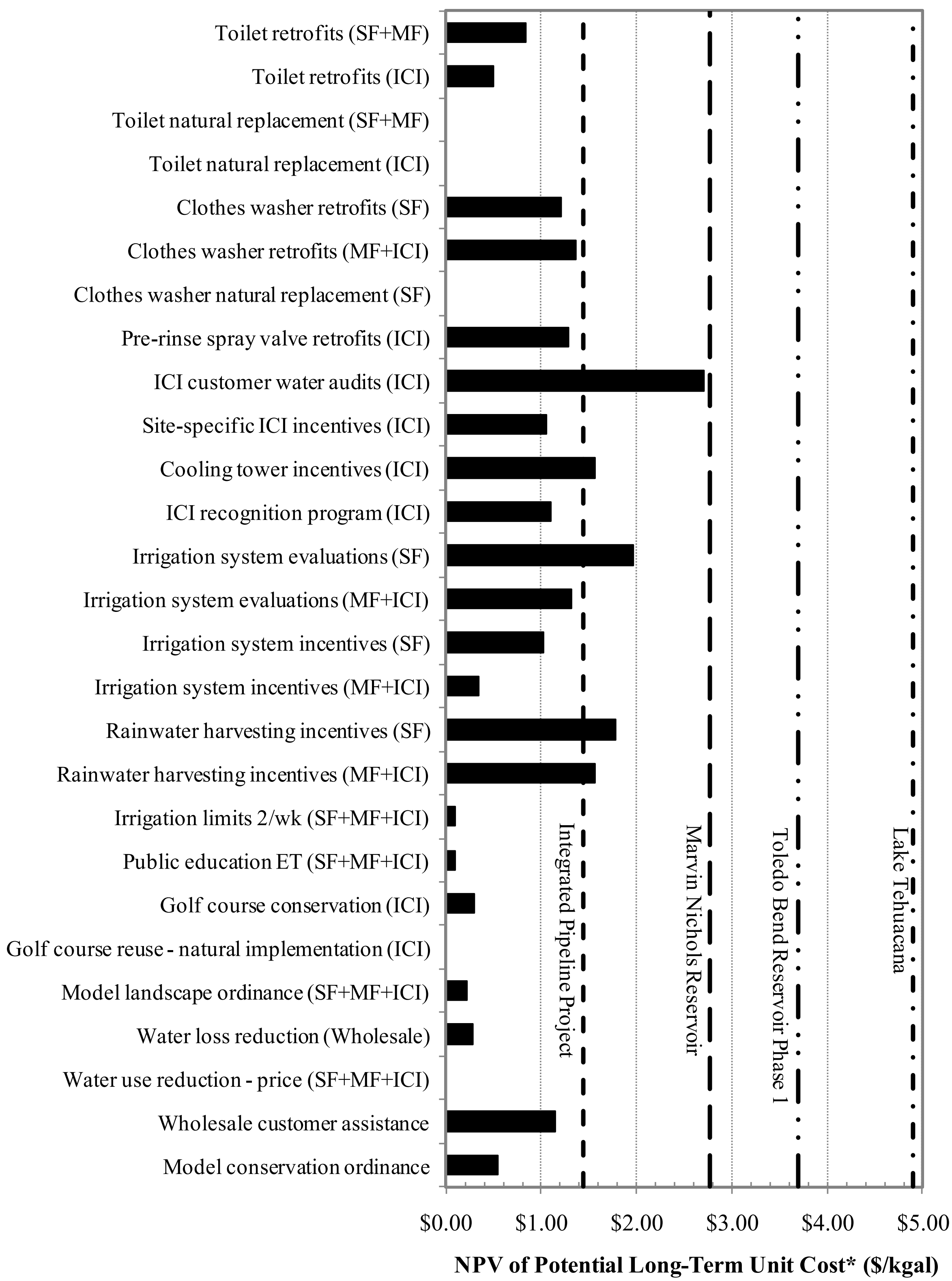


Figure 10-5: Potential Long-Term Unit Costs



* Calculated as NPV of potential long-term cost to utilities (Figure 10-4) divided by potential long-term water savings.

Costs Not Considered

TRWD has projected its wholesale raw water rates through 2022 (Ref. 36). The projected rates include the impact of the Integrated Pipeline Project but do not account for reduced water use due to the additional implementation of water conservation measures. Without additional rate increases, the projected water savings would cause TRWD to lose revenue in the amount of the fixed costs associated with the saved water. Therefore, it may become necessary for TRWD to increase its water rates to pay for fixed raw water production and transmission costs. Analysis of this cost would require a water rate study. Since no rate study was performed as part of the development of the Strategic Plan, this additional cost was not considered in the cost analysis.

In addition, customer cities could raise retail water rates for reasons not related to the cost of raw water. Such rate increases are not considered in the cost analysis.

Benefit-Cost Comparison

The overall benefit-cost analysis should include both economic and non-economic factors. However, because it is difficult to place a value on non-economic factors, the benefit-cost comparison in this section considers only the economic factors. This is a conservative approach, because non-economic factors generally favor implementation of water conservation measures.

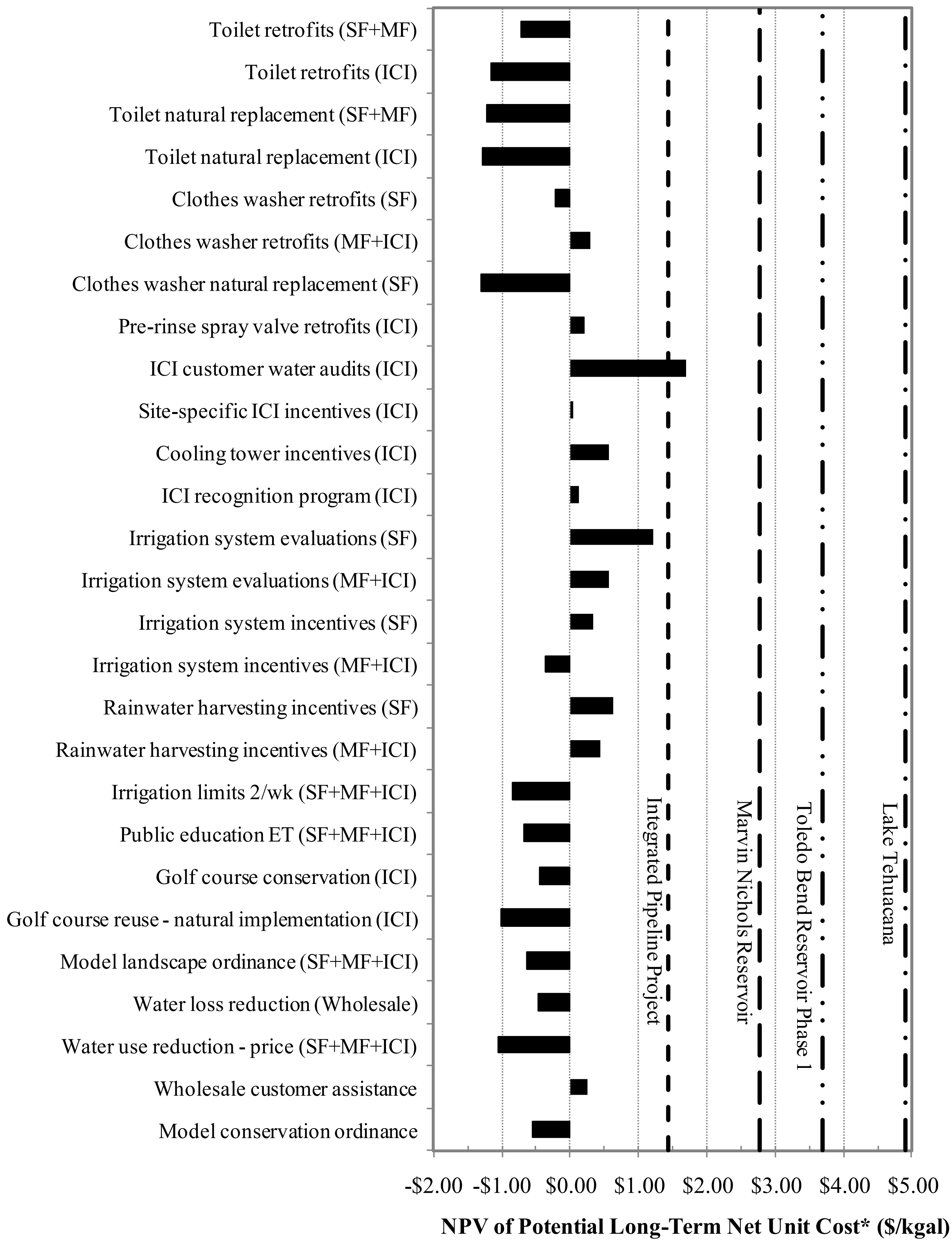
Subtracting the potential benefits from the potential costs results in a net unit cost (Figure 10-6). A negative net unit cost indicates that the potential benefits outweigh the potential costs. The measures were sorted in order of increasing net unit cost (Figure 10-7). (The scales for the first and second parts of Figure 10-7 are different.) The first year when the cumulative economic benefits outweigh the cumulative cost to utilities is also shown as the payback period. The payback period is related to the long-term benefit-cost ratio, but it also considers the timing of the benefits and costs.

There may be additional benefits (e.g., avoided capital costs, reduced water heating costs, reduced cooling tower chemical usage) and additional costs (e.g., increases in water rates) that have not been considered in the benefit-cost analysis.

10.6. Summary of Potential Water Savings, Benefits, and Costs

For the evaluated water conservation measures, the potential long-term water savings, the potential Year 5 water savings, the NPV of the potential long-term benefits, the NPV of the potential long-term cost to utilities, and the potential long-term benefit-cost ratio are summarized in Table 10-10 and Figure 10-8. As TRWD builds its water conservation program, it should select measures for implementation based on a balance of cost-effectiveness, potential water savings, and non-economic factors.

Figure 10-6: Potential Long-Term Net Unit Costs



* Includes potential benefits and potential costs. Negative value indicates the benefits are greater than costs.

Figure 10-7: Sorted Potential Long-Term Net Unit Costs

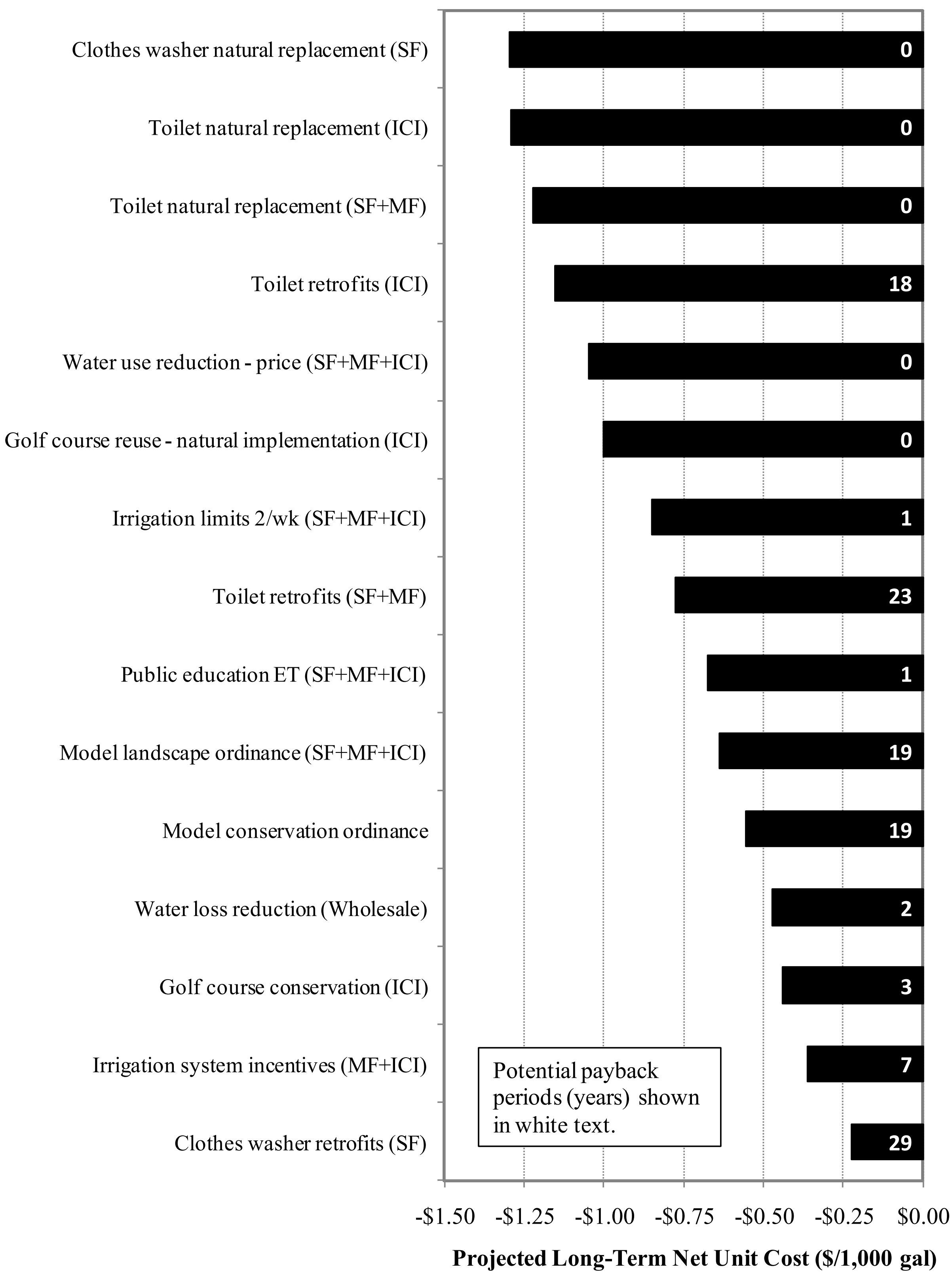


Figure 10-7 Continued: Sorted Potential Long-Term Net Unit Costs

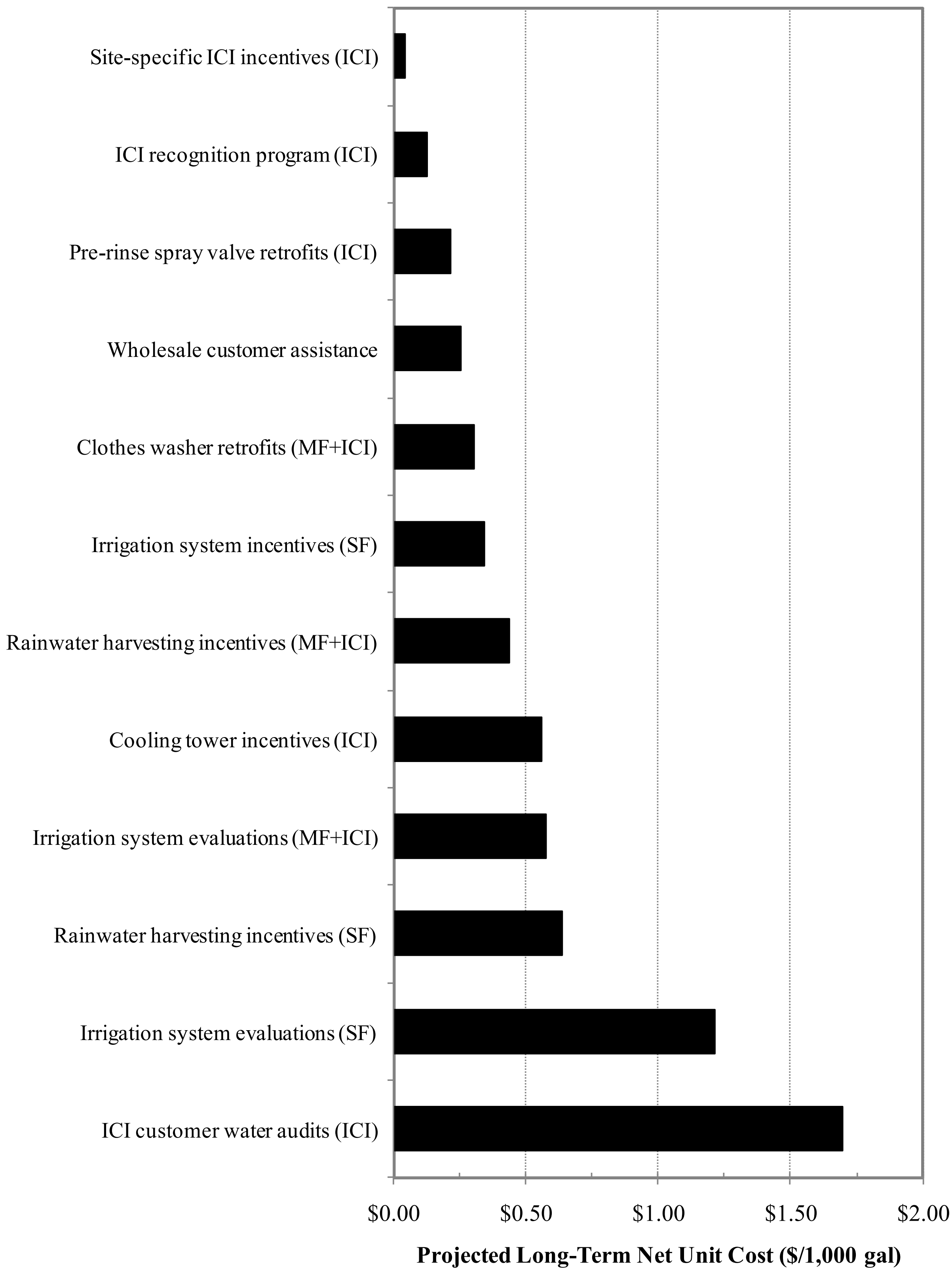
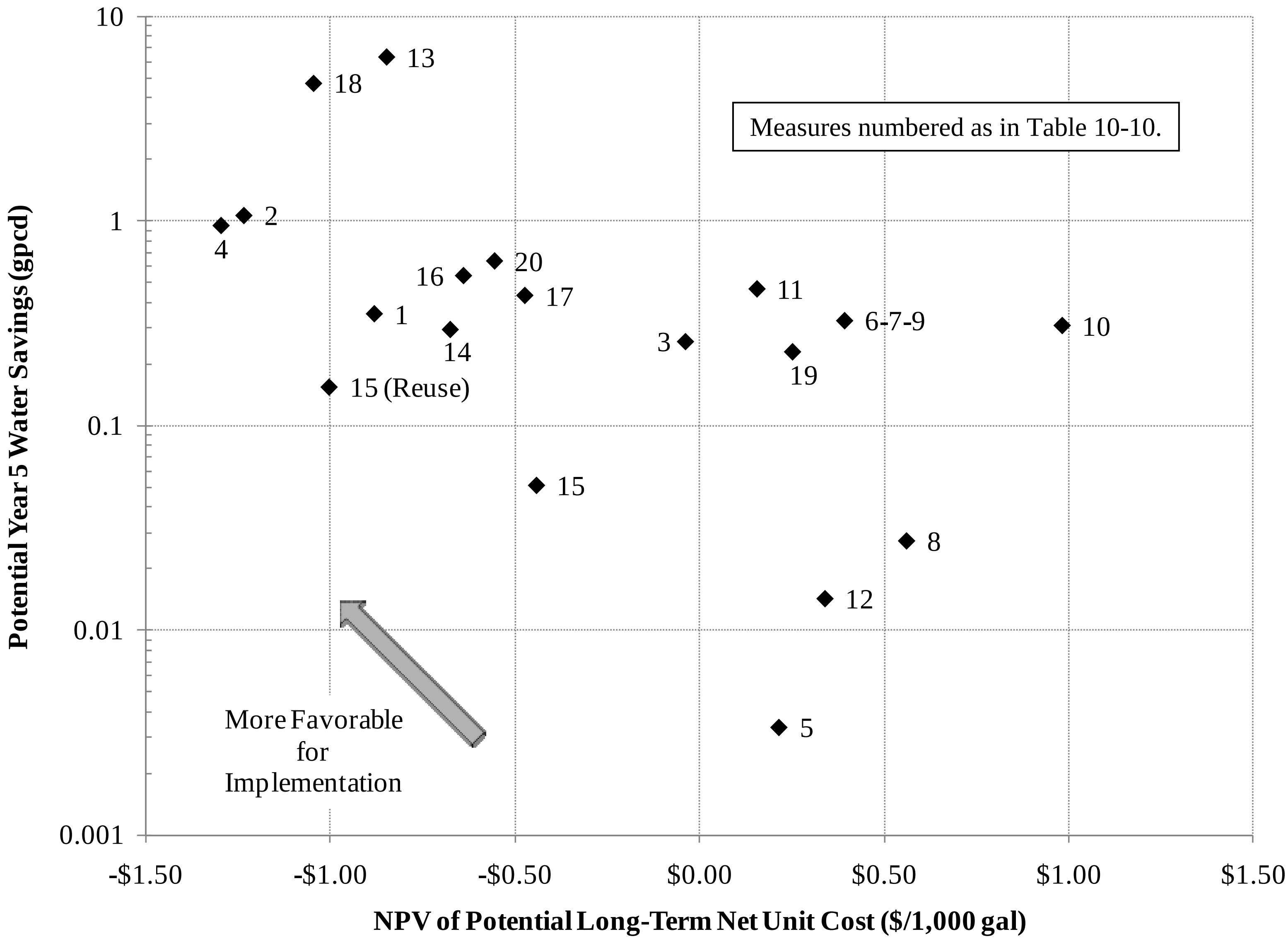


Table 10-10: Summary of Detailed Evaluation of Measures

Water Conservation Measures			Measure Type	Potential Long-Term Water Savings[a] (ac-ft)	Potential Year 5 Water Savings (gpcd)	NPV of Potential Long-Term Benefit[a] ($ millions)	NPV of Potential Long-Term Cost to Utilities[a] ($ millions)	Potential Long-Term Net Unit Cost[b] ($/kgal)
2	Toilet natural replacement	SF+MF	Passive	349,445	0.88	$139.362	$0	-$1.22
		ICI		64,248	0.19	$26.986	$0	-$1.29
4	Clothes washer natural replacement	SF		398,213	0.96	$168.170	$0	-$1.30
15	Golf course reuse (natural implementation)	ICI		16,066	0.15	$5.162	$0	-$1.00
18	Water use reduction - price[c]	SF+MF+ICI		761,491	4.74	$258.988	$0	-$1.05
Subtotal Passive Measures				***1,589,464***	***6.92***	***$598.668***	***$0***	***-$1.16***
1	Toilet retrofits	SF+MF	Active	15,365	0.25	$8.042	$4.164	-$0.77
		ICI		5,786	0.10	$3.109	$0.933	-$1.15
3	Clothes washer retrofits	SF		3,649	0.13	$1.712	$1.445	-$0.22
		MF+ICI		2,194	0.13	$0.762	$0.979	$0.30
5	Pre-rinse spray valve retrofits	ICI		70	0.003	$0.024	$0.029	$0.21
6	ICI customer water audits	ICI		796	0.07	$0.262	$0.703	$1.70
7	Site-specific ICI incentives	ICI		2,070	0.19	$0.681	$0.709	$0.04
8	Cooling tower incentives	ICI		296	0.03	$0.097	$0.151	$0.56
9	ICI recognition program	ICI		673	0.06	$0.212	$0.240	$0.13
10	Irrigation system evaluations	SF		2,191	0.21	$0.534	$1.401	$1.21
		MF+ICI		1,068	0.10	$0.260	$0.460	$0.57
11	Irrigation system incentives	SF		7,407	0.34	$1.632	$2.480	$0.34
		MF+ICI		2,679	0.12	$0.590	$0.295	-$0.36
12	Rainwater harvesting incentives	SF		156	0.005	$0.058	$0.090	$0.64
		MF+ICI		308	0.01	$0.113	$0.157	$0.44
13	Irrigation limits 2/wk	SF+MF+ICI		869,863	6.33	$268.632	$28.107	-$0.85
14	Public education ET	SF+MF+ICI		3,060	0.29	$0.768	$0.093	-$0.68
15	Golf course conservation	ICI		420	0.05	$0.102	$0.041	-$0.44
16	Model landscape ordinance	SF+MF+ICI		241,726	0.54	$68.185	$17.777	-$0.64
17	Water loss reduction	Wholesale		3,609	0.43	$0.895	$0.339	-$0.47
19	Wholesale customer assistance	Wholesale		2,500	0.23	$0.726	$0.931	$0.25
20	Model conservation ordinance	SF+MF+ICI		87,523	0.64	$31.577	$15.722	-$0.56
Subtotal Active Measures				***1,253,407***	***10.27***	***$388.973***	***$77.244***	***-$0.76***
Total			All	**2,842,871**	**17.19**	**$987.641**	**$77.244**	**-$0.98**

[a] "NPV" is net present value. Cumulative water savings, benefits, and costs projected through 2060. Assumes no additional funding after initial five-year period.
[b] Includes potential benefits and potential costs. Negative value indicates the benefits are greater than costs.
[c] Based on TRWD in-district water price projected through 2022. Does not account for unrelated customer rate increases or increases in TRWD's real water price after 2022.

Figure 10-8: Comparison of Potential Year 5 Water Savings and Potential Long-Term Net Unit Cost



10.7. Non-Economic Factors

Several non-economic factors may influence TRWD's selection of which water conservation measures to implement. These factors include coordination with customer measures, lack of enforcement authority for ordinance measures, limited potential for water savings, potential combinations of related measures, the potential for increased water savings, and ancillary benefits.

Coordination with Existing or Planned Customer Water Conservation Measures

TRWD must coordinate implementation of the Strategic Plan with each of its wholesale customers. In particular, the City of Fort Worth and the City of Arlington have implemented or are planning to implement several water conservation measures that overlap with potential TRWD measures (Table 10-11). TRWD must coordinate implementation of these measures with Fort Worth and Arlington to ensure that the measures are operated as efficiently as possible with minimal customer confusion.

Lack of Enforcement Authority for Ordinance Measures

TRWD cannot force its customers to adopt the model conservation ordinance, the model landscape ordinance, or restriction of the number of watering days per week. In addition, there may be public opposition to one or more of these measures. To implement these measures, TRWD must design model ordinances and persuade customers to adopt the ordinances by pointing out the benefits: wiser use of water, avoided costs for water and wastewater treatment, extended life of the existing water supply, deferral/downsizing of new supplies, consistency in public education efforts, etc.

Limited Potential for Water Savings

Though cost-effective compared to the next source of water supply (Figure 10-6), the pre-rinse spray valve retrofits and rainwater harvesting incentives measures have a relatively low potential for water savings (Figure 10-8). TRWD would likely be better served to use its resources to develop other water conservation measures during the next five years.

Pre-Rinse Spray Valve Retrofits

Due to HB 2428, it is projected that all PRSVs will eventually be replaced with 1.6 gpm PRSVs or better without TRWD action. Since inefficient PRSVs have not been available since 2005 and since the lifetime of a PRSV is approximately five years, the number of PRSVs that use more than 1.6 gpm is rapidly decreasing. By the first year of the planning period (2013), the large majority of inefficient PRSVs will have been replaced.

Table 10-11: Coordination with Selected Customer Water Conservation Measures

Potential TRWD Water Conservation Measures		Status of Customer Water Conservation Measures	
		Fort Worth	Arlington
1	High-efficiency toilet (HET) distribution/incentives	Implemented SmartFlush program	Implemented “Go With The Flow” program
3	High-efficiency clothes washer (HECW) incentives	Planned[a]	n/a
5	Pre-rinse spray valve retrofits	Implemented SmartSpray program	n/a
6	ICI customer water audits	Implemented SmartWater Audit Program	n/a
8	Cooling tower incentives	Planned[a]	n/a
9	ICI recognition program	Implemented SmartWater Conservation Partner Awards	n/a
10	Irrigation system evaluations	Implemented Smart Irrigation Program (SIP)	n/a
11	Irrigation system incentives	Planned pilot study of evapotranspiration (ET) irrigation controllers	n/a
13	Irrigation limits: maximum 2 times per week	Planned for summer months[a]	n/a

[a] Recommended in Fort Worth’s 10-Year Water Conservation Master Plan (Ref. 21).

The detailed evaluation of the PRSV retrofits measure is based on Fort Worth's experience with its SpraySmart program. In 2008, Fort Worth retained Niagara Conservation, Inc. to identify customers with high-flow PRSVs and to directly install the Niagara Conservation N2180 PRSV (1.28 gpm). After 1,099 PRSVs were retrofitted in 2008, Fort Worth discontinued actively seeking customers with high-flow PRSVs, because they were becoming difficult to find. Fort Worth still makes efficient PRSVs available on request.

Rainwater Harvesting Incentives

The expected participation in the rainwater harvesting incentives measure is low, resulting in low projected water savings from this measure.

Potential Combinations of Related Measures

As described in the following sections, there may be advantages to combining measures.

ICI Customer Water Audits, Site-Specific ICI Incentives, and ICI Recognition Program

The ICI customer water audits, the site-specific ICI incentives, and the ICI recognition program are closely related. Before committing sizable incentives to an ICI customer through the site-specific ICI incentives measure, TRWD should perform due diligence by conducting an indoor water audit and/or an irrigation system audit for that customer.

As evaluated in this chapter, the ICI recognition program recognizes ICI customers that meet certain water conservation criteria through their own efforts. However, it is unlikely that an ICI customer will choose to evaluate their water use and make conservation improvements on their own when they can request a TRWD auditor evaluate their water use (ICI customer water audit) and partner with TRWD in paying for the improvements (ICI site-specific incentives). Therefore, there is significant overlap in the projected water savings for the ICI recognition program and the ICI customer water audit/ICI site-specific incentives measures.

The combination of ICI customer water audits, site-specific ICI incentives, and ICI recognition program into a single water conservation measure would eliminate the overlap in projected water savings and create a logical progression from helping a customer identify potential water-savings measures to helping the customer fund these measures to recognizing the customer's accomplishments.

Combined ICI Incentives Measures

To varying degrees, the following incentive measures encourage ICI customers to purchase and install water-conserving devices:[35]

- HET distribution/incentives
- High-efficiency clothes washer incentives

[35] If TRWD decides to pursue pre-rinse spray valve retrofits, they could be added to this list.

- Cooling tower incentives
- Irrigation system incentives

These measures could be consolidated into a single ICI Device Incentives menu of measures.

Potential for Increased Water Savings

The evaluation of potential water savings is based on conservative assumptions. For the cooling tower incentives and the model landscape ordinance, TRWD could potentially realize greater savings than those projected in Section 10.4.

Cooling Tower Incentives

The water savings from the cooling tower incentives are estimated based on cooling tower operation at five cycles of concentration, but cooling tower operators may operate at higher cycles of concentration and achieve more water savings than projected in Section 10.4. The number of cycles of concentration for a cooling tower is limited by the quality of the makeup water. Concerns include scaling and corrosion of cooling tower equipment.

The Water Conservation Implementation Task Force BMP Guide (Ref. 6) says:

> "For evaporative cooling towers that use potable quality water, the minimum cycles of concentration should be at least four (4).[36] With the modern water treatment chemical and monitoring technology available today, the potential exists for systems to be operated continuously at six (6) to eight (8) cycles or even greater, contingent upon system metallurgy and allowable corrosion rates."

Model Landscape Ordinance

The water savings from the model landscape ordinance are estimated based on requiring that one-third of irrigated areas in new construction will contain low-water-use plantings. To achieve more water savings than projected in Section 10.4, the model landscape ordinance could limit turf grass to a smaller area. For example, in 2002 the City of El Paso limited turf grass in new construction to 50 percent (residential property) or 33.3 percent (commercial property) of the total landscaped area (front and back yards) (Ref. 28).

TRWD could also achieve more water savings by including other requirements in the model landscape ordinance, such as minimum soil depths, soil amendments, and turf grass summer dormancy capability.

[36] It is anticipated that the model conservation ordinance would require cooling towers to operate at a minimum of four cycles of concentration.

Ancillary Benefit from Irrigation System Evaluations

Irrigation system evaluations are a public education measure. During the evaluations, a TRWD representative has direct, face-to-face contact with the customer. In addition to teaching the customer about efficient irrigation, the representative can answer other customer questions and alert the customer to other TRWD water conservation measures. This ancillary public education benefit is not reflected in the economic evaluation.

10.8. Input from Wholesale Customer Cities

Three meetings were held during development of the Strategic Plan to obtain input from wholesale customer cities. These meetings are described below.

Meeting 1: Review Draft Implementation Plan with Wholesale Customers

On December 8, 2011, APAI presented the following draft information to representatives of TRWD, TRA, and the cities of Fort Worth, Arlington, Mansfield, and Southlake:

- Historical water savings
- Evaluation of twenty potential water conservation measures, with potential water savings, benefits, and costs.
- A draft implementation plan with recommended water conservation measures; an implementation schedule; projected water savings, benefits, and costs; recommended new labor resources; and recommended TRWD water conservation budgets.

This presentation was followed by a brief discussion of revenue loss associated with reduced water consumption due to water conservation measures.

Suggestions for improving the Strategic Water Conservation Plan included:

- Conducting additional research on code enforcement costs for a twice-weekly irrigation limitation.
- Projecting water savings for individual utilities.

Response

Additional research was conducted (Section J.13 of Appendix J) and the projected enforcement costs were revised. The projected water savings can be further broken down by customer city in proportion to population.

Meeting 2: Review Revised Draft Implementation Plan with Wholesale Customers

On February 8, 2012, TRWD water conservation staff presented a revised water conservation implementation schedule to representatives of TRA and the cities of Fort Worth, Arlington, Mansfield, and Bedford. The revised plan called for earlier implementation of high-efficiency toilet retrofits and irrigation system evaluations.

Comments about the revised plan included:

- The implementation plan should begin with the most cost-effective measures.
- The implementation plan should favor measures that are regional in scope.
- Arlington has already implemented a toilet incentive program and is hesitant to subsidize toilet programs in other cities unless sufficient benefits, such as deferred capital projects, can be shown. Fort Worth has also implemented a toilet incentive program.
- It takes a lot of work for customer cities to implement new regulations. TRWD may be able to implement other types of measures more quickly.
- Twice-weekly watering limitation:
    - Many drought contingency plans use a twice-weekly watering limitation as a Stage 1 drought response measure. If a twice-weekly watering limitation is used as a permanent water conservation measure, many drought contingency plans will have to be revised.
    - Public support is needed to implement a twice-weekly irrigation limitation.
    - Needs to be regional in nature.
- A matrix showing water conservation measures that have already been implemented by the customer cities would be useful.

Response

The recommended implementation plan (Chapter 11) does favor the most cost-effective water conservation measures, and each of the recommended measures are intended to be implemented throughout the service areas of the four primary customers (regional in scope). Implementation of the model landscape ordinance and the model water conservation ordinance has been delayed until 2015. Finally, TRWD surveyed its wholesale customers and developed a matrix showing water conservation measures that these customers have implemented (Appendix K).

It is projected that the next sources of raw water (assumed from Ref. 1 to be Marvin Nichols Reservoir, Toledo Bend Reservoir (Phase 1), and Oklahoma water) could be deferred or downsized due to a reduction in water demand from the recommended water conservation measures (Chapter 11). The long-term benefits from the recommended implementation plan (Table 10-6) do include a benefit (described in Section 10.5) from downsizing planned future water supplies.[37] With the assumption that each city experiences the same per capita water savings for each recommended measure, the projected benefits from the recommended implementation plan are broken down by primary customer in Appendix M.

[37] Since water demands and water savings were only projected through 2060, and since the downsizing benefit was reported for each water conservation measure, the downsizing benefit used in the benefit-cost analysis in Section 10.5 only considers avoided costs through 2060. This level of detail is sufficient to identify cost-effective water conservation measures and to prioritize their implementation. An analysis that considers project life cycles is presented in Appendix L.

Inclusion of a benefit from downsizing planned future water supplies is sufficient to show that each of the potential water conservation measures is cost-effective in comparison to obtaining additional raw water. However, there are other capital projects that could be deferred or downsized, such as improvements to water treatment plants, water distribution systems, wastewater treatment plants, and wastewater collection systems. Benefits from deferring or downsizing these additional capital projects have not been accounted for.

The other issues will be addressed during final planning for the recommended water conservation measures.

Meeting 3: Discuss Twice-Weekly Watering Limitation with Wholesale Customers

On March 19, 2012, TRWD, TRA, and the cities of Fort Worth, Arlington, Mansfield, and Bedford met to discuss implementation of ordinances limiting irrigation to no more than twice per week. The following comments were made during the meeting:

- Exemptions from the ordinances are important (soaker hoses, new plantings, etc.).
- It is important to try to coordinate the ordinances with Dallas Water Utilities (DWU), but it may not be possible to be completely consistent.
- Implementation needs to be regional in nature, not a patchwork of cities.
- If Fort Worth implements a permanent twice-weekly irrigation limitation, Fort Worth's wholesale customer cities are obligated to do the same. However, TRA's wholesale customers are not obligated to follow TRA's lead.
- What Texas cities have implemented twice-weekly watering restrictions? How much water savings are being achieved through the similar Stage 1 drought response measures?

Response

Most of these issues will be addressed during final planning for the recommended water conservation measures.

The City of Austin and the Lower Colorado River Authority's West Travis County Regional Water System have saved water with permanent twice-weekly watering limitations (Section H.13 of Appendix H). In addition, TRWD's four primary customers have experienced water savings of 5 to 11 percent of total water use with the temporary Stage 1 drought response measures that limit irrigation to no more than twice per week (Appendix I).

TRWD will work toward getting customer buy-in for permanent twice-weekly watering limitations.

Meeting 4: Review Second Revised Draft Implementation Plan with Wholesale Customers

On October 19, 2012, APAI presented a second revised water conservation implementation schedule to representatives of TRA and the cities of Fort Worth, Arlington, Mansfield, and

Bedford. The revised plan contained revisions to projected water savings and costs for several measures and updated water use information through 2011.

APAI also presented an example of how reducing water use causes a utility's overall cost of service to grow more slowly, even though the utility may have to increase water rates to avoid revenue loss. Despite increased rates, the bills of customers who conserve can also grow more slowly or even decline depending on the amount of reduced water use.

Comments about the revised plan included:

- Implementation barriers:
    - Fort Worth does not want to subsidize toilet incentive programs in other cities.[38]
    - Water rates are a sensitive issue, and councils/boards will need compelling reasons to raise water rates to account for the revenue loss associated with reduced water use. This is particularly true for a twice-weekly watering limitation, which is projected to substantially reduce water use. Consider delaying implementation of the twice-weekly watering limitation from 2013 to a later year and advancing other strategies. Use the delay to communicate the benefits of a twice-weekly watering limitation to decision-makers.
    - Wholesale customers do not want to pay for additional TRWD staff positions when the wholesale customers are freezing or cutting staff levels.
- Developing model conservation and model landscape ordinances and coordinating conservation-related contracts to yield economies of scale would be helpful to the wholesale customers.

Response

During final planning for the toilet incentive measure, TRWD will explore ways to pass the cost of the measure to the utilities that will benefit from the measure.

In the recommended implementation schedule (Table 11-1), TRWD will move implementation of a twice-weekly watering limitation from 2013 to 2014. TRWD will work with its wholesale customers to communicate the benefits of a twice-weekly watering limitation to council and board members, other decision-makers, and the public. To fill the gap in 2013, TRWD will also move the model water conservation ordinance and the golf course conservation measures from 2015 to 2013.

From information provided in Chapter 10, the financial benefits of the measures that require additional labor resources (Table 11-3) outweigh the costs of the measures. This analysis accounts for the cost of the additional labor resources. TRWD will work with its wholesale customers to communicate the need for these labor resources and the benefits of the associated

[38] Arlington made a similar comment in Meeting 2.

water conservation measures to council and board members, other decision-makers, and the public.

Meeting 5: Discuss Implementation Issues with Wholesale Customers

On December 6, 2012, TRWD, TRA, and the cities of Fort Worth, Arlington, and Mansfield met to discuss water conservation implementation issues. The following comments were made during the meeting:

- The Strategic Plan should clearly state that changes to the plan are acceptable as conditions change.
- The projected water savings have been placed in the context of additional people that could be served with existing water supplies. Not everyone favors growth, so the projected water savings should also be placed in other contexts, such as comparison to the water available from existing or future water supplies.
- A footnote should be added to clarify that the "water use reduction – price" measure is based only on the projected TRWD in-district water price through 2022 and does not include the impact of other rate increases.
- A footnote should be added to the recommended TRWD water conservation budget to emphasize that the recommended budget is for water conservation activities (toilet retrofits, ICI water audits, etc.) in addition to those implemented by the Fort Worth and Arlington water conservation programs.
- The customers expressed conditional support for the plan, pending development of:
    - Equitable methods for funding the recommended measures, particularly those that overlap with existing customer water conservation programs. Fort Worth and Arlington reemphasized that, since they already spend money to implement toilet retrofits and ICI programs, they do not want to subsidize these programs for other cities.
    - A method for customer input during final planning of the recommended water conservation measures and development of final TRWD water conservation budgets. There is concern that the TRWD will not consider customer input.

Response

As stated in Section 1.2, the Strategic Plan is intended to be implemented with a "common sense" approach, whereby progress assessments are conducted annually and adjustments are made as necessary to address changing needs and conditions, while achieving the stated goals and targets.

The projected 2017 water savings equal approximately 21 percent of the annual yield that TRWD could potentially obtain from the future Marvin Nichols Reservoir (Ref. 1). This additional context was added to Sections ES.5 and 11.2.

Footnotes were added to Tables 10-3 and 10-6 to clarify that the "water use reduction – price" measure is based only on the projected TRWD in-district water price through 2022 and does not include the impact of other rate increases.

A footnote to Table 11-4 was expanded to clarify that the recommended TRWD water conservation budgets are for water conservation activities (toilet retrofits, ICI water audits, etc.) beyond those established and implemented by the Fort Worth and Arlington water conservation programs.

To address customer concerns, TRWD will form an ongoing Water Conservation Implementation Committee consisting of representatives from TRWD, the cities of Fort Worth, Arlington, and Mansfield, and TRA. Through the Committee, TRWD will work with the customers to obtain input during planning of the recommended water conservation measures. This has been included as an implementation recommendation in Section 11.6.

11. Recommended Implementation Plan, 2013 through 2017

The Strategic Plan is designed to provide the next steps in a long-range, disciplined approach to water conservation. Benefits of this approach include extending the life of existing water supplies, reducing peak infrastructure requirements, avoiding certain capital and operating costs, encouraging citizens and customers to use water wisely, and positioning TRWD to obtain future water rights. The numerical goal of the Strategic Plan is to reduce per capita consumption by an average of one percent per year during the five-year planning period (Figure 10-1).[39]

While significant analysis and efforts have gone into development of the Strategic Plan, the Plan should be reassessed annually to make sure that TRWD and its customers are achieving their water conservation goals, to revamp programs if necessary, and to take advantage of new water conservation opportunities, such as federal or state funding for water conservation. The overall conservation program should be flexible, allowing measures to be adjusted based on continued feasibility and support of goals, feedback from stakeholders and focus groups, and public participation or interest.

As described in the following sections, recommended the implementation plan consists of new water conservation measures, an implementation schedule, new labor resources, TRWD budgets, and other recommendations.

11.1. Recommended Implementation Schedule

Considering how effective TRWD's water conservation program has been over the last several years (Figure 10-1), all of the water conservation measures presently employed by TRWD (described in Chapter 6) are recommended for continuation through the planning period. In addition, it will be important to use the multimedia public outreach campaign to educate the public about new measures as they are implemented and to encourage participation.

The recommended implementation schedule for the next five years (Table 11-1 and Figure 11-1) is based on the following prioritization criteria for new water conservation measures:

- Implement the more cost-effective measures early. However, if necessary, delay implementation while working to increase public acceptance.
- Implement measures with higher water savings early.
- Limit the number of programs to be planned/implemented each year based on available resources.
- Align strategies that have similarities/synergies.

For each recommended measure, target customer participation and target customer markets are shown in Table 10-1.

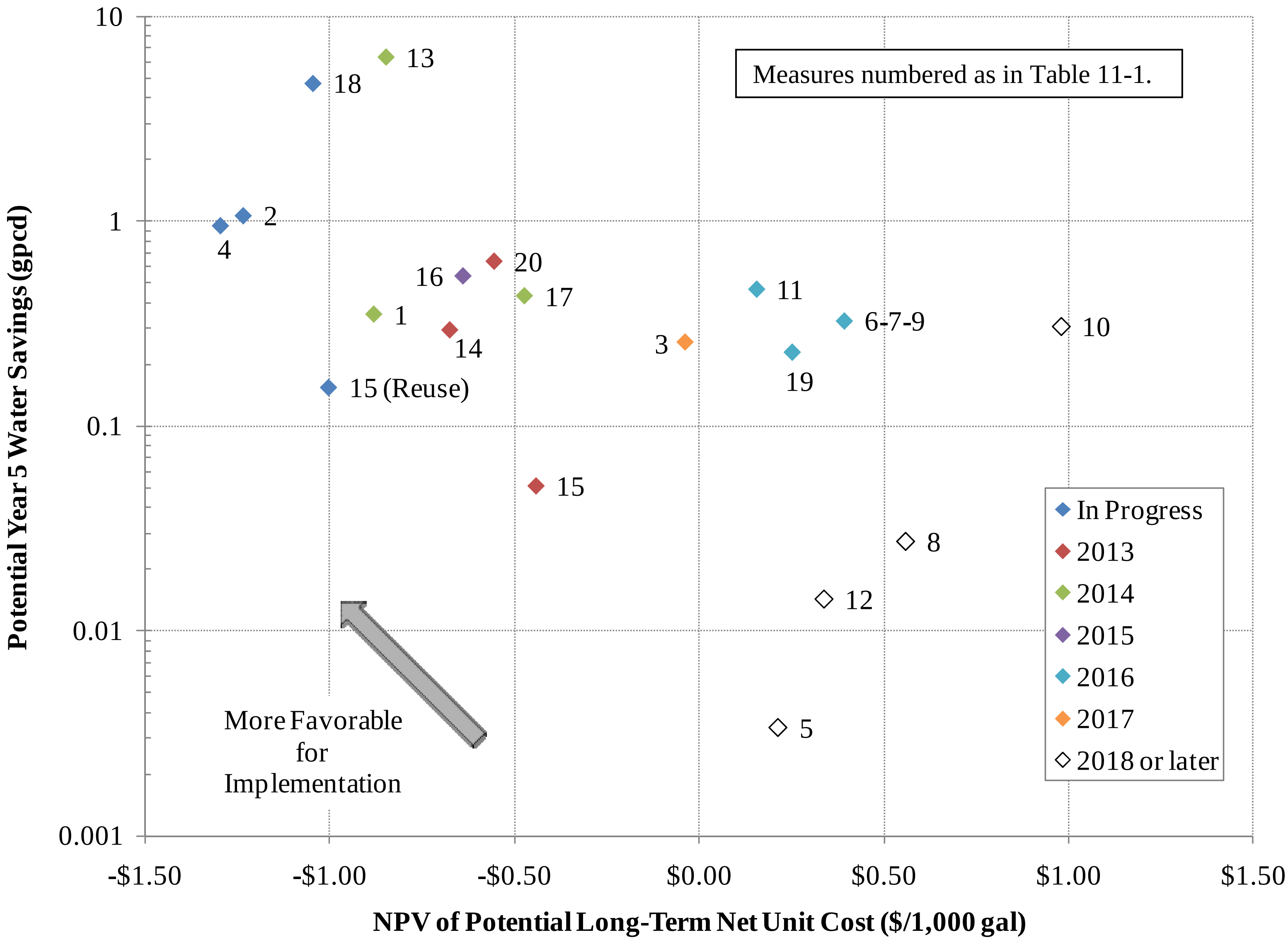
[39] Other goals are presented in Section 10.1.

Table 11-1: Recommended Implementation Schedule for Evaluated Measures

Measure		Year				
		2013	2014	2015	2016	2017
2	Toilets, natural replacement with HETs					
4	Residential clothes washers, natural replacement with HECWs					
15	Golf course reuse (natural implementation)*					
18	Water use reduction due to increases in real water price					
14	Public education (ET irrigation recommendations)					
20	Model conservation ordinance					
15	Golf course conservation					
13	Irrigation limits: maximum 2 times per week	X				
1	Residential high-efficiency toilet (HET) distribution/incentives	X				
1	*Create ICI device incentives menu:* High-efficiency toilet (HET) distribution/incentives	X				
17	Water loss reduction	X				
16	Model landscape ordinance	X	X			
11	*Add measure to ICI device incentives menu:* Irrigation system incentives			X		
11	Residential irrigation system incentives			X		
19	Wholesale customer assistance			X		
6 7 9	*Site-specific ICI customer program:* ICI customer water audits Site-specific ICI incentives ICI recognition program			X		
3	Residential high-efficiency clothes washer (HECW) incentives				X	
3	*Add measure to ICI device incentives menu:* High-efficiency clothes washer (HECW) incentives				X	
8	*Add measure to ICI device incentives menu:* Cooling tower incentives					X
10	Irrigation system evaluations	Y	Y	Y	Y	X
12	Rainwater harvesting incentives					
5	Pre-rinse spray valve retrofits					

*: Natural conversion of golf course irrigation from raw or potable water to reclaimed water.
X: TRWD staff will perform final planning of measures in the years before implementation.
Y: TRWD will continue its pilot irrigation system evaluation program.

Figure 11-1: Implementation Schedule, Cost-Effectiveness, and Water Savings



The following recommendations are given in support of the implementation schedule (Table 11-1):

- As soon as possible, TRWD should develop a model conservation ordinance and encourage customers to adopt and enforce the ordinance.
- TRWD is already working to implement the public education (ET irrigation recommendations) measure. The golf course conservation measure will build on this measure by encouraging golf courses to use the ET irrigation recommendations. Both of these are relatively low-cost measures, and they are also recommended for implementation in 2013.
- TRWD should develop a model ordinance restricting irrigation to a maximum of two times per week and encourage customers to adopt and enforce the ordinance. This measure would make permanent the irrigation restriction that TRWD activated from August 29, 2011 through May 3, 2012 as part of Stage 1 of its Drought Contingency Plan. Although this measure is projected to have substantial water savings, implementation should be delayed until 2014 to allow TRWD to work with its wholesale customers to communicate the benefits of a twice-weekly watering limitation to council and board members, other decision-makers, and the public.
- Although the high-efficiency toilet distribution/incentives measure is the most cost-effective active measure in the long-term, it will require substantial budget increases. Since there is not sufficient time remaining to increase the budget for 2013, it is recommended that the high-efficiency toilet distribution/incentives measure be implemented in 2014.
- TRWD should create an “ICI Device Incentives Menu” to promote use of water-efficient fixtures and equipment by a large number of ICI customers. This menu would begin with implementation of high-efficiency toilet distribution/incentives in 2014 and would expand in later years to include high-efficiency clothes washer incentives and irrigation system incentives.
- TRWD should also create (by 2016) a “Site-Specific ICI Customer Program” that would provide in-depth assistance to individual ICI customers that desire it. This program would include the ICI customer water audits, site-specific ICI incentives, and ICI customer recognition measures. This program, and the ICI Device Incentives Menu described above, would complement the SmartWater ICI Audits program that Fort Worth implemented in 2010 by expanding audits to other cities and by making it more cost-effective for ICI water users to upgrade equipment. Examples of Fort Worth’s success with this program are cited in Section 7.3.
- Since TRWD staff will be busy implementing the irrigation system incentives in 2016, the high-efficiency clothes washer incentives should be delayed until 2017.
- Although implementation of the irrigation system evaluations is not recommended until 2018 (after the five-year planning period), TRWD should begin final planning for this measure in 2017.
- Given the number of programs that TRWD must develop to meet the recommended schedule and the relatively low projected water savings from the pre-rinse spray valve

retrofits, rainwater harvesting incentives, and cooling tower incentives, these measures are not recommended for implementation in the next five years.

11.2. Projected Water Savings, Benefits, and Costs

By 2017, the recommended implementation plan is projected to achieve the following water savings, benefits, and costs:

- Annual water savings of 30.1 mgd (Table 11-2), which is 56 percent greater than the projected conservation savings (about 19.3 mgd) in the 2011 Region C Water Plan (Table 2-2).
- Annual per-capita water savings of 15.6 gpcd (Figure 11-2). The recommended implementation plan would put TRWD on course to meet its 2018 water use goal of 166 gpcd (Table 6-1).
- Cumulative present value benefits of about $30.9 million (Figure 11-3).
- Cumulative present value costs to utilities of about $14.4 million.
- Cumulative benefit-cost ratio of about 2.1.

The projected water savings from the implementation plan are in addition to the water savings that have already been achieved (an average of 23.2 mgd from 2007 through 2011). Therefore, it is projected that continuation of TRWD's existing water conservation measures and implementation of the recommended measures will achieve a total water savings of approximately 53.3 mgd compared to 2006 water use. At the projected five-year average per capita water demand (165.1 gpcd), these water savings would stretch the existing water supply enough to meet the needs of an additional 322,800 people by 2017. Placed in a different context, these water savings equal approximately 21 percent of the annual yield that TRWD could potentially obtain from the future Marvin Nichols Reservoir (Ref. 1).

The implementation plan would reduce projected per capita water use and, therefore, could either delay the need for additional water supplies or allow TRWD to downsize its share of future water supply projects. By 2030, the implementation plan could delay the need for additional water supplies by as many as 9 years (based on the discussion on page 103 about water conservation savings during a severe drought). As described in Section 10.5, construction of future water supplies is expected to be a cooperative effort between TRWD and other agencies. Since other agencies might not be able to defer construction of new facilities, it has been assumed, for the purpose of evaluating the cost-effectiveness of potential water conservation measures, that TRWD will downsize its share of each planned future water supply according to the projected water conservation savings during a severe drought (also discussed in Section 10.5). Either way, the recommended water conservation implementation plan is cost-effective compared to developing additional water supplies.

Table 11-2: Projected Water Savings from Recommended Implementation Plan

Water Conservation Measures		Projected Water Savings (mgd)					Projected Water Savings (gpcd)				
		2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
2	Toilet natural replacement	0.50	0.89	1.27	1.67	2.07	0.28	0.49	0.69	0.88	1.07
4	Clothes washer natural replacement	0.49	0.74	0.99	1.42	1.85	0.28	0.41	0.53	0.75	0.96
15	Golf course reuse (natural implementation)	0.30	0.30	0.30	0.30	0.30	0.17	0.16	0.16	0.16	0.15
18	Water use reduction - price	2.27	2.86	4.64	6.81	9.16	1.28	1.58	2.50	3.60	4.74
14	Public education (ET)	0.52	0.54	0.55	0.56	0.57	0.29	0.29	0.29	0.29	0.29
20	Model conservation ordinance	-	1.13	1.16	1.18	1.20	-	0.62	0.62	0.62	0.62
15	Golf course conservation	0.02	0.04	0.06	0.08	0.10	0.01	0.02	0.03	0.04	0.05
13	Irrigation limits 2/wk	-	11.26	11.49	11.73	11.98	-	6.20	6.20	6.20	6.20
1	Toilet retrofits	-	0.14	0.27	0.41	0.54	-	0.07	0.15	0.21	0.28
17	Water loss reduction	-	0.26	0.52	0.80	0.82	-	0.14	0.28	0.42	0.42
16	Model landscape ordinance	-	-	0.20	0.41	0.61	-	-	0.11	0.21	0.32
11	Irrigation system incentives	-	-	-	0.17	0.35	-	-	-	0.09	0.18
19	Wholesale customer assistance	-	-	-	0.09	0.18	-	-	-	0.05	0.09
6	ICI customer water audits	-	-	-	0.03	0.06	-	-	-	0.01	0.03
7	Site-specific ICI incentives	-	-	-	0.07	0.14	-	-	-	0.04	0.07
9	ICI recognition program	-	-	-	0.02	0.05	-	-	-	0.01	0.02
3	Clothes washer retrofits	-	-	-	-	0.13	-	-	-	-	0.07
8	Cooling tower incentives	-	-	-	-	-	-	-	-	-	-
10	Irrigation system evaluations	-	-	-	-	-	-	-	-	-	-
12	Rainwater harvesting incentives	-	-	-	-	-	-	-	-	-	-
5	Pre-rinse spray valve retrofits	-	-	-	-	-	-	-	-	-	-
Total		**4.1**	**18.1**	**21.4**	**25.7**	**30.1**	**2.3**	**10.0**	**11.6**	**13.6**	**15.6**

Figure 11-2: Projected Per-Capita Water Savings

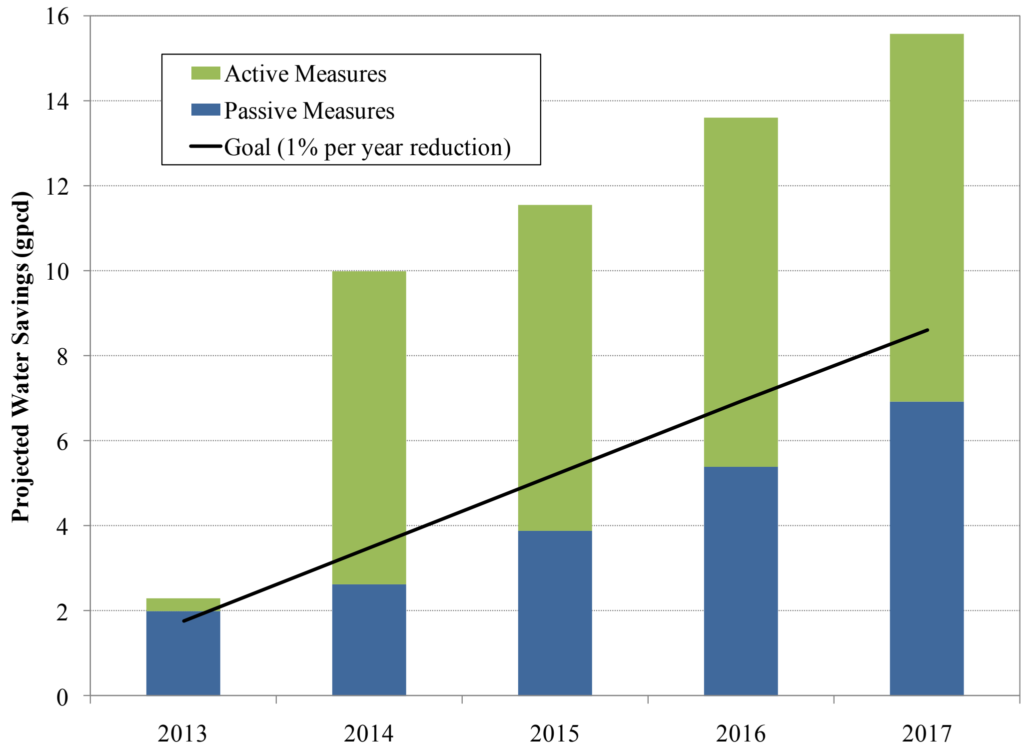
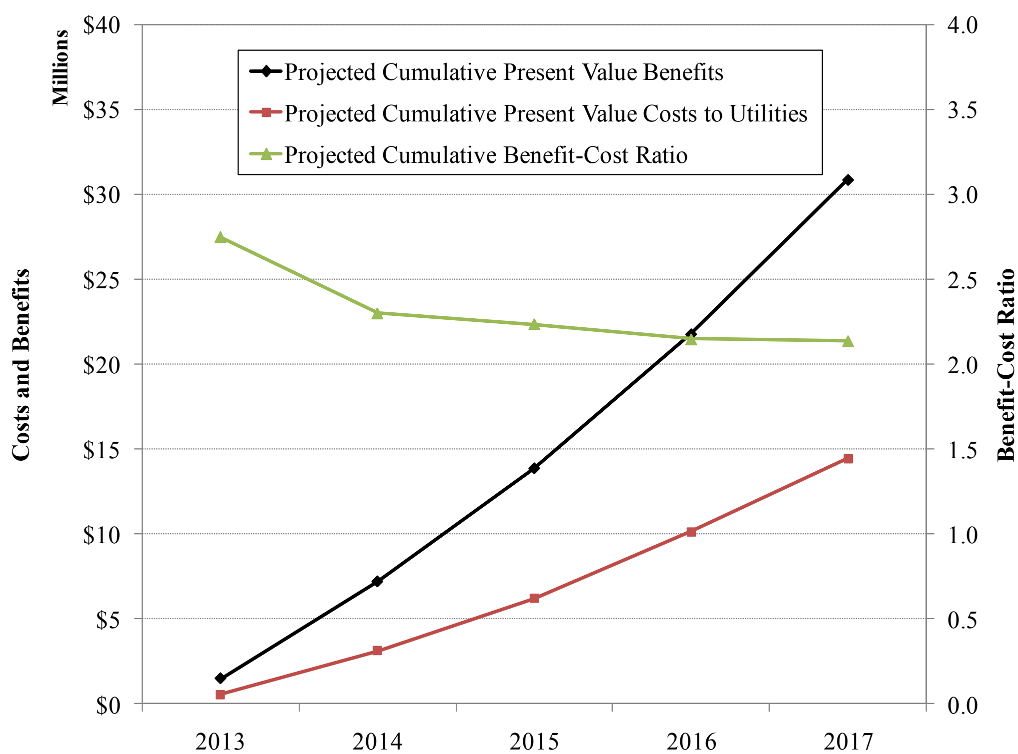


Figure 11-3: Projected Present Value Benefits and Costs to Utilities



It is assumed that Fort Worth and Arlington will continue their existing water conservation measures. Although TRWD will realize additional savings from these measures, additional savings from existing Fort Worth and Arlington measures have not been estimated and are not included in Table 11-2 or Figure 11-2.

11.3. Recommended New Labor Resources

TRWD will implement some of the recommended water conservation measures (e.g., the ordinance measures) with existing staff members.[40] The remaining recommended measures will require new labor resources to effectively implement the Strategic Plan. New labor resources could consist of additional TRWD staff members and/or retaining contractors. During the final planning stage for each recommended measure, TRWD will decide whether to add staff or retain contractors. Table 11-3 presents the overall new labor resource requirements in terms of full-time equivalent (FTE) positions, summarized by strategy and year. It is anticipated that additional labor resources equivalent to 6 FTEs will be required to effectively implement the recommended measures during the five-year implementation period.

The recommended total number of existing TRWD staff positions and new labor resources is fewer than the number of existing water conservation staff positions for the City of Austin and the San Antonio Water System (SAWS) (Figure 11-4).[41]

The recommended new labor resources have been based on customer participation assumptions and staff time required for similar programs at other utilities. Each of the recommended water conservation measures should be reviewed annually to verify that customer participation and the production capacity of the existing staff continue to warrant the recommended new labor resources.

11.4. Recommended TRWD Water Conservation Budgets

The opinions of probable cost presented in Section 10.5 represent "costs to utilities" that are borne by both TRWD and its wholesale customers. In this section, recommended TRWD water conservation budgets are presented for the next five years (Table 11-4). TRWD budgets do not include costs borne by the wholesale customers, such as enforcement of regulations. The recommended budgets are designed to give TRWD the flexibility to either add staff or retain contractors to implement the recommended water conservation measures.

The recommended budgets are the probable amounts that TRWD must spend on each strategy to achieve the projected water savings (Table 11-2). In addition, TRWD should continue to fund its existing water conservation measures at existing levels (adjusted for inflation). The recommended total water conservation budgets range from \$1.66 million in 2013 to \$5.00 million in 2017.

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[40] TRWD's customers may have to add staff members to implement some of the measures, particularly for ordinance enforcement. Although customer-borne costs are included in the opinions of probable utility cost in Section 10.5, numbers of additional staff members have not been estimated and are not included in Table 11-3.

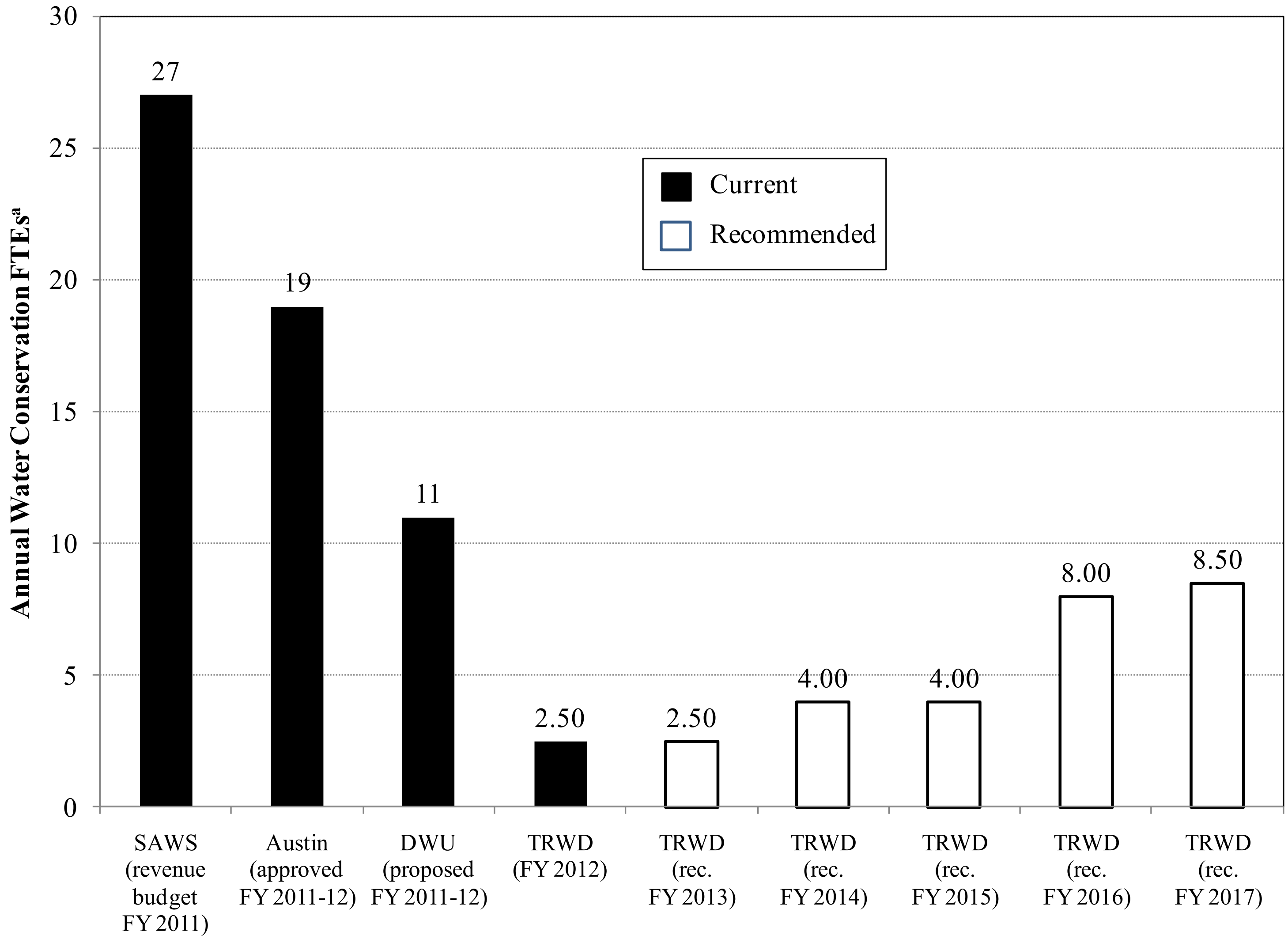
[41] Includes existing TRWD staff.

Table 11-3: Recommended New Labor Resources

Recommended Water Conservation Measures[a]	Recommended New Labor Resources (FTEs)[b,c]					
	2013	2014	2015	2016	2017	Five-Year Total
Toilet retrofits - Clerical		+1.50				+1.50
Irrigation system incentives - Clerical				+1.00		+1.00
Wholesale customer assistance - Application review, installation/savings verification				+0.25		+0.25
Site-specific ICI customer program - ICI water audits, installation/savings verification[d]				+2.75		+2.75
Clothes washer retrofits - Clerical					+0.50	+0.50
TOTAL	**+0.00**	**+1.50**	**+0.00**	**+4.00**	**+0.50**	**+6.00**

[a] Some recommended water conservation measures/tasks are not shown, because it is assumed that TRWD will implement them using existing staff members.
[b] TRWD can either add staff members or retain contractors to implement these measures.
[c] Does not include staff increases for TRWD customers.
[d] As described in Section 7.3, Fort Worth uses a contractor to conduct its SmartWater ICI Audit program.

Figure 11-4: Comparison of Labor Resources with Other Texas Utilities



[a] FTEs for other utilities do not include contractors. Refs. 37, 38, and 39.

Table 11-4: Recommended TRWD Water Conservation Budget

Water Conservation Measures		Recommended TRWD Water Conservation Budget[a]				
		2013	2014	2015	2016	2017
2	Toilet natural replacement	$0	$0	$0	$0	$0
4	Clothes washer natural replacement	$0	$0	$0	$0	$0
15	Golf course reuse (natural implementation)	$0	$0	$0	$0	$0
18	Water use reduction - price	$0	$0	$0	$0	$0
14	Public education (ET)	$2,000	$2,000	$2,000	$2,000	$2,000
20	Model conservation ordinance[b]	$0	$0	$0	$0	$0
15	Golf course conservation	$7,000	$7,000	$7,000	$8,000	$8,000
13	Irrigation limits 2/week[b]	-[c]	$0	$0	$0	$0
1	Toilet retrofits[d]	-[c]	$1,215,000	$1,237,000	$1,259,000	$1,282,000
17	Water loss reduction	-[c]	$122,000	$43,000	$44,000	$45,000
16	Model landscape ordinance[b]	-[c]	-[c]	$0	$0	$0
11	Irrigation system incentives	-	-	-[c]	$638,000	$666,000
19	Wholesale customer assistance	-	-	-[c]	$237,000	$229,000
6-7-9	Site-specific ICI customer program[d]	-	-	-[c]	$384,000	$395,000
3	Clothes washer retrofits	-	-	-	-[c]	$602,000
10	Irrigation system evaluations[d]	-[e]	-[e]	-[e]	-[e]	-[c,e]
Subtotal		***$9,000***	***$1,346,000***	***$1,289,000***	***$2,572,000***	***$3,229,000***
Continue existing TRWD programs		$1,649,000	$1,679,000	$1,710,000	$1,741,000	$1,773,000
Update Strategic Water Conservation Plan		-	-	-	$380,000	-
Total Water Conservation Budget		**$1,658,000**	**$3,025,000**	**$2,999,000**	**$4,693,000**	**$5,002,000**

[a] Costs inflated at an annual inflation rate of 1.8 percent per year (see Appendix J for discussion).
[b] Existing TRWD staff members will develop the model ordinances and coordinate customer adoption.
[c] Existing TRWD staff members will perform final planning and development of measures in the years before implementation.
[d] TRWD will coordinate with existing Fort Worth and Arlington measures. The recommended budgets are for water conservation activities (toilet retrofits, ICI water audits, etc.) beyond those established and implemented by the Fort Worth and Arlington water conservation programs.
[e] Assumes that TRWD will continue its pilot irrigation system evaluation program. The pilot program is included in the "continue existing TRWD programs" line item.

Although it is recommended that TRWD proceed with implementation of recycled water projects to increase water efficiency, recycled water planning has been conducted separately from water conservation planning, and no budget recommendations for recycled water projects have been developed as part of the Strategic Plan.

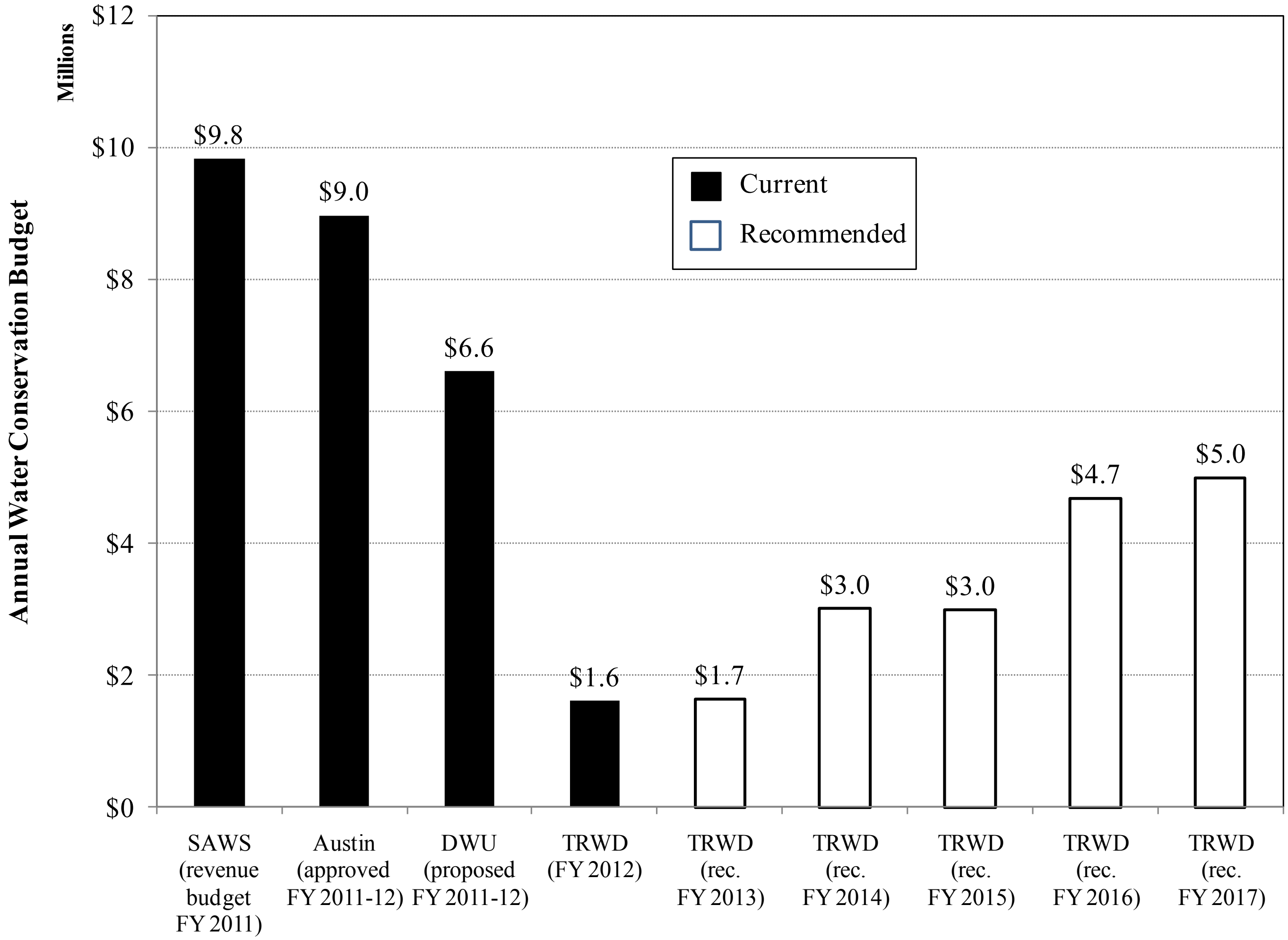
The recommended future TRWD budgets are less than existing water conservation budgets for the City of Austin, the San Antonio Water System (SAWS), and Dallas Water Utilities (Figures 11-5 and 11-6).

11.5. Implementation Steps

TRWD should implement new water conservation strategies in the following general steps:

- Final planning and development: Increase staff or hire a contractor as necessary to administer the measure. Identify, research, and make decisions about key implementation issues (e.g., rebates versus vouchers, eligibility requirements, ordinance language, etc.). Identify methods for engaging the target customer market. If necessary, conduct pilot testing for a limited time to gain experience with the individual measure. Planning and development typically occurs one or more years prior to full-scale implementation.
- Marketing and education: Conduct an aggressive campaign to solicit the participation of targeted customers. Educate customers about potential water savings expected from the particular measure, how water is conserved, and other opportunities to save. This may involve meetings with stakeholder groups, multi-media advertising campaigns, or other communication methods. Marketing and education should begin a short time prior to full-scale implementation and should continue to some degree throughout the life of the measure.
- Full-scale implementation: Depending on the individual measure, conduct day-to-day operations necessary to carry out individual education and outreach initiatives or provide financial or other incentives to encourage customer participation.
- Verification/follow-up/data collection: Confirm the installation of conservation devices and equipment if necessary. For some measures, this may involve site inspections. Record relevant data about the customer and the measure. Compare water use before and after installation. Verification/follow-up/data collection begins with full-scale implementation and continues until the individual measure is discontinued.
- Savings/cost comparison: Estimate the water savings and the value of the water saved through the measure. Estimate the cost to initiate and monitor the measure throughout its life. Compare savings to costs in terms of a net unit cost, benefit-cost ratio, or payback period. Savings/cost comparisons should be conducted annually to monitor the progress of the measure toward meeting its goals. If the measure is not meeting its goals, it should be reevaluated, and program parameters should be changed or revised goals should be established.

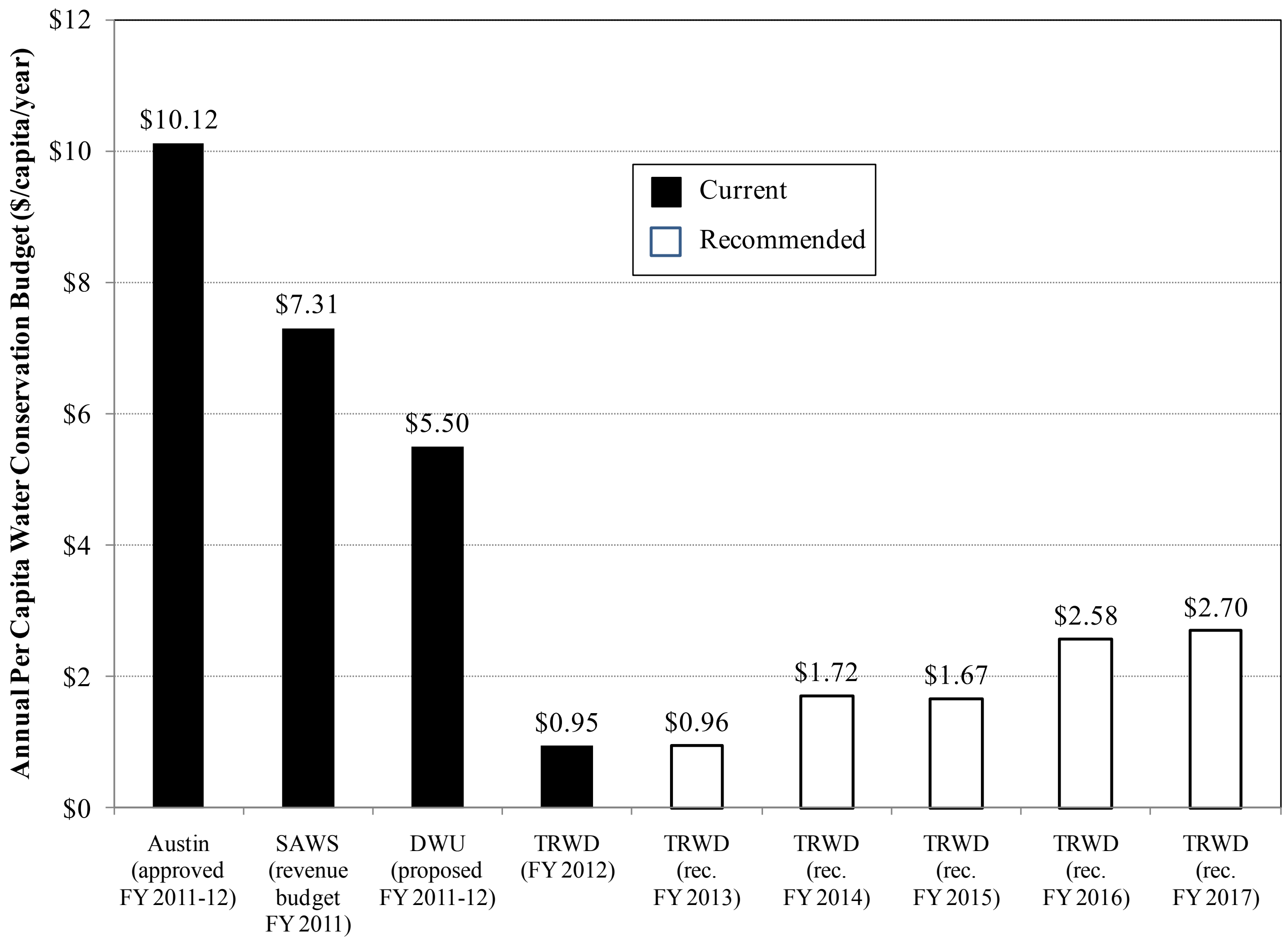
Figure 11-5: Comparison of Water Conservation Budgets with Other Texas Utilities



Notes:

1. Assumes that SAWS will spend conservation revenues on the water conservation program.
2. DWU water conservation budget does not include the leak detection and repair budget.
3. Refs. 37, 38, and 39.

Figure 11-6: Comparison of Recommended Per Capita Water Conservation Budgets with Other Texas Utilities



Notes:

1. Austin, SAWS, and DWU populations estimated. TRWD future population estimated using 2011 NCTCOG population estimates (Ref. 40) and a 1.7 percent growth rate (consistent with Region C projections (Ref. 1).
2. Assumes that SAWS will spend conservation revenues on the water conservation program.
3. DWU water conservation budget does not include the leak detection and repair budget.
4. Refs. 38, 37, 41, and 39.

11.6. Implementation Recommendations

During final planning for measure implementation, TRWD should consider the recommendations in the following sections.

Form an Ongoing Water Conservation Implementation Committee

To address customer concerns, TRWD should form an ongoing Water Conservation Implementation Committee consisting of representatives from TRWD, the cities of Fort Worth, Arlington, and Mansfield, and TRA. Through the Committee, TRWD should work with the customers to obtain input during planning of the recommended water conservation measures.

Build on the Experience of Other Regional Water Conservation Programs

In the final planning of its measures, TRWD should build on the experience of other utilities. Many of the regional water conservation programs surveyed in Appendix D have implemented measures that are recommended for TRWD. These utilities are listed in the measure descriptions in Table 9-2.

Make Measures Available to Customers throughout the Service Area

TRWD should make the regional water conservation measures available to customers throughout its wholesale service area. The regional water providers that have achieved the most significant long-term water savings follow this policy (see the review of other regional water conservation programs in Appendix D). Where possible, TRWD should also target high water users for participation in the conservation program.

Consider a "Service Rule" Enforcement Method

After the wholesale customers adopt the model ordinances, TRWD should encourage them to consider a service rule enforcement method, where compliance with certain water conservation rules is part of the terms of obtaining water service. Under this method, if a retail customer violates a water conservation rule, the city or utility personnel document the violation with digital photography and/or video, and the local utility assesses a fine on the customer's water bill. The Southern Nevada Water Authority member agencies use this enforcement method, and the City of Austin is considering code revisions to move toward service rule enforcement (Ref. 42).

Some of the advantages of the service rule enforcement method over an ordinance-based method are that the utility (rather than the court system) controls the enforcement process, collected fines go to the utility rather than the municipal general fund, the utility controls whether fines are negotiated downward, and enforcement time per violation is reduced.

Minimize Cost and Maximize Efficiency of Incentive Measures

The main implementation methods for incentive measures are rebates/coupons/vouchers, distribution to retail customers, and direct installation. To minimize cost and maximize efficiency, TRWD should pursue the following strategies to the extent practicable:

- Favor online applications and email responses to customers over paper communications, avoiding mailing costs and reducing turnaround time.
- To minimize the number of financial transactions and staff time consider:
    - Providing electronic vouchers or coupons to qualified customers for redemption at an equipment supplier location. The City of Arlington has changed from toilet distribution events to this distribution method. Advantages include paying the incentive amounts directly to a limited number of equipment suppliers, not having to provide storage for the equipment, not having to provide labor to distribute the equipment, and convenient hours for the customer to pick up the equipment.
    - For a rebate to a qualified customer, notify the retail water provider to issue a credit to the customer's water account. TRWD would provide a monthly list of qualified customers to a limited number of retail water providers, along with the corresponding incentive payment.[42] This method would also require agreements with retail water providers.

Periodically Reevaluate Continued HET Distribution/Incentives

Due to the impact of HB 2667, it is projected that all toilets will eventually be replaced with 1.28 gpf toilets or better without TRWD action. An HET distribution or incentive program accelerates replacement of inefficient toilets and accelerates the associated water savings. From the analysis in previous sections, this appears to be an effective water conservation measure for the next five years. However, the number of inefficient toilets in the service area will decline over time and so will the benefits of an active HET distribution/incentives program. The Contra Costa Water District is considering discontinuation of its toilet rebate program due to market saturation, new laws requiring high-efficiency toilets (1.28 gallons per flush), and an opportunity to reallocate its resources for larger savings from landscape irrigation measures (Ref. 43). TRWD should periodically evaluate whether to continue an active HET distribution/incentives program.

Target High-Flow Toilets for HET Distribution/Incentives

In 1992, the National Energy Policy Act required that toilets manufactured after January 1, 1994 cannot use more than 1.6 gpf. Such toilets are called ultra-low-flow toilets, or ULFTs. Since

[42] The recommended TRWD water conservation budgets (Table 11-4) assume that TRWD will pay the incentive costs. This means that all TRWD customers share proportionally in the costs of incentive measure. Alternatively, TRWD could emulate the Metropolitan North Georgia Water Planning District (MNGWPD) toilet rebate program. Under agreements with local water providers, the MNGWPD serves as a central clearinghouse, processing rebate applications and tracking participating customers, and the local utility bears the cost of the incentive. This method would reduce TRWD's budget from the levels shown in Table 11-4 but could reduce water savings if local utilities decide not to participate.

about 1995, almost all new toilets and retrofitted toilets have been ULFTs. However, a recent evaluation of the flush volume of toilets in homes constructed since 2001 found a median flush volume of about 1.93 gpf (Ref. 44). Many ULFTs are not performing to their nominal water use, representing an opportunity for additional water savings if they are replaced with HETs (1.28 gpf).

Underperforming ULFTs could be identified individually during a customer water audit. However, unless it is proven that certain models do not function properly, it is not clear how to identify and target them on a large scale. For this reason, it is also difficult to estimate the associated water savings potential and to determine whether pursuing these poor-performing toilets would be cost-effective. Until more information is available, TRWD should target its HET distribution/incentives measure to replace toilets that use 3 gpf or more.

Target Highest ICI Water Users for Site-Specific ICI Customer Program

The site-specific ICI customer program should target customers that will yield the most water savings at the least cost. To achieve this, TRWD's first priority should be to target the highest water-using ICI customers for individual attention.

If TRWD has additional resources, the second priority should be to target customers in the highest water-using ICI customer types (*e.g.*, office buildings, hotels, schools, etc.). TRWD could increase participation from these customer types through presentations to building manager associations, trade groups, school administrators, or other relevant organizations.

Monitor Developments in Pre-Rinse Spray Valve Recommendations

The detailed evaluation of the PRSV retrofits measure (Chapter 10) is based on Fort Worth's experience with its SpraySmart program. Fort Worth distributes the Niagara Conservation N2180 (1.28 gpm) PRSV. Although it appears to be cost-effective to replace high-flow PRSVs, the projected water savings are too low to warrant implementation in the next five years. However, certain high-efficiency PRSV models use a lower flow rate and have the potential to realize more water savings, even for customers that are using a "low-flow" 1.6 gpm PRSV. For example, the T&S Brass B-0107-C uses 0.65 gpm.

If TRWD considers proceeding with implementation of a high-efficiency PRSV retrofit program, it should do the following before selecting a PRSV model:

- Monitor development of the EPA WaterSense PRSV performance specifications. The EPA WaterSense program is working to develop draft performance specifications for high-efficiency PRSVs (Ref. 45). The WaterSense program labels products that are at least 20 percent more efficient than standard models, so it is likely that the specification will limit flow rates for WaterSense-labeled PRSVs to 1.28 gpm or less.
- Consider pilot testing to ensure that customers are satisfied with the selected PRSV. A recent study performed for the WaterSense program field-tested 14 PRSVs that meet the ASTM F2324-03 standards for flow rate and cleanability (Ref. 46). The PRSV models

were not identified. This study found that customers are less satisfied with PRSVs that use less than 1.0 gpm.

11.7. General Recommendations

During the next five years, TRWD should monitor the effectiveness of the Strategic Plan, collect additional data, continue effective communications with its wholesale customer communications, and update the Strategic Plan.

Monitor the Effectiveness of the Strategic Plan

TRWD should monitor the effectiveness of the Strategic Plan by reviewing water use data, tracking water conservation implementation, and updating the annual regression model.

Review Water Use Data

Each year, TRWD should update the water use analysis (Chapter 4). The updated water use analysis should include:

- Annual water use,
- Per capita water use,
- Customer water sales by sector (residential, commercial, industrial, and other),
- Residential per capita water sales,
- Nonrevenue water and water loss,
- Seasonal water use, and
- Peak day water use

Where possible, the water use statistics should be calculated for TRWD as a whole and for each customer individually. TRWD should analyze these statistics for trends that indicate:

- The effectiveness of the regional water conservation program, and/or
- Water customers that should be targeted for additional conservation measures, or
- Water customers that should be targeted for increased participation in existing measures.

Compare Per Capita Water Use to Targets and Goals

The Water Conservation Implementation Task Force recommended crediting indirect reuse diversion volumes against total diversion volumes for the purpose of calculating per capita water use for targets and goals (Ref. 7). TRWD should develop water accounting procedures to track indirect reuse volumes and credit them against per capita water use. For example, it is projected (Row [P] in Table 8-1) that 31.7 percent of the TRWD raw water supply in 2020 will consist of recycled water. Assuming that actual indirect reuse volumes confirm this projection, the 2020 TRWD per capita water use should be reduced by 31.7 percent for purposes of comparison to targets and goals.

Track Water Conservation Implementation

In addition to tracking water use, TRWD should track participation in each water conservation measure and estimate water savings where possible. For example, TRWD should estimate water savings from residential toilet retrofits by multiplying 14.4 gallons per toilet per day (see discussion in Appendix H) by the number of residential toilets distributed.

Update the Annual Water Demand Model

Finally, each year TRWD should update the predictor variables in the annual water demand model (described in Section 6.5). The predictor variables are average soil moisture, total June through September rainfall, number of days with temperatures greater than 100°F, and employment.

The annual water demand model is designed to predict what water use would be in the absence of a regional water conservation program. For a given year, savings from the regional water conservation program are estimated by subtracting actual water consumption from the annual water demand model prediction (Figure 6-1). A decrease in actual water use that is not explained by the predictor variables is attributable to the water conservation program or drought contingency measures.[43] To isolate savings from ongoing water conservation efforts, an independent estimate of water savings from the drought contingency measures (such as the one shown in Appendix I) is necessary.

Collect Additional Data

TRWD collected data necessary to evaluate its water conservation potential from its four primary customers and their customers. During collection of data, the following issues became apparent:

- Planning data are collected from the wholesale customers only on an as-needed basis, and some planning data were not available.
- There are no standard protocols for calculating planning data, and some reporting procedures can be improved.
- There is no centralized database, and there are no standard formats for the exchange of planning data.

Recommended improvements in the data collection and management process are outlined in Appendix N.

Improve Customer Utility Profiles

TRWD obtains water use data from customer utility profiles. These profiles (when complete) provide the following information:

[43] Drought/emergency water use restrictions were considered for inclusion in the annual water demand model but were not a significant predictor of annual water use during the calibration period 1997-2004 and were not included as a predictor variable.

- Monthly records of total diverted or treated water,
- Annual records of water sales by sector (residential, commercial, industrial, wholesale, and other),
- Annual records of nonrevenue water,
- Annual total per capita water use, and
- Annual per capita water use by sector (residential, commercial, industrial, wholesale, and other).

Although this information is valuable, more detailed data are needed to refine the water use analysis, refine the projected water savings for various water conservation measures, and effectively target customers for water conservation measures.

TRWD's short-term priority for additional data collection should be to work with the wholesale customers to:

- Obtain monthly records of water sales by sector. This will enable more reliable estimates of seasonal water use by sector and more reliable projections of water savings from measures that address outdoor water use.
- Standardize calculation of the reported water use data (see discussion in Appendix N). In particular, standardization of nonrevenue water calculation and reporting should be one of the topics that TRWD addresses in the water loss reduction measure recommended for implementation in 2014.

Link Retail Customer Water Use Data and GIS

As a long-term priority for additional data collection, TRWD should develop and maintain a GIS water consumption database for use in targeting, tracking implementation, and assessing the effectiveness of water conservation measures. The GIS database would link retail customer billing records by account (monthly water use, customer type), appraisal district information by parcel (lot size, building age), U.S. Census information by Census block (persons per household), weather data (temperature, precipitation, evapotranspiration), utility data (water price), and aerial photographs (see discussion in Appendix N).

Development of a GIS water consumption database would be a long-term project, requiring extensive coordination with the wholesale customers to coordinate reporting of customer billing records on a monthly basis. The result would be an unparalleled tool for local water conservation planning and analysis, water demand forecasting, and water system planning.

Continue Communication with Wholesale Customers

TRWD should continue to conduct regular meetings with customer water conservation coordinators to discuss conservation opportunities, coordinate implementation of water conservation measures, and share information. Regular communication will be particularly important as the regional water conservation program grows.

Update the Strategic Plan

This Strategic Plan presents a five-year plan (through 2017) for implementing new regional water conservation measures. During the next five years, customer water use patterns may change, new conservation technologies may emerge, and some water conservation measures may be more or less successful than projected. To keep abreast of these developments, TRWD should update the Strategic Plan every five years. The update should include analysis of recent water use, evaluation of potential new water conservation measures, reevaluation of existing measures, and an implementation plan for the next five years (through 2022).

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45. U.S. EPA, Notification of Intent (NOI) to Develop Draft Performance Specifications for High-Efficiency Pre-Rinse Spray Valves: July 10, 2009, URL http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/pre_rinse_spray_valves/PRSV_Notice_of_Intent.pdf.

46. Eastern Research Group, Pre-Rinse Spray Valves Field Study Report: prepared for EPA WaterSense, March 31, 2011, URL http://www.epa.gov/WaterSense/docs/final_epa_prsv_study_report_033111v2_508.pdf.

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Appendix A:
Customer Water Conservation Implementation Reports

2009 Arlington Water Conservation Implementation Report

Texas Commission on Environmental Quality

Water Conservation Implementation Report

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name:	City of Arlington - Arlington Water Utilities		
Address:	P.O. Box 90231, MS 01-0130, Arlington, TX 76010		
Telephone Number:	(817) 459-6601	**Fax:**	(817) 459-6807
Form Completed By:	Darryl Westbrook	**Title:**	Ast. Dir. Water Utilities
Signature:		**Date:**	

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

____Municipal____ Use

_________________ Use

_________________ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Description of Water Conservation Measure:

Update of Conservation Oriented Water Rates______________________________

Date Implemented: __October 2008___________________

Description of Water Conservation Measure:

Landscape Irrigation Management Ordinances – Prohibition of outdoor watering year-round from 10 am to 6 pm; All new and all existing commercial irrigation systems must install a rain and freeze sensor; Adopted new state irrigation system rules (2008).

Date Implemented: __Adopted in January 2005 (10-6 outdoor watering from June – Sept.) and updated January 2007 (10-6 outdoor watering year-round);_January 2008 (state irrigation rules)________

Description of Water Conservation Measure:

Water Conservation Education – Utility bill inserts, brochures available, public service announcements, participation in community fairs, WaterWise program for 5th grade students, SaveArlingtonWater website (created in 2006) updates, city vehicle magnets, city property yard signs, newspaper and webpage ads, etc.

Date Implemented: ___Throughout 2008_____________

Description of Water Conservation Measure:

Addition of Conservation Program Coordinator________________________ _

Date Implemented: ___April 2008_______________

Description of Water Conservation Measure:

Promotion of water efficient landscaping – Texas SmartScape classes, city building landscape conversions, smart yard contest (created in 2004)_______________ _

Date Implemented: ___Throughout 2008_______________

Description of Water Conservation Measure:

Conservation coordination with other city departments – monthly conservation coordination meetings with Parks, irrigation audits, irrigation system upgrades

Date Implemented: ___Throughout 2008_______________

Description of Water Conservation Measure:

Landscape Irrigation Audits for Residential Properties________________________ _

Date Implemented: ___August 2008_______________

Description of Water Conservation Measure:

Residential high-efficiency toilet and low-flow plumbing fixture replacement program

Date Implemented: ___December 2008____________

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: _____174 gpcd______________________

Date to achieve target: ______________2010_____________________________

10-Year Specific/Quantified Target: ______171 gpcd_____________________

Date to achieve target: _______________2015____________________________

B. State if these targets in the water conservation plan are being met.

The targets within the 2005 conservation plan are being met. The City of Arlington's municipal per capita water use for 2005 was 168 and in 2008 it was 158.

C. List the **actual amount of water saved.**

In 2005, the City of Arlington population was 362,972 and municipal per capita water use was 168. In 2008, the City of Arlington population was 367,737 and municipal per capita water use was 158. Estimated water savings for 2008 over 2005 water usage is 1,050,050,250 gallons.

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

____

____

If you have any questions on how to fill out this form or about the Water Conservation program, please

contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

2009 Bedford Water Conservation Implementation Report

Texas Commission on Environmental Quality

Water Conservation Implementation Report

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name: Stephanie Corso

Address: 1813 Reliance Pkwy

Telephone Number: **(817)952-2258** **Fax: (817)952-2240**

Form Completed By: Stephanie Corso **Title:Environmental Specialist**

Signature: **Date:**

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

Municipal Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Description of Water Conservation Measure:

Accurate Metering of Treated Water Deliveries from the Trinity River Authority (TRA)--Water deliveries are metered by the Trinity River Authority using meter with accuracy of ± 2%. These meters are calibrated on a monthly basis by the Trinity River Authority to maintain the required accuracy.

Date Implemented: Since 1974 (per TRA)

Description of Water Conservation Measure:

Metering of Customer and Public Uses and Meter Testing, Repair, and Replacement-- All connections to the water system are metered connections. The City of Bedford changes out 100 residential meters per month. A dead meter list is maintained on a monthly basis to detect stopped meters. The City does not conduct meter testing; instead these meters are replaced on a 10 year replacement cycle.

Date Implemented: 10/1/05

Description of Water Conservation Measure:

Determination and Control of Unaccounted Water-- Measures to control unaccounted water are part of the routine operations of the City of Bedford. Maintenance crews and personnel are asked to look for and report evidence of leaks in the water distribution system. Meter readers are asked to watch for and report signs of illegal connections, so they can be addressed quickly.

Date Implemented: 07/1/06

Description of Water Conservation Measure:

Continuing Public Education and Information Campaign-- Insert water conservation information with water bills. Encourage local media coverage of water conservation issues and the importance of water conservation. Notify local organizations, schools, and civic groups that City staff and staff of the Tarrant Regional Water District are available to make presentations on the importance of water conservation and ways to save water. Make information on Texas Smartscape principles, water conservation brochures, and other water conservation materials available to the public at City Hall and other public places. Continue to update the information on water conservation available on the City Web site and include links to the Texas Smartscape Web site and to information on water conservation on TRWD, TWDB, and TCEQ Web sites.

Date Implemented: 10/1/08

Description of Water Conservation Measure:
Landscape Water Management Regulations—the City of Bedford has adopted several landscape water management regulations as part of the development of the 2009 Water Conservation Plan. These regulations are intended to minimize waste in landscape

irrigation.

Date Implemented: Ch 344 Irrigation Rules (12/08), Water Resource Management (04/14/09)

Description of Water Conservation Measure:

The City of Bedford adopted a Water Resource Management ordinance that prohibits outdoor watering of landscape with irrigation or sprinkler systems from 10 am – 6 pm from June to September. This ordinance also requires the installation of rain and freeze sensors on irrigation systems and prohibits the use of systems with broken heads or one that causes significant runoff.

Date Implemented: Water Resource Management (04/14/09), Rain and Freeze (08/01/08)

Description of Water Conservation Measure:

Staff attends Tarrant Regional Water District Committee meetings and symposiums concerning water conservation methods. Brochures have been distributed and the City is participating in the Save Tarrant Water campaign

Date Implemented: 06/2008

Description of Water Conservation Measure:

Water Rate Structure-- The City will adopt, within five years or in conjunction with any water rate study, an increasing block rate structure.

Date Implemented: N/A

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: 148 GPCD

Date to achieve target: 2015

10-Year Specific/Quantified Target: 140 GPCD

Date to achieve target: 2020

B. State if these targets in the water conservation plan are being met.

These targets are the current goals established in the development of the 2009 Water Conservation Plan. These goals were set based on the recommendation by the Texas Water Conservation Implementation Task Force to reduce gallons per capita per day per year by 1% until the goal of 140 GPCD is met. The City will use this next year to determine the feasibility of these goals and to evaluate the effectiveness of the current operating procedures in the ability to track and monitor these goals.

C. List the **actual amount of water saved.**

The City has consistently kept water loss below 12%.

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

The City of Bedford's water conservation goals prior to the development of the 2009 plan were primarily based on minimizing water loss. Currently the City has been meeting the goal stated in this plan of keeping annual water loss below 12%. As stated in section B of this segment, the City will evaluate current procedures and work towards any changes that are necessary to meet the requirements of the conservation plan and to meet the specified targets.

2009 Benbrook WSA Water Conservation Implementation Report

Texas Commission on Environmental Quality

Water Conservation Implementation Report

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name:	Benbrook Water Authority	
Address:	1121 Mercedes Street, Benbrook Texas, 76126	
Telephone Number:	(817) 249-1250	Fax: (817) 249-6965
Form Completed By:	Michael Langlois	Title: Water Production Superintendant
Signature:		Date: April 6th 2009

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

Residential_ Use

Commercial Use

Industrial__ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Description of Water Conservation Measure:
_Public Education and Information

Date Implemented: __Since and before 2005

Description of Water Conservation Measure:
_Non-Promotional Water Rate Structure___________________________________

Date Implemented: __Revised 2009____________________

Description of Water Conservation Measure:
_Meter change out program____

Date Implemented: _Since or before 1960_____________________

Description of Water Conservation Measure:
__Leak and Detection Program____

Date Implemented: __Since and before 2005____________________

Description of Water Conservation Measure:
_Record management system and annual statistical reports___________________

Date Implemented: __Since and before 2005____________________

Description of Water Conservation Measure:

Date Implemented: ______________________

Description of Water Conservation Measure:

Date Implemented: ______________________

Description of Water Conservation Measure:

Date Implemented: ______________________

Description of Water Conservation Measure:

Date Implemented: ______________________

Description of Water Conservation Measure:

Date Implemented: ______________________

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: 187 gpcd

Date to achieve target: 2010

10-Year Specific/Quantified Target: 178 gpcd

Date to achieve target: 2015

B. State if these targets in the water conservation plan are being met.

Yes, our actual use for the year 2008 was 161 gpcd. We are already exceeding our 10 year target

C. List the actual amount of water saved.

(2005) 197 gpcd – (2008) 161 gpcd = 36 gpcd. Population of 24,904 x 36gpcd x 365 = reduction of 327,238,560 gallons per year

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

____
____
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____

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

2009 Fort Worth Water Conservation Implementation Report

Texas Commission on Environmental Quality

Water Conservation Implementation Report

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name:	City of Fort Worth, Water Department		
Address:	1130 Fournier St., Fort Worth, TX 76102		
Telephone Number:	**(817) 392-8740**	**Fax: (817) 392-8735**	
Form Completed By:	Micah S. Reed	**Title: Wtr. Cons. Mgr.**	
Signature:		**Date:**	

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

_Residential______ Use   _Irrigation______ Use

_Commercial_____ Use   _Gas Well______ Use

_Industrial_______ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Description of Water Conservation Measure:

_System Water Audit and Water Loss – Detailed analysis of all non-revenue water in the system. There are many variables which influence the revenue and non-revenue components of Fort Worth's water system. The audit involves many of the Water Department divisions, including Engineering, Customer Services, and Operations. It evaluates the marginal costs (purchase of water from TRWD as well as treatment and distribution costs) and costs of service, so that the analyses have sound figures with which to develop the cost-benefit scenarios. The City conducts this audit annually.

Date Implemented: ___2002___________________

Description of Water Conservation Measure:
_Water Conservation Pricing - Each customer is assessed a meter charge based on meter size. There is an additional usage charge. The rates adopted and implemented effective January 1, 2009 for the Residential customer class include a conservation rate structure. Fort Worth measures in hundred cubic feet (ccf). The City has continued to increase the conservation pricing by introducing a fourth tier within the residential rates and a second tier within the irrigation category.
Date Implemented: _ _1994_ rv. 2009________________

Description of Water Conservation Measure:
_Water Waste Ordinance - The City has an existing ordinance which prohibits wasting water. This ordinance prohibits watering between 10 a.m. and 6 p.m. year round. In addition the Irrigation ordinance requires only licensed irrigators to alter existing, or install new irrigation systems within Fort Worth.
Date Implemented: _____________________

Description of Water Conservation Measure:
Public Education - The City currently provides education programs for grades 4 through 5 in schools within the Fort Worth Independent School District. The programs incorporate the following themes: Waterama for 4th Grade, Major Rivers for 4th Grade, and Waterwise for 5th Grade. The program is intended to increase use of these curricula not only among Fort Worth ISD schools but also among the 13 other school districts which operate within Fort Worth's city limits in addition to all the school districts within the wholesale customer boundaries.
Date Implemented: ____1990__________________

Description of Water Conservation Measure:
Athletic Field Conversion - The City has conducted pilot programs to assess different water-saving methodologies and technologies at City athletic fields. The Gateway Park development includes synthetic turf soccer and rugby fields to improve levels of water conservation at this facility. The best, most effective methods will be considered for all appropriate City facilities. Once it has been determined that specific landscape water management techniques are effective, they will be presented to private facilities such as golf courses and to customers with significant irrigated areas.

Date Implemented: ______2006________________

Description of Water Conservation Measure:
Water Conserving Plumbing Fixtures - The City complies with the U.S. Energy Policy Act of 1992 (Public Law 102-486, 106 Stat. 2776, 102D Congress, Oct. 24, 1992), which includes requirements for maximum water use allowed for toilets, urinals, showerheads, and faucets. Additionally, the City has implemented a toilet replacement program for commercial, residential and low income/senior citizen residents in late 2009.

Date Implemented: 1992

Description of Water Conservation Measure:
Meter Replacement Program - The City has implemented a meter exchange program that provides for the annual replacement of meters in the system that do not register the correct amount of water flowing through them. This program has already replaced more than 49,000 meters since 2006.
Date Implemented: 2006

Description of Water Conservation Measure:
Metering – All new connections and retrofits of existing connections are metered.

Date Implemented: 1980

Description of Water Conservation Measure:
Water Reuse - Reuse is a major component of the City's vision to manage its water resources in the most efficient manner. Fort Worth already conducts a small amount of reuse from its Village Creek Wastewater treatment plant and is currently investigating a number of other plans. This will be developed in more detail by 2015. The City is also currently constructing a pipeline to serve customers for limited uses.

Date Implemented: 1999

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: ______180 GPCD______________

Date to achieve target: ____________2015 _____________________

10-Year Specific/Quantified Target: _____171 GPCD______________

Date to achieve target: _________2020__________________________

B. State if these targets in the water conservation plan are being met.

The overall trend in gallons per capita per day is going down. Recent conservation programs on track to begin in late 2009 and 2010 will help ensure that the trend continues going down and that all previously stated goals are met.

C. List the **actual amount of water saved.**

____

____

____

____

____

____

____

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

____

____

____

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

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2012 Mansfield Water Conservation Implementation Report

TWDB 1966
Rev 2/15/12

TWDB-Water Conservation Annual Report

Formerly WRD-265

UTILITY DATA

Name of Utility: City of Mansfield

Public Water Supply Identification Number (PWS ID), WR No. : 2200018

Address: 1200 East Broad St City: Mansfield

State: Tx Zip Code: 76063 Email: keith.hawes@mansfield-tx.gov

Telephone Number: 817-477-2248 Fax: ______________

Regional Water Planning Group: C Map

Form Completed By: Keith Hawes Date: 5/1/2012

Title: Water Demand Manager

Reporting Period (fiscal or calendar year): 01/01/2011 to 12/31/2011

Total Gallons of Water Produced Treated or Raw (minus Wholesale)	Population of Retail Service Area	Total Gallons per Capita per Day (GPCD)*	Residential GPCD** (Should not be higher than total GPCD)	Total Number of Connections	Water Loss in GPCD***	Water Loss in Percent****
4,290,284,000	59,500	198	114	19,622	10	5

* **Total GPCD:** form calculation is made by dividing the total water produced by the population served and then dividing by 365

** **Residential GPCD:** user calculation is made by dividing the total single family plus multi-family residential water sales by the population served and then dividing by 365

*** **Water Loss GPCD:** form calculation is made by dividing the amount you provide in number 7G on page 4 by the population served and then dividing by 365

**** **Water Loss Percentage:** form calculation is made by dividing the amount you provide in number 7G on page 4 by the total gallons of water produced

Please provide the **specific and quantified five and ten-year targets** as listed in your water conservation plan:

Targets taken from WCP	Total GPCD Target	Water Loss Target in GPCD	Year to Achieve Target
Five-year target	160	10	2012
Ten-year target	155	10	201

LONG TERM WATER CONSERVATION PROGRAM

1. Approximately how much water in gallons did the utility save during the reporting period due to the overall conservation program?

Water Conserved	Water Reused*	Total Water Saved	Dollar Value of Water Saved**
275,500,000	0	275,500,000	

* Form inserts calculated Total from number 14 on page 6

** Based on water savings and the cost of treatment or purchase of your water, and any deferred capital costs due to conservation

2. In your opinion, how you would rank the effectiveness of your utility's conservation program?

Effective	Somewhat Effective	Less than Effective	Not Effective	Do Not Know
◉	○	○	○	○

Please provide additional information about any successes or problems you may have experienced in implementing your plan.

Stage 1 water restrictions are enforced. We have a strong irrigation program and we educate the public on water conservation techniques.

3. Education and Information Program

Please check the appropriate boxes regarding any educational and information activities your utility has provided during the reporting period:

	Implemented	Total Number
Brochures Distributed	☑	
Messages Provided on Utility Bills	☐	
Press Releases	☑	
TV Public Service Announcements	☐	
Radio Public Service Announcements	☐	
School Program	☐	
Displays and Presentations	☑	
Plant Tours	☑	
Other, please describe:		

4. Water Conservation Retrofit and Plumbing Rebate Programs

Please check the appropriate boxes regarding any plumbing fixture programs your utility has provided during the reporting period:

	Give-away	Rebate	Retrofit
Toilets	☐	☐	☐
Showerheads	☐	☐	☐
Faucet Aerators	☐	☐	☐
Other, please describe:			

5. Rate Structure

Have your rates or rate structure changed since your last report? Yes ○ No ●
If yes, please describe the changes, or attach a copy of the new rate structure.

6. Universal Metering and Meter Repair

During the reporting period what was the system-wide number of:

	Total Number	Total Tested	Total Repaired	Total Replaced
Production or master meters	19,622	71	2	616
Meters larger than 1 ½"	526	1	2	18
Meters 1 ½ or smaller	19,096	70		596

Does your system have automated meter reading? Yes ● No ○

7. Water Loss and Leak Detection

Please provide the following data regarding water loss in your utility during the reporting period:

	Total Gallons During the Reporting Period
A. PRODUCTION - Water treated or raw (minus Wholesale)	4,290,284,000
B. Water sold	4,068,697,000
C. Water used for line flushing	373,000
D. Water used for fire department use	
E. Water used for flushing and storage tank cleaning	
F. Water used for any un-metered use (facility use, etc.)	
G. WATER LOSS* = A minus B,C,D,E,F	221,214,000

* **WATER LOSS** includes un-accounted-for water, water lost from main line breaks and meter inaccuracies, and storage over-flow.

How many leaks were repaired in the system or at service connections during the reporting period? 169

Please check the appropriate boxes regarding the main cause of water loss in your utility during the reporting period:

Leaks	☑
Un-metered utility or city uses	☑
Master meter problems	☐
Customer meter problems	☐
Record and data problems	☑
Other, please describe:	

Would you like to receive free technical assistance or equipment from the TWDB regarding leak detection and water loss? Yes ○ **No** ◉

8. Water Conservation Programs

Please check the appropriate boxes regarding what conservation programs your utility provided during the reporting period:

Landscape Program	☑
Educational and Information Program	☑
School Education Program	☐
Rainwater Harvesting	☑
Leak Detection	☐
Water Loss	☐
Reuse	☐
Treated Effluent	☐
Other, please describe:	

9. How often does your utility staff review your water conservation program?
Anually

10. What year did your utility adopt, or revise, their water conservation plan? 2008

11. What might your utility do to improve the effectiveness of your water conservation program?

TWDB-Water Conservation Annual Report
Formerly WRD-265

TWDB 1966
Rev 9/26/11

12. What might the TWDB do to assist you in improving the effectiveness of your water conservation program?

13. If known, how much expense has your utility incurred in implementing your water conservation program during the reporting period (*literature, materials, staff time, etc.*)?
_________________ (dollars/year)

14. Recycling and Reuse of Water or Wastewater Effluent

Please provide the following data regarding what types of water recycling or reuse activities were practiced by your utility during the reporting period, and what volume:

Use	Total Annual Volume (in gallons)
On-site irrigation	
Plant wash down	
Chlorination/de-chlorination	
Industrial	
Landscape irrigation (parks, golf courses)	
Agricultural	
Other, please describe:	
Total	

Could treated effluent be substituted for certain potable water now being used? Yes ○ No ◉

15. Drought Contingency and Emergency Water Demand Management

During the reporting period, did your utility activate its Drought Contingency Plan?
Yes ◉ Number of Days 150

No ○
If yes, please check all the appropriate boxes for the reason why:

Reason	
Water Shortage	☑
High Demand	☑
Capacity Issues	☐
Equipment Failure	☐
Other, please describe:	

Submit by Email Print Reset Form

2009 North Richland Hills Water Conservation Implementation Report

Texas Commission on Environmental Quality

Water Conservation Implementation Report

TCEQ

This report must be completed by entities that are required to submit a water conservation plan to the TCEQ in accordance with Title 30 Texas Administrative Code, Chapter 288. Please complete this report and submit it to the TCEQ. If you need assistance in completing this form, please contact the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name: City of North Richland Hills

Address: 7200 A Dick Fisher Dr. South, North Richland Hills TX 76180

Telephone Number: **817-427-6440** **Fax: 817-427-6444**

Form Completed By: Jimmy Cates **Title: Operations Manager**

Signature: Jimmy Cates **Date: April 21, 2009**

I. WATER USES

Indicate the type(s) of water uses (example: municipal, industrial, or agricultural).

Municipal Use

Industrial Use

__________ Use

II. WATER CONSERVATION MEASURES IMPLEMENTED

Provide the water conservation measures and the dates the measures were implemented.

Description of Water Conservation Measure:

Prohibited outdoor watering of landscape and lawns with irrigation or sprinkler systems during the hours of 10 am – 6 pm, throughout the year on a daily basis.

Date Implemented: September 2008

Description of Water Conservation Measure:
Implemented an educational program for school students called WaterWise. This program is designed to teach and educate elementary grade school students about the importance of water conservation.

Date Implemented: September 2007

Description of Water Conservation Measure:
Updated City's water conservation plan to include new targets/goals for water conservation.

Date Implemented: April 2009

Description of Water Conservation Measure:
Implemented leak/detection/repair program. The program consists of methods and techniques to identify and repair hidden or unseen water leaks in the distribution system.

Date Implemented: September 2008

Description of Water Conservation Measure:
Adopted irrigation ordinances requiring rain and freeze sensors.

Date Implemented: July 2007

Description of Water Conservation Measure:
City staff attends Tarrant Regional Water District Committee meetings and symposiums concerning water conservation methods.

Date Implemented: September 2007

Description of Water Conservation Measure:
City replaces approximately 9,000 – 10,000 feet of deteriorated water main lines in the City. These are typically water main lines that have reoccurring water main breaks.

Date Implemented: February 2005

Description of Water Conservation Measure:
Meter replacement program. The City continues to replace water meters that are older than 10 year of age on annual basis. About 2,000 meters are replaced annually under this program.

Date Implemented: August 2006

Description of Water Conservation Measure:
City's website. The City's website is updated quarterly to include information about water conservation and techniques.

Date Implemented: October 2006

Description of Water Conservation Measure:
City staff continues to provide educational presentations or educational material to customers concerning water conservation.

Date Implemented: October 2006

Description of Water Conservation Measure:

Date Implemented: ______________

III. TARGETS

A. Provide the **specific and quantified five and ten-year targets** as listed in water conservation plan for previous planning period.

5-Year Specific/Quantified Target: 115 GPCD Total Water Use

Date to achieve target: 2010

10-Year Specific/Quantified Target: 109 GPCD Total Water Use

Date to achieve target: 2015

B. State if these targets in the water conservation plan are being met.

No, based upon history data.

2005 – 208 GPCD Total Water Use

2006 – 210 GPCD Total Water Use

2007 – 158 GPCD Total Water Use

2008 – 180 GPCD Total Water Use

C. List the **actual amount of water saved.**

Between 2005 – 2008 the GPCD has dropped by 15%.

D. If the targets are not being met, provide an explanation as to why, including any progress on the targets.

The original targets were set too low. The City is working very hard to implement water conservation methods and techniques. In some cases, weather impacts the goals or targets. We have experienced A couple of droughts 2006 – 2007 and some wet years. New targets and goals are included in the City's updated water conservation plan for 2009.

If you have any questions on how to fill out this form or about the Water Conservation program, please contact us at 512/239-4691.

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

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Appendix B:
Summary of Customer Water Conservation Plans

	City **Plan Date**	Arlington April 2009	Bedford May 2009
4	Specification of Water Conservation Goals		
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %	161 153 146 12%	156 148 140 12%
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair		
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries	Meters Lake Arlington and TRWD supplies and discharge on distribution. Annual calibration and repair if necessary.	Meters TRWD within 2%. TRWD supplies 100% of water to Bedford.
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement	Replace meters every 20 years. Average 97% accuracy. Plans to implement AMR.	No testing. Replaced every 10yrs.
5.3	Record Management System	included	included
5.4	Determination and Control of Unaccounted Water	Intends to maintain 12% in 2009 and beyond. City to target real losses.	Intends to maintain 12% in 2009 and beyond.
5.5	Leak Detection and Repair	Meter readers check for illegal connections. Inspect air release valves. Distribution system rated using age, material, soil, history, etc.	Meter readers check for illegal connections. Visual leak inspection.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report	included	included
5.7	Water Conservation Implementation Report	included	
6	Continuing Education And Information Campaign		
6.1a		Billing inserts 1x per year	Billing inserts ?x per year
6.1b		Promote Texas Smartscape	Promote Texas Smartscape
6.1c		Web: savealringtonwater.com	Web: city site
6.1d		Promote EPA WaterSense	Promote local media coverage
6.1e		Promote regional education	
6.1f		PSA's	
6.1g		Staff available to make presentations	
6.1h		School education: 2MGY savings estimated for WaterWise - 10yr at 17MGY	

	City **Plan Date**	Arlington April 2009	Bedford May 2009
7	Water Rate Structure		
7.1	Information	Increasing block structure.	Plans to adopt increasing block within 5 years
8	Other Water Conservation Measures		
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures	600 toilets and 300 showerhead/sink replacement programs	Might be open to rebate system via TRWD depending on city funding.
8.2	Reservoir System Operation Plan	TRWD supplies to Lake Arlington (to Pierce WTP) and directly to Kubala TWP. Supply related to conservation pool of Lake Arlington and Lake Benbrook.	Purhcases from TRA (from TRWD). No reservoirs to operate.
8.3	Consideration for Landscape Water Management Regulations (Optional)	No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. Commercial irrigation to be retrofitted with rain/freeze gauges. Enforcement via warning and fines.	No automated sprinklers 10am-6pm June1 - Sep30. New systems have freeze/rain gauges. Commercial irrigation to be retrofitted with rain/freeze gauges. No sprinkling onto impervious surfaces and no poorly maintaned systems. Enforcement via warnings and fines.
8.4	Requirement for Water Conservation Plans By Wholesale Customers	Included in contracts with wholesale customers.	
8.5	Coordination with Regional Water Planning Group	included	included
8.6	Reuse and/or Recycling of Wastewater and/or Graywater	WWTP via TRA. Expects 58 MGY via FW Village Creek reuse.	None.
8.7	Additional Measures		
8.7a		Pressure reduction	
8.7b		Water waste prohibition ordinance within 5yrs	
8.7c		Residential irrigation audits free if use >25k/mo	
8.7d			

	City Plan Date	Benbrook WSA 2009	Bethesda WSC March 2009
4	Specification of Water Conservation Goals		
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %	161 156 151	126 121 117 12%
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair		
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries	Meters Lake Benbrook. Calibrate meter annually.	
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement	Replace residential every 15yrs and commercial every 10yrs. Ongoing replacement to touch reach meters.	Older meters checked; method not described.
5.3	Record Management System	included	included
5.4	Determination and Control of Unaccounted Water	Utilizes 16.0121 and reports to TWDB.	goal is 5% or less loss
5.5	Leak Detection and Repair	Utilize billing dept to scan for variances. Visual leak inspection. Distribution system rated using age, material, soil, history, etc.	Visual leak detection and illegal water use. Water auditing.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report		included
5.7	Water Conservation Implementation Report		
6	Continuing Education And Information Campaign		
6.1a		Publish articles in local paper 4x per year	Billing inserts ?x per year
6.1b		New customers receive general conservation info	Promote local media coverage
6.1c			Promote Texas Smartscape
6.1d			Participate in school programs
6.1e			
6.1f			
6.1g			
6.1h			

	City **Plan Date**	Benbrook WSA 2009	Bethesda WSC March 2009
7	Water Rate Structure		
7.1	Information	Increasing block structure.	Increasing block.
8	Other Water Conservation Measures		
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures		no rebates
8.2	Reservoir System Operation Plan	TRWD operates reservoir.	n.a.
8.3	Consideration for Landscape Water Management Regulations (Optional)		No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces or during rain. Must maintain systems.
8.4	Requirement for Water Conservation Plans By Wholesale Customers		Yes.
8.5	Coordination with Regional Water Planning Group	included	
8.6	Reuse and/or Recycling of Wastewater and/or Graywater		
8.7	Additional Measures		
8.7a			
8.7b			
8.7c			
8.7d			

	City **Plan Date**	Burleson March 2009	D/FW Airport August 2008	Euless April 2009
4	Specification of Water Conservation Goals			
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %	133 130 126 12%		146 144 138 12%
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair			
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries	Fort Worth supplies and meters deliery within 2%.	All but some irrigation demand is metered - supplies from Dallas/Fort Worth metered.	
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement	>4" tested annually, >1.5" tested every 3yrs, otherwise every 10yrs. Customer can request test.	Beginning to change meters every 10years. Currently change if needed.	>2" every 10 years otherwise 15 years
5.3	Record Management System	included		included
5.4	Determination and Control of Unaccounted Water	Intends to maintain 12% in 2009 and beyond.	None - assuming non-metered irrigation is difference from supply and demand meters.	Keep at or below 12%
5.5	Leak Detection and Repair	Meter readers check for illegal connections. Visual leak inspection. Areas with history of leaks targeted.	Visual and aucustical methods.	Visual leak inspection. Areas with history of leaks targeted.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report	included		included
5.7	Water Conservation Implementation Report			
6	Continuing Education And Information Campaign			
6.1a		Billing inserts ?x per year	Billing inserts ?x per year	Billing inserts 12x per year
6.1b		Promote local media coverage	Web: intranet	Host annual forum
6.1c		Staff available to make presentations		Staff available to make presentations
6.1d		Promote Texas Smartscape		Promote Texas Smartscape
6.1e		Web: city site		Web: city site
6.1f				
6.1g				
6.1h				

	City **Plan Date**	Burleson March 2009	D/FW Airport August 2008	Euless April 2009
7	Water Rate Structure			
7.1	Information	Increasing block structure.	Flat rate.	Flat rate.
8	Other Water Conservation Measures			
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures	no rebates	no rebates	no rebates
8.2	Reservoir System Operation Plan		n.a.	n.a.
8.3	Consideration for Landscape Water Management Regulations (Optional)	No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces and no poorly maintaned systems. Enforcement via warning and fines.	No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces and no poorly maintaned systems. Enforcement via warning and fines.	No automated sprinklers 10am-6pm.
8.4	Requirement for Water Conservation Plans By Wholesale Customers			n.a.
8.5	Coordination with Regional Water Planning Group	included	included	included
8.6	Reuse and/or Recycling of Wastewater and/or Graywater		Use storm water runoff for irrigation.	
8.7	Additional Measures			
8.7a		Pressure reduction		
8.7b				
8.7c				
8.7d				

	City **Plan Date**	Fort Worth March 2009	Grand Prairie April 2009	Grapevine April 2009
4	Specification of Water Conservation Goals			
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %	192 179 170	152 150 149 6%	
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair			
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries		Have meters from 3 suppliers.	
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement		Replacing all meters with AMR - 50% through process. Will not begin inspection until complete.	All meters 10yrs, production meters annually.
5.3	Record Management System			
5.4	Determination and Control of Unaccounted Water		General water audit - plan comprehensive audit in 2011.	
5.5	Leak Detection and Repair	Visual and acoustic leak detection. Has ILI of 4.7.	Visual inspection, water auditing. Aucustic equipment rented on as-needed basis.	Visual inspection, water auditing.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report		included	
5.7	Water Conservation Implementation Report			
6	Continuing Education And Information Campaign			
6.1a		Billing inserts 12x per year	Water wise presentations >=1x per year	Publications mailed 5x per year
6.1b		Staff available to make presentations	Staff available to make presentations	New customers get addtl water conservation matl
6.1c		Web: city site	Web: city site	
6.1d		Participate in school programs	Participate in school programs	
6.1e		Established Customer Advisory Committee	Short films at movie theatres	
6.1f				
6.1g				
6.1h				

	City **Plan Date**	Fort Worth March 2009	Grand Prairie April 2009	Grapevine April 2009
7	Water Rate Structure			
7.1	Information	Increasing block structure.	Residential increasing block otherwise flat.	Flat rate.
8	Other Water Conservation Measures			
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures	no rebates. Potentially in future.	no rebates	no rebates
8.2	Reservoir System Operation Plan	TRWD	n.a.	
8.3	Consideration for Landscape Water Management Regulations (Optional)	Looking into specific types of methodologies for City athletic fields.	Moisture/freeze sensors, new residential wind sensors, no watering 10-6 april-oct, city facilities xeriscaped. Impervious surface (water waste) ordinance.	Consider future landsacpe mangement regulations. Only have watering restrictions in drought plan currently.
8.4	Requirement for Water Conservation Plans By Wholesale Customers	Yes		
8.5	Coordination with Regional Water Planning Group	included		
8.6	Reuse and/or Recycling of Wastewater and/or Graywater	Yes. Plan to increase.		Yes at WWTP.
8.7	Additional Measures			
8.7a		Exploring pressure reduction		
8.7b				
8.7c				
8.7d				

	City **Plan Date**	Haltom City April 2005	Hurst April 2009	Johnson Co. SUD 2009
4	Specification of Water Conservation Goals			
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %		153 184 174 5%	130 140 130 10%
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair			
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries	Fort Worth in charge.	Fort Worth in charge.	Seven meters maintaned at least 2% accuracy
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement	>4" annually, >1.5" every 4 years otherwise every 10 years.	Replace master meter every 10 years. Annual check of >2": repace if >+/- 1.5% accuracy.	Follow AWWA standards
5.3	Record Management System		included	included
5.4	Determination and Control of Unaccounted Water	Annual water audit.	Maintain 5%	Ranges from 8 to 17%, with average of 10% - plan to maintain 10%.
5.5	Leak Detection and Repair	Visual inspection, water auditing.	Visual leak inspection.	Visual theft/leak detection. Meter hydrants, monthly audits.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report			included
5.7	Water Conservation Implementation Report			
6	Continuing Education And Information Campaign			
6.1a		Billing inserts ?x per year	Billing inserts 12x per year	Newsletter articles inserted ?x per year
6.1b			Staff available to make presentations	Promote local media coverage
6.1c			Web: city site	Information at local library
6.1d			Participate in school programs	Promote regional message
6.1e				Web: SUD site
6.1f				Participate in useful programs
6.1g				
6.1h				

	City **Plan Date**	Haltom City April 2005	Hurst April 2009	Johnson Co. SUD 2009
7	Water Rate Structure			
7.1	Information	Flat rate.	Flat rate.	increasing block
8	Other Water Conservation Measures			
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures	no rebates	no rebates	no rebates
8.2	Reservoir System Operation Plan		n.a.	BRA responsible
8.3	Consideration for Landscape Water Management Regulations (Optional)		No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces. Enforcement via warning and fines.	No sprinking during rain or freeze conditions. No sprinkling onto impervious surfaces. Must maintain systems. Enforcement via warning and fines.
8.4	Requirement for Water Conservation Plans By Wholesale Customers		n.a.	
8.5	Coordination with Regional Water Planning Group		included	
8.6	Reuse and/or Recycling of Wastewater and/or Graywater			
8.7	Additional Measures			
8.7a				
8.7b				
8.7c				
8.7d				

	City Plan Date	Keller May 2009	Lake Worth May 2009	Mansfield 2007
4	Specification of Water Conservation Goals			
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %	219 212 207 10%	130 124 118	 160 155 10%
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair			
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries	Fort Worth in charge.	Fort Worth in charge.	All master meters within 5% accuracy. Largest meter 0.5% accurate as per manufacturer.
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement	All meters <5yrs old. Inspect >3" annually, others as needed. AMR installed.	Follow AWWA standards	Follow AWWA standards
5.3	Record Management System	included		included
5.4	Determination and Control of Unaccounted Water	Intend it reduce from 10% to 8% by 2018.		Maintain programs for 10%.
5.5	Leak Detection and Repair	Meter readers check for illegal connections. Visual leak inspection. Areas with history of leaks targeted.	Visual leak inspection.	Visual leak inspection and illegal water use.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report	included		included
5.7	Water Conservation Implementation Report			
6	Continuing Education And Information Campaign			
6.1a		Billing inserts ?x per year	Billing inserts ?x per year	Billing inserts ?x per year
6.1b		Promote local media coverage	Web: city site	Promote local media coverage
6.1c		Staff available to make presentations		Staff available to make presentations
6.1d		Promote Texas Smartscape		Promote Texas Smartscape
6.1e		Web: city site		Web: city site
6.1f		Participate in school programs		Participate in school programs
6.1g				
6.1h				

	City Plan Date	Keller May 2009	Lake Worth May 2009	Mansfield 2007
7	Water Rate Structure			
7.1	Information	Increasing block structure.	Flat rate. Will explore increasing block rate for the future.	Increasing block structure.
8	Other Water Conservation Measures			
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures	no rebates	Plans to explore rebates	
8.2	Reservoir System Operation Plan	n.a.	n.a.	n.a.
8.3	Consideration for Landscape Water Management Regulations (Optional)			No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces. Must maintain systems. New systems to have manual shutoff valve.
8.4	Requirement for Water Conservation Plans By Wholesale Customers	n.a.	n.a.	Yes
8.5	Coordination with Regional Water Planning Group	included	included	included
8.6	Reuse and/or Recycling of Wastewater and/or Graywater	n.a.	n.a.	n.a.
8.7	Additional Measures			
8.7a				
8.7b				
8.7c				
8.7d				

	City **Plan Date**	Northlake August 2006	North Richland Hills 2009	Southlake April 2008
4	Specification of Water Conservation Goals			
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %		186 176 166 10%	306 190 180
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair			
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries		All water incoming/outgoing is metered.	Plan to replace 3 of 4 master meters with Fort Worth.
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement		Replace all every 10yrs.	Test >2" annually, otherwise every 10yrs.
5.3	Record Management System		included	
5.4	Determination and Control of Unaccounted Water		Maintain programs for 10%.	Monthly water audits
5.5	Leak Detection and Repair		Visual leak detection and illegal water use. Water auditing.	Visual leak detection. Use SCADA to monitor pressure. Audio equipment for smaller lines.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report			
5.7	Water Conservation Implementation Report			
6	Continuing Education And Information Campaign			
6.1a		Web: city site	Billing inserts ?x per year	Web: city site
6.1b		Billing inserts ?x per year	Promote local media coverage	Billing inserts ?x per year
6.1c			Staff available to make presentations	Mass phone messaging system available.
6.1d			Promote Texas Smartscape	
6.1e			Web: city site	
6.1f			Participate in school programs	
6.1g				
6.1h				

	City Plan Date	Northlake August 2006	North Richland Hills 2009	Southlake April 2008
7	Water Rate Structure			
7.1	Information		Flat rate.	Increasing block structure.
8	Other Water Conservation Measures			
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures			
8.2	Reservoir System Operation Plan		n.a.	
8.3	Consideration for Landscape Water Management Regulations (Optional)	No automated sprinklers 10am-7pm June1 - Sept30. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces. Must maintain systems.	No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces. Enforcement via warning and fines.	No automated sprinklers 10am-6pm. No water wasting.
8.4	Requirement for Water Conservation Plans By Wholesale Customers		Yes	
8.5	Coordination with Regional Water Planning Group	included	included	
8.6	Reuse and/or Recycling of Wastewater and/or Graywater		n.a.	
8.7	Additional Measures			
8.7a				Plan to hire conservation coordinator in future.
8.7b				
8.7c				
8.7d				

	City **Plan Date**	TRA April 2009	Watauga May 2009
4	Specification of Water Conservation Goals		
4.1	Current GPCD 5r GPCD 10yr GPCD Unaccounted %		110 105 100 10%
5	Metering, Water Use Records, Control Of Unaccounted Water, And Leak Detection And Repair		
5.1	Accurate Metering of Raw Water Supplies and Treated Water Deliveries	Meters Lake Arlington and TCWSP WTPs	Master meters from North Richland Hills (3) and Fort Worth (1) inspected annually as per contract.
5.2	Metering of Customer and Public Uses and Meter Testing, Repair and Replacement	Inspect meters weekly, bleed valves every 3months.	Replace every 4 years as well as on ongoing basis
5.3	Record Management System	included	included
5.4	Determination and Control of Unaccounted Water	Verify master meters, encourage customers to control losses.	Maintain programs for 10%.
5.5	Leak Detection and Repair	Visual leak detection and water auditing.	Visual leak detection and illegal water use. Water auditing.
5.6	Monitoring of Effectiveness and Efficiency – Annual Water Conservation Report		included
5.7	Water Conservation Implementation Report		
6	Continuing Education And Information Campaign		
6.1a		Provide info to customers for their distribution.	Web: city site
6.1b			Billing inserts ?x per year
6.1c			Promote Texas Smartscape
6.1d			
6.1e			
6.1f			
6.1g			
6.1h			

	City **Plan Date**	TRA April 2009	Watauga May 2009
7	Water Rate Structure		
7.1	Information		Flat rate.
8	Other Water Conservation Measures		
8.1	Ordinances, Plumbing Codes, or Rules on Water-Conserving Fixtures		
8.2	Reservoir System Operation Plan	n.a.	n.a.
8.3	Consideration for Landscape Water Management Regulations (Optional)		No automated sprinklers 10am-6pm. New systems have freeze/rain gauges. No sprinkling onto impervious surfaces. Must maintain systems. Enforcement via warning and fines.
8.4	Requirement for Water Conservation Plans By Wholesale Customers	Yes. Requirements vary based on demands.	n.a.
8.5	Coordination with Regional Water Planning Group	included	included
8.6	Reuse and/or Recycling of Wastewater and/or Graywater		n.a.
8.7	Additional Measures		
8.7a			
8.7b			
8.7c			
8.7d			

Appendix C:
Summary of Customer Water Rates

Utility	***Arlington***	***Bedford***	***Benbrook***	***Burleson***	***D/FW Airport***
Effective Date	October 2011	October 2010	March 2012	February 2012	October 2012
Rate Structure	Inclined Block	Flat		Inclined Block	Flat

Water Volume Charges

User Type	Tier		Arlington Beginning Usage (gal)	Arlington Volume Charge ($/1,000 gal)	Bedford Beginning Usage (gal)	Bedford Volume Charge ($/1,000 gal)	Benbrook Beginning Usage (gal)	Benbrook Volume Charge ($/1,000 gal)	Burleson Beginning Usage (gal)	Burleson Volume Charge ($/1,000 gal)	D/FW Airport Beginning Usage (gal)	D/FW Airport Volume Charge ($/1,000 gal)
Residential	1		0	$1.42	0	$2.89	3,000	$3.66	0	$3.40		
	2		3,000	$2.02			7,488	$3.84	10,001	$4.10		
	3		11,000	$2.98			14,969	$4.05	20,001	$4.75		
	4		16,000	$3.41			22,450	$4.25				
	5		30,000	$4.08			29,931	$4.45				
	6						37,412	$4.72				
	7						44,893	$4.84				
	8						52,374	$5.08				
Commercial	1		0	$2.08	0	$2.89	3,000	$3.85	0	$3.40	0	$4.00
	2		16,000	$2.38			7,488	$4.13	10,001	$4.10		
	3						14,969	$4.25	20,001	$4.75		
	4						22,450	$4.45				
	5						29,931	$4.65				
	6						37,412	$4.89				
	7						44,893	$5.08				
	8						52,374	$5.08				
Industrial	1											
	2											
	3											
Irrigation	1		0	$3.41								
	2		30,000	$4.08								
	3											
	4											
	5											
Construction	1		0	$4.75								
	2		100,000	$6.00								
Gas Well	1								0	$11.39		
Fire Hydrant	1											
Bulk	1											
Governmental	1											

Water Meter Charges

Meter Size (in)	Cust. Usage (gal)	Cust. Age	Arlington Fixed Monthly Charge	Arlington Associated Gallons	Bedford Fixed Monthly Charge	Bedford Associated Gallons	Benbrook Fixed Monthly Charge	Benbrook Associated Gallons	Burleson Fixed Monthly Charge	Burleson Associated Gallons	D/FW Airport Fixed Monthly Charge	D/FW Airport Associated Gallons
5/8					$18.37							
5/8		>65			$16.70							
3/4			$8.57						$11.00			
3/4	<2,000		$5.00									
1			$15.00		$36.73				$16.00			
1		>65			$33.40							
1 1/4												
1 1/2			$34.28		$73.47				$30.25			
2			$59.99		$117.59				$44.50		Unknown	
3			$138.77		$220.49				$107.20			
4			$222.75		$352.82				$178.45			
5												
6			$517.89		$1,323.04				$356.60			
7												
8			$811.55						$534.70			
10			$1,219.05						$712.80			
12									$819.70			

Other Charges

User Type		Arlington Ready for Service Fee	Bedford Ready for Service Fee	Benbrook Ready for Service Fee	Burleson Ready for Service Fee	D/FW Airport Ready for Service Fee
Residential				$17.63		
Commercial				$14.90		
Bulk						

Typical Water Bill

Usage (gal)	Usage Type	Arlington Water Bill	Bedford Water Bill	Benbrook Water Bill	Burleson Water Bill	D/FW Airport Water Bill
10,000	Residential	$26.97	$45.60	$43.71	$45.00	
25,000	Residential	$74.58	$88.95	$103.91	$109.75	

Utility	Euless	Fort Worth	Grand Prairie	Grapevine	Haltom City
Effective Date	October 2011	January 2012	October 2011	January 2008?	October 2010
Rate Structure	Inclined Block	Inclined Block	Inclined Block	Flat	Flat

Water Volume Charges

User Type	Tier		Euless Beginning Usage (gal)	Euless Volume Charge ($/1,000 gal)	Fort Worth Beginning Usage (gal)	Fort Worth Volume Charge ($/1,000 gal)	Grand Prairie Beginning Usage (gal)	Grand Prairie Volume Charge ($/1,000 gal)	Grapevine Beginning Usage (gal)	Grapevine Volume Charge ($/1,000 gal)	Haltom City Beginning Usage (gal)	Haltom City Volume Charge ($/1,000 gal)
Residential	1		0	$2.48	0	$2.63	0	$0.12	2,000	$2.74	1,000	$4.44
	2		3,000	$3.41	5,984	$3.74	3,000	$3.16				
	3		9,000	$3.98	14,961	$4.65	20,000	$5.43				
	4		16,000	$4.36	22,442	$5.61						
	5		35,000	$4.96								
	6											
	7											
	8											
Commercial	1		0	$3.74	0	$2.98	0	$3.18	Various	$2.74	1,000	$4.44
	2											
	3											
	4											
	5											
	6											
	7											
	8											
Industrial	1		0	$3.74	0	$2.79	0	$3.18				
	2											
	3											
Irrigation	1		0	$3.74	0	$3.74						
	2		9,000	$3.98	37,403	$4.65						
	3		16,000	$4.36	74,805	$5.61						
	4		35,000	$4.96								
	5											
Construction	1											
	2											
Gas Well	1		0	$6.60	0	$6.02	0	$6.27			0	$10.41
Fire Hydrant	1		0	$6.60			0	$6.27	0	$2.74	0	$4.44
Bulk	1											
Governmental	1						0	$2.86				

Water Meter Charges

Meter Size (in)	Cust. Usage (gal)	Cust. Age	Euless Fixed Monthly Charge	Euless Associated Gallons	Fort Worth Fixed Monthly Charge	Fort Worth Associated Gallons	Grand Prairie Fixed Monthly Charge	Grand Prairie Associated Gallons	Grapevine Fixed Monthly Charge	Grapevine Associated Gallons	Haltom City Fixed Monthly Charge	Haltom City Associated Gallons
5/8					$7.50		$6.46		$9.75	2,000		
5/8		>65										
3/4			$7.95		$7.55				$9.75	2,000		
3/4	<2,000											
1			$9.29		$11.00		$8.62		$28.89	9,000		
1		>65										
1 1/4							$9.71					
1 1/2			$13.02		$19.00		$10.79		$61.73	21,000		
2			$21.57		$28.50		$17.82		$97.29	34,000		
3			$43.58		$61.75		$59.67		$217.67	78,000		
4			$77.35		$108.00		$75.90		$277.85	100,000		
5			$121.97									
6			$174.03		$235.00		$113.77		$370.87	134,000		
7												
8					$402.00		$157.05		$658.13	239,000		
10					$630.00		$164.63		TBD			
12							$174.17		TBD			

Other Charges

User Type		Euless Ready for Service Fee	Fort Worth Ready for Service Fee	Grand Prairie Ready for Service Fee	Grapevine Ready for Service Fee	Haltom City Ready for Service Fee
Residential						$12.25
Commercial						$12.25
Bulk					$59.13	$12.25

Typical Water Bill

Usage (gal)	Usage Type	Euless Water Bill	Fort Worth Water Bill	Grand Prairie Water Bill	Grapevine Water Bill	Haltom City Water Bill
10,000	Residential	$39.83	$38.34	$28.94	$31.67	$52.21
25,000	Residential	$102.95	$106.07	$87.69	$72.77	$118.81

		Utility	***Hurst***		***Johnson County SUD***		***Keller***		***Lake Worth (Inside)***		***Mansfield***	
		Effective Date	October 2011		2011		2011?		October 2008?		November 2010	
		Rate Structure	Flat		Inclined Block		Inclined Block		Flat		Inclined Block	
Water Volume Charges												
User Type	**Tier**		**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**
Residential	1		2,000	$5.70	0	$4.00	0	$1.87	0	$3.05	2,000	$2.74
	2				6,000	$4.50	2,001	$3.04			32,000	$3.43
	3				12,000	$5.25	10,001	$3.36				
	4				18,000	$5.75	20,001	$3.79				
	5						25,001	$4.90				
	6						40,001	$5.33				
	7											
	8											
Commercial	1		2,000	$4.89	0	$4.00	0	$1.87	0	$4.55	2,000	$2.74
	2				6,000	$4.50	2,001	$3.04			32,000	$3.43
	3				12,000	$5.25	10,001	$3.68				
	4				18,000	$5.75	20,001	$4.31				
	5						25,001	$4.90				
	6						40,001	$5.33				
	7											
	8											
Industrial	1										2,000	$2.06
	2										32,000	$2.57
	3											
Irrigation	1											
	2											
	3											
	4											
	5											
Construction	1											
	2											
Gas Well	1											
Fire Hydrant	1											
Bulk	1		2,000	$8.55					0	$4.55		
Governmental	1											
Water Meter Charges												
Meter Size (in)	**Cust. Usage (gal)**	**Cust. Age**	**Fixed Monthly Charge**	**Associated Gallons**	**Fixed Monthly Charge**	**Associated Gallons**	**Fixed Monthly Charge**	**Associated Gallons**	**Fixed Monthly Charge**	**Associated Gallons**	**Fixed Monthly Charge**	**Associated Gallons**
5/8					$33.00		$16.88				$21.17	2,000
5/8		>65										
3/4					$33.00		$21.20				$21.17	2,000
3/4	<2,000											
1					$77.50		$25.51				$52.90	2,000
1		>65										
1 1/4												
1 1/2					$155.00		$41.50				$105.82	2,000
2					$248.00		$57.49				$169.30	2,000
3					$465.00		$89.49				$338.59	2,000
4					$775.00		$110.72				$581.95	2,000
5							$142.71					
6					$2,232.00		$174.69				$1,191.42	2,000
7							$195.94					
8							$221.49					
10												
12												
Other Charges												
User Type				**Ready for Service Fee**		**Ready for Service Fee**		**Ready for Service Fee**		**Ready for Service Fee**		**Ready for Service Fee**
Residential				$14.18				$16.88		$6.00		
Commercial				Various				$16.88		$14.00		
Bulk				$21.27						$25.00		
Typical Water Bill												
Usage (gal)	**Usage Type**			**Water Bill**		**Water Bill**		**Water Bill**		**Water Bill**		**Water Bill**
10,000	Residential			$45.60		$75.00		$44.94		$36.50		$43.09
25,000	Residential			$131.10		$155.75		$97.49		$82.25		$84.19

		Utility	***North Richland Hills***		***Northlake (Inside)***		***Southlake***		***Watauga***	
		Effective Date	October 2012		June 2012		????		December 2011	
		Rate Structure	Inclined Block		Inclined Block		Inclined Block		Flat	
Water Volume Charges										
User Type	**Tier**		**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**	**Beginning Usage (gal)**	**Volume Charge ($/1,000 gal)**
Residential	1		1,998	$3.94	3,001	$2.75	2,001	$3.33	1,997	$6.04
	2		22,441	$4.02	15,001	$3.60	10,001	$3.85		
	3				30,001	$4.95	25,001	$4.12		
	4						40,001	$4.64		
	5									
	6									
	7									
	8									
Commercial	1		1,998	$3.94	0	$3.85			Various	$6.04
	2		22,441	$4.02	15,001	$4.65				
	3				30,001	$5.65				
	4									
	5									
	6									
	7									
	8									
Industrial	1									
	2									
	3									
Irrigation	1		0	$4.06						
	2									
	3									
	4									
	5									
Construction	1									
	2									
Gas Well	1									
Fire Hydrant	1						Various	Various		
Bulk	1									
Governmental	1									
Water Meter Charges										
Meter Size (in)	**Cust. Usage (gal)**	**Cust. Age**	**Fixed Monthly Charge**	**Associated Gallons**	**Fixed Monthly Charge (Residential)**	**Associated Gallons**	**Fixed Monthly Charge**	**Associated Gallons**	**Fixed Monthly Charge**	**Associated Gallons**
5/8										
5/8		>65								
3/4			$9.75	1,997	$19.50	3,000			$14.20	1,997
3/4	<2,000									
1			$16.28	3,336	$30.00	3,000			$19.76	2,581
1		>65								
1 1/4									$26.83	3,441
1 1/2			$32.47	6,650	$40.00	3,000			$56.26	7,009
2			$51.97	10,644	$60.00				$73.53	9,725
3			$97.50	19,972	$85.00				$135.66	17,953
4			$104.03	21,311	$125.00				$226.09	29,922
5										
6			$324.97	66,565	$250.00	3,000			$578.49	74,805
7										
8			$585.00	119,830						
10										
12										
Other Charges										
User Type				**Ready for Service Fee**		**Ready for Service Fee**		**Ready for Service Fee**		**Ready for Service Fee**
Residential								$28.35		
Commercial										
Bulk										
Typical Water Bill										
Usage (gal)	**Usage Type**			**Water Bill**		**Water Bill**		**Water Bill**		**Water Bill**
10,000	Residential			$41.31		$38.75		$54.99		$62.56
25,000	Residential			$100.46		$88.50		$112.74		$153.19

Appendix D:
Review of Other Regional Water Conservation Programs

D. Review of Other Regional Water Conservation Programs

April 19, 2011

Task A.5 in development of Tarrant Regional Water District's (TRWD's) Strategic Water Conservation Plan (as modified by the Request to Provide Consulting Services approved February 7, 2011) is to review the water conservation efforts of up to six wholesale and/or large municipal utility water providers in the U.S. The purpose of the review is to identify elements of these regional water conservation programs that may be applicable to TRWD and its Tarrant County service area. For each agency, information is presented about the driving factors for water conservation, program history, budgets and staffing, the agency role in the regional water conservation program, regional water conservation measures, whether wholesale customer participation is mandatory or voluntary, lessons learned, and water conservation goals and program effectiveness.

TRWD identified the following agencies for review of their regional water conservation programs:

1. Contra Costa Water District (CCWD)
2. Southern Nevada Water Authority (SNWA)
3. South Florida Water Management District (SFWMD)
4. Metropolitan North Georgia Water Planning District (MNGWPD)
5. Denver Water (DW)
6. Western Municipal Water District (WMWD)

APAI reviewed published materials for the six entities listed above and interviewed the water conservation coordinators for the first five agencies listed.[44] In addition, TRWD reviewed published materials and interviewed the water conservation coordinators for the following agencies:

7. Lower Colorado River Authority (LCRA)
8. North Texas Municipal Water District (NTMWD)
9. Regional Water Providers Consortium (RWPC)

Service area information is presented below for each agency (Table D-1). Agency water conservation contact information is presented in Table D-2.

SFWMD, MNGWPD, and RWPC are not water providers and mostly provide planning services for large regions. CCWD, SNWA, and NTMWD are wholesale water providers. DW, WMWD, and LCRA are wholesale and retail water providers.

[44] APAI was unable to interview the water conservation coordinator for the Western Municipal Water District.

Table D-1: Service Area Information

Agency	Type of Entity	Service area	Water provider?		Population Served	Number of Wholesale Customers	Current Demands	
			Raw	Treated			Average	Peak Day
South Florida Water Management District	Regional governmental agency	16 counties in South Florida (Miami, Fort Lauderdale, part of Orlando metro areas)	No	No	7.5 million	Not applicable; SFWMD is not a water provider	3.4 bgd	Not reported
Metropolitan North Georgia Water Planning District	Created in 2001 to serve as the water planning organization for the metropolitan Atlanta area	15 counties in the Atlanta metro area	No	No	More than 4.4 million	Not applicable; the District is not a water provider	151 gpcd (2006 base year)	Not reported
Contra Costa Water District	Wholesale water provider	Portions of Contra Costa County, CA	Yes	Yes	550,000	5 municipal customers, 46 industrial customers, and approximately 50 irrigation customers.	Raw water: 64,435 ac-ft/yr Treated water: 28,475 ac-ft/yr	Not reported. CCWD does not focus on reducing peak day flows, because they have excess treatment capacity.
Southern Nevada Water Authority	Wholesale water provider	Las Vegas metro area	Yes, to Boulder City for irrigation customers	Yes	Nearly 2 million	7	376.6 mgd in 2009	544.9 mgd in 2009
Denver Water	Wholesale and retail water provider	Denver metro area	Yes, to some individual customers and the City of Arvada	Yes	More than 1,300,000	24 "master meter" cities/utilities. Additional "total service" and "read and bill" cities/utilities. The master meter cities are essentially wholesale water customers.	170 mgd in 2009	342 mgd in 2009

Table D-1 Continued: Service Area Information

Agency	Type of Entity	Service area	Water provider?		Population Served	Number of Wholesale Customers	Current Demands	
			Raw	Treated			Average	Peak Day
Western Municipal Water District	Wholesale and retail water provider	Western portion of Riverside County, CA	Yes	Yes	2009: 880,600	8	93.1 mgd in 2009	Not reported
Regional Water Providers Consortium	Created in 1996 through an intergovernmental agreement to coordinate regional water supply planning.	Portland, OR metro area	No	No	90-95 percent of the metro area	22: 16 cities, 5 water districts, 1 public utility district. The regional government, Metro, also participates in the RWPC.	Not reported	Not reported
Lower Colorado River Authority	Wholesale and retail water provider	Lower Colorado River Basin, TX 600 mile stretch of the Texas Colorado River between San Saba and the Gulf Coast	Yes	Yes	As of 2008, approximately 284,000 (retail and wholesale), not including City of Austin.	41 municipal raw water wholesale customers	128 mgd to firm water supply customers in 2006. Does not include interruptible agricultural irrigation supplies.	Not reported
North Texas Municipal Water District	Wholesale water provider	Primary service area includes Collin, Rockwall, Kaufman, and Hunt Counties	No	Yes	Over 1.6 million	13 member cities and 32 customers	Water year 2010: 90.7 billion gallons produced	Not reported

Table D-2: Agency Contact Information

Agency	Contact	Title	Phone Number	Email Address
South Florida Water Management District	Natalie Schneider	Section Leader, Intergovernmental Programs	561-682-2545	nschneid@sfwmd.gov
Metropolitan North Georgia Water Planning District	Pat Stevens	Environmental Planning Division Chief	404-463-3255	pstevens@atlantaregional.com
Contra Costa Water District	Chris Dundon	Water Conservation Administrator	925-688-8136	cdundon@ccwater.com
Southern Nevada Water Authority	Doug Bennett	Conservation Manager	702-862-3777	doug.bennett@snwa.com
Denver Water	Melissa Elliott	Manager of Water Conservation	303-628-6457	melissa.elliott@denverwater.org
Western Municipal Water District	Tim Barr*	Water Use Efficiency Manager	951-571-7254	tbarr@wmwd.com
Regional Water Providers Consortium	Patty Burk	Administrative Assistant, Portland Water Bureau	503-823-7528	RWPCinfo@portlandoregon.gov
Lower Colorado River Authority	Nora Mullarkey	Water Conservation Manager	512-473-4009	nora.mullarkey@lcra.org
North Texas Municipal Water District	Denise Hickey	Public Relations Coordinator	972-442-5405	dhickey@ntmwd.com

* APAI was unable to schedule an interview with Mr. Barr.

Throughout this Appendix, information that has the most significant implications for TRWD strategic water conservation planning is shown in bold, italicized text.

D.1. Criteria for Selection of Water Conservation Programs for Evaluation

The following driving factors for water conservation were identified from interviews and published materials:

- Drought
- Long-term water supply limitation
- Reliability of other water supplies
- Cost of other water supplies
- Deferral of water infrastructure expansion
- Legislative water use reduction mandate
- Planning rules
- Water use permit requirements

The driving factors for each agency are summarized in Table D-3.[45] The water provider agencies are motivated to conserve water primarily due to legislative mandates and the limitations and costs of other water supplies.

Table D-3: Summary of Driving Factors for Water Conservation

Agency	Drought	Long-Term Water Supply Limitation	Reliability of Other Water Supplies	Cost of Other Water Supplies	Deferral of Water Infrastructure Expansion	Legislative Water Use Reduction Mandate	Planning Rules	Water Use Permit Requirements
South Florida Water Management District	x						x	x
Metropolitan North Georgia Water Planning District								x
Contra Costa Water District	x					x		
Southern Nevada Water Authority		x						
Denver Water	x			x				
Western Municipal Water District			x			x		
Regional Water Providers Consortium		x					x	
Lower Colorado River Authority		x			x		x	
North Texas Municipal Water District	x	x						

[45] Many tables of information are presented in the remainder of this memorandum. The information contained in each table was specifically mentioned in published materials or during interviews with agency water conservation coordinators. A blank cell in a table does not necessarily mean that an agency has not addressed certain issues. Instead, it means that APAI did not identify relevant information during the program review.

D.2. Program History

The history of the regional water conservation program for each agency is summarized in Table D-4. Most of the agencies started their programs in response to drought or long-term water supply limitations. Six agencies began their water conservation programs with public education and outreach. Three agencies began their water conservation programs with an array of measures.

Table D-4: Summary of Regional Conservation Programs History

Agency	Program Start Date	Initial Water Conservation Measures
South Florida Water Management District	1992	8 mandatory conservation requirements for water use permit applicants
Metropolitan North Georgia Water Planning District	2001	10 mandatory water conservation measures for local utilities
Contra Costa Water District	1988	Drought response measures, followed by California Urban Water Conservation Council BMPs
Southern Nevada Water Authority	Mid 1990s	Bureau of Reclamation BMPs
Denver Water	Late 1970s	Public education and outreach
Western Municipal Water District	≤ 1989	Landscapes Southern California Style, an outdoor water conservation education center.
Regional Water Providers Consortium	2000	Public education and outreach
Lower Colorado River Authority	1980s	Required customer conservation plans, provided technical assistance to customers, distributed educational materials, and conducted workshops for teachers.
North Texas Municipal Water District	Mid 1990s	Provided the "Learn to be Water Wise" curriculum to area school districts

D.3. Water Conservation Budgets and Staffing

Available water conservation budgets and staffing are shown for each agency in Table D-5.[46] In terms of population served and average day water demand (Figure D-1), the water provider agencies (CCWD, SNWA, DW, and WMWD) spend much more money on water conservation than the planning agencies (SFWMD and MNGWPD). Available water conservation budgets for the water provider agencies range from $1 to $17 per person served and $10,000 to $90,000 per million gallons per day (mgd) of average day water demand.

As an example, ***to be similar to CCWD's water conservation budget in terms of service area population and average day demand, TRWD's annual water conservation budget would be in the range of $8.8 million to $10.0 million***.[47] CCWD was chosen for this example because it is a regional water provider that has achieved long-term water conservation (see additional discussion in Section D.8).

Table D-5: Water Conservation Budgets and Staffing

Agency	Water Conservation Annual Budget	Water Conservation Staff (FTEs)
South Florida Water Management District	$1.55 million (FY 2011) Expect cuts in FY 2012 due to decreases in ad valorem taxes. Possible that FY 2012 funding will only include staffing.	10.2 (FY 2011)
Metropolitan North Georgia Water Planning District	Less than $1 million.	Staffing provided by the Atlanta Regional Commission Environmental Planning Division
Contra Costa Water District	FY 2009: $2,114,444 FY 2010: $2,880,014 These budgets include the labor and material costs for surveys, devices, rebates, and other outreach programs, as well as additional costs for the DMP. Costs for the public information program and the school education program are not included. The District obtained $126,000 in FY09 and $430,874 in FY10 in grant funding for the Water Conservation Program.	10 (4 temporary)

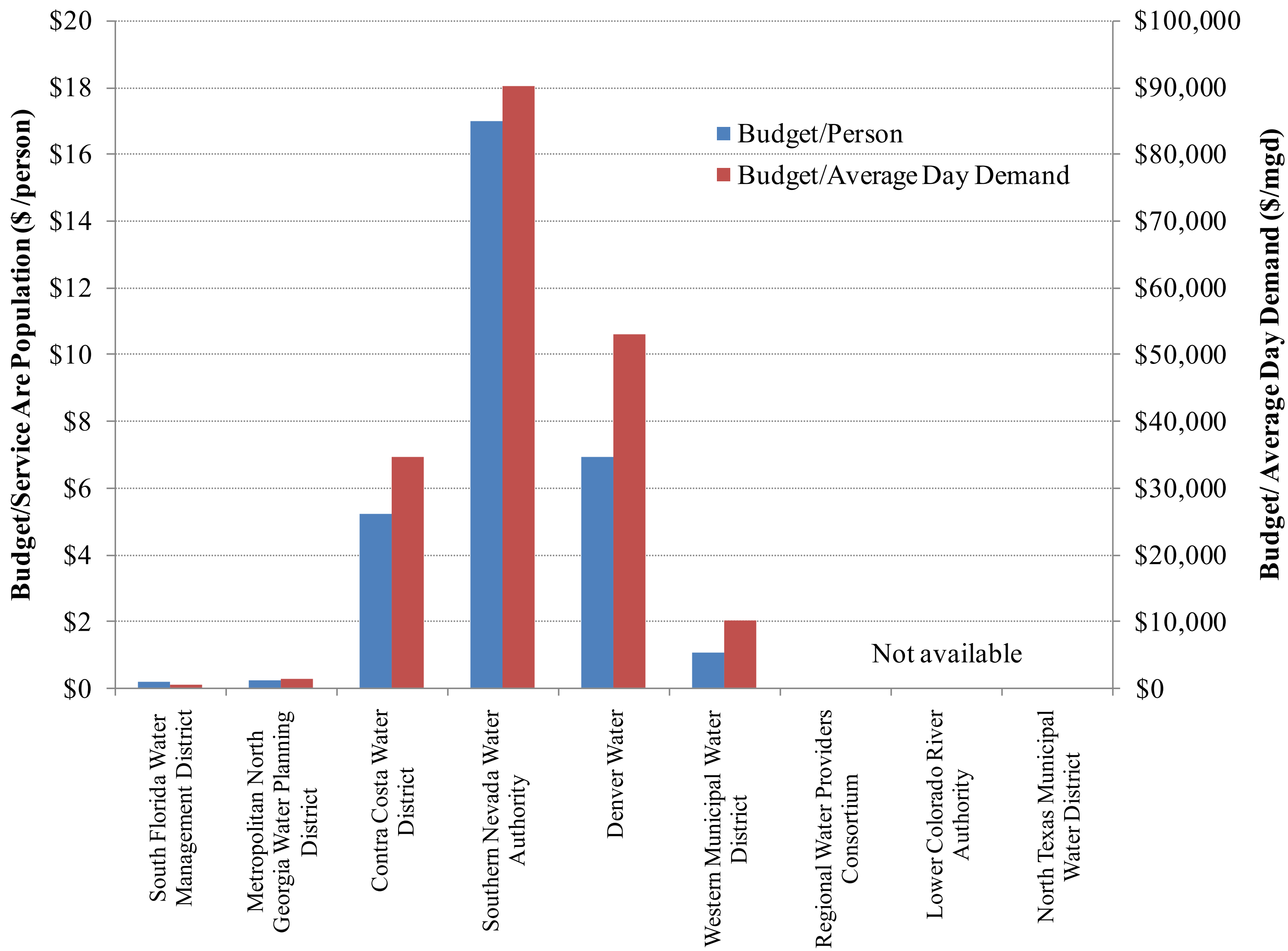
[46] In some cases (e.g., CCWD, WMWD, and NTMWD) the budgets listed do not include all water conservation expenditures, so actual water conservation budgets may be somewhat larger.

[47] Based on the Fort Worth, Arlington, Trinity River Authority, and Mansfield service areas. Note that the CCWD budget used in this example does not include public information and school education programs.

Table D-5 Continued: Water Conservation Budgets and Staffing

Agency	Water Conservation Annual Budget	Water Conservation Staff (FTEs)
Southern Nevada Water Authority	2008: $50 million 2009: $34 million Bulk of budget spent on customer rebates.	34
Denver Water	2007: $4.7 million 2008: $6.6 million 2009: $8.7 million 2010: $11.4 million 2011: $9 million	Public Affairs Division: 2007: 12 2008: 15 2009: 17 2010: 18 2011: 18 Also 12-16 seasonal employees in the summer.
Western Municipal Water District	2009-10: $2,119,595 2010-11: $953,166 Does not include salaries and benefits. For 2010-11, 31 percent of the non-recurring expenses are allocated to wholesale water and 69 percent to retail water.	Not reported, but *Water Use Efficiency Master Plan* projects 5 FTEs to implement the Plan.
Regional Water Providers Consortium	FY 2009-10: $767,774 Of this, $484,615 (approximately 63 percent) was spent on regional water conservation (materials and services and personnel/overhead costs). The RWPC spends approximately $120,000 per year on television and radio ad purchases.	5, split between Portland and the RWPC. Some of the individual utilities have conservation staff as well. The RWPC spends approximately $20,000 per year on contractors for the web site, public relations, a schools theater group, and graphic design.
Lower Colorado River Authority		6
North Texas Municipal Water District	Estimated costs for first three years of "Water IQ: Know Your Water" public awareness water conservation program: $2.0 million $1.8 million $1.6 million	

Figure D-1: Normalized Water Conservation Budgets



D.4. Agency Roles in the Regional Water Conservation Program

The agencies review plans and coordinate conservation measures, provide and secure funding, develop and operate conservation measures, and monitor progress. These roles are summarized in Table D-6.

Planning and Coordination

SFMWD, MNGWPD, and RWPC have developed water supply and water conservation plans for large areas in Florida, Georgia, and Oregon, respectively. These plans were developed using a "bottom-up" process with significant input from local water providers. The projected water savings from the water conservation measures are based on broad assumptions, and the structure[48] and implementation details[49] are left to the local water providers. The level of detail in the SFMWD and MNGWPD plans can be likened to that in the Region C Water Plan.[50] SFMWD, MNGWPD, and RWPC staff members serve as a technical resource to assist local utilities with water conservation planning and implementation.

Five of the water provider agencies (CCWD, SNWA, DW, WMWD, and LCRA) have developed strategic water conservation plans for their service areas that include detailed program structure and implementation plans. Wholesale customer input into water conservation planning varies among the agencies: for example, CCWD wholesale customers do not seek much input, while SNWA conducts monthly meetings of an interagency committee to share information and get feedback. In addition, the SNWA Board of Directors consists of one representative from each wholesale customer.

SNWA conducts and/or participates in various water conservation research projects and uses the results to inform its water conservation planning. Current research projects include:

- EPA New Homes Water Efficiency Benchmarking
- Watering Group Assistant Study
- Smart Controls Exemption Study
- Leak Detection Research
- School Audits
- Turf Assessment Project
- Smart Sprinklers Study

[48] As an example of different measure structures, a toilet replacement program could be structured as a direct installation program, where utility personnel delivers and installs the new toilet, or it could be structured as a rebate program, where the retail customer purchases and installs a qualifying new toilet and receives a rebate.

[49] Implementation details include items such as what customers qualify to participate in a program, rebate amounts, etc.

[50] 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, October 2010.

Table D-6: Summary of Agency Roles in Regional Water Conservation Programs

Agency	Planning/Coordination						Funding		Conservation Measures				Progress Monitoring	
	Develop Conservation Plans	Set Conservation Goals	Provide Technical Support	Conduct Conservation Research	Share Information/Conduct Regular Customer Meetings	Advocate/Assist with Coordination of Conservation Regulations	Provide Funding for Conservation Programs	Solicit Grant Funding	Develop/Operate Education/Recognition Programs	Develop/Operate Rebate/Incentive Programs	Operate Reclaimed Water Project	Verify Installation of Conservation Equipment	Track Water Conservation Activities	Track Water Use and Conservation Savings
South Florida Water Management District	x	x	x				x		x				x	x
Metropolitan North Georgia Water Planning District	x	x	x				x		x	x			x	x
Contra Costa Water District	x	x					x	x	x	x		x	x	x
Southern Nevada Water Authority	x	x	x	x	x	x	x		x	x	x	x	x	x
Denver Water	x	x	x				x		x	x	x		x	x
Western Municipal Water District	x	x	x			x	x	x	x	x	x		x	x
Regional Water Providers Consortium	x	x	x		x				x				x	
Lower Colorado River Authority	x	x	x	x	x				x	x	x			x
North Texas Municipal Water District	x	x				x			x		x			x

Completed SNWA research projects include:

- Xeriscape Conversion Study
- Construction Water Use Study
- National Multiple Family Submetering and Allocation Billing Study
- Automated Irrigation Controllers

LCRA plans to evaluate and research potential water conservation measures (e.g., smart controllers, separate irrigation meters, and water heating technologies), develop metrics for program effectiveness, develop a verification plan for municipal and industrial programs, and conduct surveys to track changes in attitudes and behaviors about water conservation.

Funding Sources

Agency funding sources for the regional water conservation programs included water rates, property and sales taxes, state appropriations, local government dues, connection fees, grants, funding from the agency's water supplier, and federal land auction sales (Table D-7). Funding from these sources depends on the following factors:

- Water use (water rates),
- Tourism (sales tax),
- Land area (property tax and federal land auction sales),
- Population (local government dues),
- New customers (connection fees),
- Participation in water conservation measures (funding from agency water supplier), and
- Other factors (state appropriations and grants).

SNWA tries to place the costs of the program on the elements that lead to increased costs for the water system. As a result, SNWA receives funding based on customer water use, tourism, new land area in its service area, and new customers in its service area (Table D-7).

Role in Conservation Measures

The involvement of the agencies in the implementation of water conservation measures varies considerably, as described below. This section is intended to provide a general description of the roles of the agencies; details about the water conservation measures are presented in Section D.5.

Table D-7: Summary of Funding Sources

Agency	Component of Water Rate	Property Taxes	Sales Tax	State Appropriations	Local Government Dues	Connection Fees	Grant Funding	Water Supplier	Percentage of Federal Land Auction Sales
South Florida Water Management District		x							
Metropolitan North Georgia Water Planning District				x	x				
Contra Costa Water District	x								
Southern Nevada Water Authority	x		x			x			x
Denver Water	x								
Western Municipal Water District*							x	x	
Regional Water Providers Consortium					x				
Lower Colorado River Authority	x								
North Texas Municipal Water District	x								

*WMWD has other sources that have not been identified.

Less Active Agencies

In the SFWMD, MNGWPD, RWPC, and NTMWD planning areas, the agencies fund and operate regional public education programs, but local utilities are generally responsible for funding and implementing other water conservation measures. Exceptions include the following:

- SFWMD provides funding for local measures through its Water Savings Incentive Program (WaterSIP), competitive water conservation grant program that provides a rebate of up to 50 percent of project cost (with a maximum rebate of $50,000) for projects that use technology to implement water conservation. SFMWD also operates mobile irrigation labs to evaluate agricultural irrigation systems.
- MNGWPD operates a regional toilet rebate program. Local utilities are welcome to participate in the regional program or operate their own toilet rebate program. MNGWPD receives and processes the rebate applications, and local utilities issue credits to successful applicants.
- SFMWD, MNGWPD, RWPC, and NTMWD each operate regional public education programs. In varying degrees, these programs include advertising conservation messages in multiple media, developing and providing public education materials, conducting workshops, and promoting partnerships with EPA’s WaterSense programs.

More Active Agencies

The remaining agencies are more active, operating and funding regional incentive programs (in addition to regional public education programs) and making the regional water conservation measures available to all customers in the retail and wholesale service areas.[51] According to CCWD, regional programs should be developed when they will lead to greater economic benefits and greater water savings than localized programs.[52]

In these service areas, the wholesale customers are responsible for developing local water conservation regulations, setting retail rate structures, and water loss prevention/leak detection within their systems.

Progress Monitoring

Most agencies track water conservation activities (e.g., percentage of utilities implementing a given measure, number of rebates issued, etc.) and water use and conservation savings (Table D-6).

D.5. Regional Water Conservation Measures

Regional water conservation measures are summarized in this section. Types of measures include:

- Wholesale water rates
- Indoor residential measures
- Outdoor residential and commercial measures
- Industrial, commercial, and institutional (ICI) measures
- Regulatory measures
- Public education
- Wholesale customer rebate program
- Other measures

Wholesale Water Rates

Many of the water provider agencies charge their wholesale customers a flat rate for water. This wholesale water rate structure neither encourages nor discourages water conservation.

LCRA's wholesale water rate structure encourages water conservation: the less water that a wholesale customer uses, the smaller the customer's effective water rate. LCRA's wholesale water rate structure includes the following volumetric and reservation charges:

- Full rate ($151 per ac-ft) for water contractually reserved and actually taken.

[51] Although it appears that WMWD has some conservation measures that target retail customers only.

[52] Greater economic benefits may result from economies of scale. Greater water savings benefits may result from uniform water conservation messaging.

- One-half rate ($75.50 per ac-ft) for water contractually reserved but not taken. Although this is a "take or pay" charge, the cost of not taking the water is less than the cost of taking the water.
- Double rate ($302 per ac-ft) for water taken in excess of the contractually reserved amount.

The conservation coordinators interviewed suggested other ideas for alternative wholesale water structures to encourage water conservation, including seasonal rates or tiered rates based on per capita water use.

Residential, ICI, and Regulatory Measures

Existing and planned residential, ICI, and regulatory measures are summarized in Tables D-8 through D-10. Implementation methods for these measures vary by strategy and agency and include:

- Rebates
- Direct installation of plumbing fixtures
- Distribution of plumbing fixtures
- Distribution of coupons for businesses that implement certain conservation measures
- Financial incentives based on actual water savings
- Site visits for customer education and conservation recommendations
- Requirements/ordinances/terms of service
- Local utility chooses its own implementation method

Although some measures are available to all customers, other measures target a limited number of high water users. For example, CCWD and WMWD target all customers for landscape water use surveys, but DW targets only large-scale irrigation customers. Targeting high water users is a way to increase the cost-effectiveness of a measure.

For residential measures, most of the regional water conservation programs strike a balance between measures that address both indoor and outdoor water use. Exceptions include SFMWD, which focuses on outdoor water, and MNGWPD and RWPC, which focus on indoor water use.

ICI measures include the extension of domestic measures (e.g., replacement of inefficient toilets) to ICI settings, but also target specific industries (e.g., car washes, restaurants, hotels, and sports facilities) and uses (e.g., process water and cooling water).

SFMWD plans to reduce water use at SFMWD facilities and other public facilities. This shows leadership, it can serve as a demonstration of conservation technologies, and it can make other customers more willing to participate in conservation measures.

Table D-8: Summary of Indoor Residential and Outdoor Residential and Commercial Water Conservation Measures

Measures	South Florida Water Management District	Metropolitan North Georgia Water Planning District	Contra Costa Water District	Southern Nevada Water Authority	Denver Water	Western Municipal Water District	Regional Water Providers Consortium	Lower Colorado River Authority	North Texas Municipal Water District
Indoor Residential Measures									
Replacement of Older, Inefficient Toilets		x	x		x	x		x	
Residential Water Audits/Surveys		x	x	x	x				
Distribution of Low-Flow Plumbing Fixtures		x	x	x			x	x	
High-Efficiency Clothes Washer Rebates			x		x	x		x	
High-Efficiency Appliances in New Construction				x					
Multi-Family Submeter Installation/Rebates					x	x			
Outdoor Residential and Commercial Measures									
Evaluation of Irrigation Systems/ Customer Water Use Surveys	x		x		x	x		x	
Alternative Water Sources	x							x	
Turf Grass Removal Rebates			x	x		x			
Weather-Based Irrigation Controller Incentives			x	x	x	x			
Commercial Irrigation Equipment Incentives			x		x	x		x	
Pool Cover Rebates				x					
Rain Sensor Rebates				x	x			x	
High-Efficiency Irrigation Nozzle Rebates					x	x		x	
Coupons for Landscape Mulch			x						
Water-Efficient Landscape Design Course				x					

Table D-9: Summary of Industrial, Commercial, and Institutional (ICI) Water Conservation Measures

ICI Measures	South Florida Water Management District	Metropolitan North Georgia Water Planning District	Contra Costa Water District	Southern Nevada Water Authority	Denver Water	Western Municipal Water District	Regional Water Providers Consortium	Lower Colorado River Authority	North Texas Municipal Water District
Customer Water Audits/Surveys		x	x		x				
Replacement of Older, Inefficient Toilets/Urinals		x	x	x	x	x		x	
Flushometer and Valve Rebates					x				
Replacement of Inefficient Plumbing Fixtures				x					
Car Wash Water Recycling (Requirement or Incentive)		x	x	x	x				
Restaurant Water Upon Request			x	x					
Replace Water-Cooled Equipment				x	x	x		x	
Retrofit of Cooling Towers to Prevent Drift				x					
Hotel Linen Exchange				x					
Flow Meter and AMR Device Rebates					x				
High-Efficiency Clothes Washer Rebates					x				
Cooling Tower Conductivity Controller Rebates					x	x			
Boilerless Steamer Rebates					x	x			
Efficient Commercial Dishwasher Rebates					x				
Pre-Rinse Spray Valve Rebates								x	
Sports Field Conversion to Artificial Turf				x					
General ICI Rebates/Incentive Contracts	x			x	x	x		x	
Recognition Programs	x			x	x				
Business Leaders Group				x					
Other Measures	x				x	x			

Table D-10: Summary of Regulatory Water Conservation Measures

Regulatory Measures	South Florida Water Management District	Metropolitan North Georgia Water Planning District	Contra Costa Water District	Southern Nevada Water Authority	Denver Water	Western Municipal Water District	Regional Water Providers Consortium	Lower Colorado River Authority	North Texas Municipal Water District
Model Water Waste Ordinance		x		x	x	x			
Require Rain Sensors for Irrigation Systems	x	x			x				x
Restrict Watering Days	x			x	x			x	x
Restrict Watering Hours				x	x			x	x
Require Water-Efficient Landscaping	x								
Limits on Fountains, Water Features, and Misting Systems				x					
Limits on Vehicle Washing				x					x
Limits on Turf Grass Installation				x					
Mandatory Water Budgets (Golf Courses)				x					
Require Soil Amendment for New Development					x				
Model Landscape Ordinance						x		x	
Model New Construction Ordinance						x			
Require High-Efficiency Plumbing Fixtures	x								
Require Submeters (Multi-Family)		x							
Require Conservation-Oriented Rate Structures	x								*
Require Conservation Landscape Guidelines in New Wholesale Service Agreements								x	
Require Customer Conservation Plans								x	x
Require Conservation Coordinators and Annual Reports								x	

*The NTMWD model water conservation plan says that member cities “should” adopt a conservation-oriented rate structure.

The regulatory measures in the regional water conservation programs primarily target water waste in outdoor water use. They focus on reducing irrigation amounts to match plant water needs and increasing irrigation efficiency. Indoor water use regulations focus on use of high-efficiency plumbing fixtures (e.g., toilets that use 1.28 gallons per flush) and submetering of multi-family units.

As a final observation on the residential, ICI, and regulatory measures, CCWD is considering discontinuation of its toilet rebate program due to market saturation, new laws requiring high-efficiency toilets (1.28 gallons per flush), and an opportunity to reallocate its resources for larger savings from landscape irrigation measures.

Public Education

Agency public education programs include the following elements:

- Multi-media campaigns (television ads, radio ads, newspaper ads, billboards, direct mail)
- Workshops on various water conservation topics
- Interactive web site
- News releases
- Brochures
- Participation in community events
- School presentations
- Newsletters
- Watering schedules provided by email
- Blogs
- Recognition programs
- Public-private partnerships
- Demonstration gardens
- Teacher training/teacher grants
- Science fairs
- Landscape design support
- Other elements

Each agency operates a public education program. Due to the size and nature of the service areas, the water providers are able to tailor their messages a little more than the planning agencies. Two agencies said that they rarely use television and radio ads, because they are much more expensive than other types of public education.

SNWA concentrates its major multi-media advertising purchases over short periods of time rather than advertising for an extended period. These bursts of advertising are usually associated with specific actions that SNWA desires its customers to perform (such as resetting irrigation controllers based on seasonal irrigation limitations). SNWA believes that short-term media saturation gets customer to perform specific actions better than sustained advertising over a long period of time.

Other Measures

LCRA plans to implement a wholesale customer system conservation program. Under this program, a wholesale customer would identify a conservation measure that is specifically tailored to their own customer/service area, and LCRA would provide a financial incentive to help offset the cost of implementing the measure. LCRA must approve the projects in advance, and the rebate would be paid over time through a performance contract based on demonstrated water savings.

Since 1996, SFMWD has provided over $150 million in funding to more than 400 alternative water supply projects, including reclaimed water, brackish water, aquifer storage and recovery, stormwater reuse, and other projects. SFMWD has also provided more than $2.3 million in funding for water conservation through the previously described WaterSIP grant program.

The water provider agencies lack authority to set local conservation regulations. To address this restriction, ***SNWA and NTMWD facilitated the adoption of the same water conservation plans and ordinances by each of their member agencies.*** This allows SNWA and NTMWD to provide public awareness messages that are applicable throughout its service area, avoiding customer confusion.

Generally speaking, the wholesale customers are responsible for controlling water loss within their own service areas. However, DW did fund a leak detection study for 9 of its master meter cities.

There are active reclaimed water projects in at least 7 of the 9 agency service areas.[53] Direct reuse projects include irrigation (residential lots, golf courses, parks, schools, athletic fields, medians, cemeteries, and other land uses), cooling water use, and other industrial uses. Indirect reuse projects include augmentation of water supplies with reclaimed water. All treated wastewater from the SNWA service area that is not reused directly is discharged back to its water supply.

D.6. Mandatory or Voluntary Wholesale Customer Participation

Wholesale customer participation requirements are summarized in Table D-11. Of the regional water conservation programs, two (MNGWPD and DW) require local utilities to implement each water conservation measure. The Georgia Environmental Protection Division enforces compliance in the MNGWPD planning area during the permitting process for water withdrawals, wastewater discharges, and stormwater discharges. As part of the terms of services, DW requires its master meter cities to implement the same types of water conservation programs as DW (implementation can consist of participation in a program operated by DW).

[53] The agencies described in this memorandum do not necessarily operate the reclaimed water projects.

Table D-11: Summary of Wholesale Customer Participation Requirements

Agency	All Measures Mandatory	Some Measures Mandatory	Voluntary, But Subject to Legislative Water Savings Mandate	Voluntary
South Florida Water Management District		x		
Metropolitan North Georgia Water Planning District	x			
Contra Costa Water District			x	
Southern Nevada Water Authority				x
Denver Water	x			
Western Municipal Water District			x	
Regional Water Providers Consortium				x
Lower Colorado River Authority				x
North Texas Municipal Water District				x

SFMWD requires applicants for water use permits (which are renewed every five years) to implement the following conservation measures:

- Local government ordinances that:
  - Limit irrigation hours.
  - Promote water-efficient landscaping.
  - Promote the installation of ultra-low volume plumbing fixtures in all new construction.
- Adoption of a water conservation-based rate structure.
- Leak detection programs for utilities with unaccounted-for water losses of greater than 10 percent.
- Rain sensors on new automatic irrigation systems.
- Public education programs.
- Landscape and golf applicants must use water-efficient landscaping principles and install and use rain sensors or similar devices.

Participation in other SFMWD water conservation measures is voluntary.

Wholesale customer participation in the CCWD and WMWD regional water conservation programs is voluntary, but the wholesale customers are subject to a legislative mandate to reduce water use by 20 percent by 2020. In addition, some of the wholesale customers have pledged to implement the fourteen California Urban Water Conservation Council (CUWCC) Best Management Practices (BMPs).

Wholesale customer participation in SNWA, RWPC, LCRA, and NTMWD regional water conservation measures is voluntary.

D.7. Lessons Learned

Selected lessons learned by the agencies during planning, development, and operation of the regional water conservation programs are summarized in this section.

Three agencies advised significant involvement of stakeholders in the water conservation planning process. A bottom-up process, where local utilities help develop the plan, is beneficial. Stakeholder buy-in is important to the success of the plan.

Two agencies recommended coordinating with wholesale customers to implement similar regulations and similar conservation measure details. One agency further suggested that all conservation measures be available throughout the agency service area and not just in certain areas. In this way, regulations and conservation measures apply equally to all customers in the agency service area, customer confusion is reduced, and public education is less complicated.

Two agencies wish that they had an integrated retail customer billing and water conservation database. This would greatly simplify tracking of water conservation activities (e.g., high-efficiency toilet installation), evaluation of water savings for different measures, and trending of water use by customer class.

CCWD encourages identifying ways for the wholesale customers to have a vested interest in the regional water conservation program; otherwise, the wholesale customers will “let TRWD do it.”

The SNWA member agencies use a service rule model of enforcement, where compliance with water conservation rules is part of the terms of obtaining water service. When fines are necessary, they are assessed on the water bill rather than through a process that involves municipal courts.

D.8. Water Conservation Goals and Effectiveness

The goals and the effectiveness of the regional water conservation programs are summarized in Table D-12.

Per capita water use goals range from 85 to 199 gallons per capita per day (gpcd). In percentage terms, the current goals range from 5.2 to 22 percent water savings. The wide range reflects the different demand profiles, water supply situations, and degree of water conservation implementation in each service area. For these reasons, water use should not be directly compared between different utilities.

Table D-12: Summary of Program Goals and Progress

Agency	Numerical Goal	Goal Date	Percentage Water Use Reduction	Progress Monitoring				Conservation Progress
				Total Water Use	Per Capita Water Use	Per Account Water Use	Measure Participation	
South Florida Water Management District	Reduce water use by 177 mgd	2025	5.2	x	x			Estimated incremental water conservation savings by year: FY 2008: 1.73 mgd FY 2009: 3.1 mgd FY 2010: 4.7 mgd
Metropolitan North Georgia Water Planning District	135 gpcd	2035	9.4		x		x	2009 water use was 102 gpcd, a reduction of 47 gpcd from 2000.*
Contra Costa Water District	121 gpcd**	2020	20	x		x	x	Total FY2010 CCWD water use was 48,331 acre feet less than it was in the late 1980s before CCWD instituted its conservation program.
Southern Nevada Water Authority	199 gpcd	2035	19.8		x		x	Reduced total per capita water use from 318 gpcd in 2001 to 248 gpcd in 2009.
Denver Water	165 gpcd	2016	22	x	x		x	To date, Denver Water has reduced system-wide per capita water use by 19 percent, or 30 gpcd.
Western Municipal Water District	85 gpcd**	2020	20	x			x	Water savings not reported. Comprehensive regional conservation program just getting started.
Regional Water Providers Consortium							x	Water savings not reported.
Lower Colorado River Authority	6,200 ac-ft (excluding Austin)	2019	4.3	x	x			Estimated savings of 560 ac-ft from mandatory watering schedule in West Travis County Regional Water System.
North Texas Municipal Water District	165 gpcd	2017			x			Water savings not reported.

*Extreme drought in 2006-2008, the recent economic recession, and a very wet year in 2009 make it difficult to assess how much of the change is due to conservation.

** Estimated based on 20%/2020 legislative mandate and population and water demand information from Table D-1.

The agencies report varying degrees of progress toward their water use goals. For each agency, the reported progress is generally consistent with the goal timeline. It can be difficult to assess the impact of water conservation and whether a goal has been achieved. For example, 2009 water use in the MNGWPD planning area was 102 gpcd, significantly less than the 2035 goal of 135 gpcd. However, the 2009 water use was influenced by extreme drought from 2006 to 2008, a severe economic recession, and the highest annual rainfall since 1948, so it is difficult to assess how much of the change is due to conservation and how long water use will remain at this level.

CCWD, SNWA, and DW have achieved significant long-term water savings:

- CCWD has achieved a 34 percent reduction in total water use since the late 1980s (about 1.9 percent per year). The population has grown in the CCWD service area since the late 1980s, so the per capita water use reduction has been even larger.
- SNWA has reduced per capita water use by 22 percent since 2001 (about 2.5 percent per year).
- DW has reduced per capita water use by 19 percent since 2001 (about 2.1 percent per year).

These three agencies commit the largest annual conservation budgets and staffs (Table D-5), operate regional conservation programs that address a variety of water uses (Section D.5), and make the regional water conservation measures available to all customers in the retail and wholesale service areas.

Historical water use for several water provider agencies is summarized in Figures D-2 through D-6. With the exception of WMWD, per capita water use has decreased in recent years. WMWD is currently expanding its regional water conservation program.

Historical peak day water use was available from SNWA and DW. Although the 2009 peak day water use for SNWA is not substantially different than it was in 2000, the population in the SNWA service area has increased by 25 percent. On a per capita basis, SNWA peak day water use has decreased steadily. Since 2000, DW's peak day water use has decreased on both an overall and a per capita basis.

For purposes of tracking water conservation progress, the agencies monitor total water use, per capita or per account water use, and participation levels for each water conservation measure. For some measures (e.g., toilet retrofits), it is possible to extrapolate estimated savings from customer participation levels. For other measures (e.g., public education), it can be difficult to estimate the corresponding water savings. For example, of its estimated 48,331 acre-feet of current water savings, CCWD can attribute 4,036 acre-feet to its "active" water conservation measures and 8,553 acre-feet to changes in the plumbing code. The rest of the savings results from other measures and have not been broken down by measure.

Figure D-2: CCWD Historical Water Use

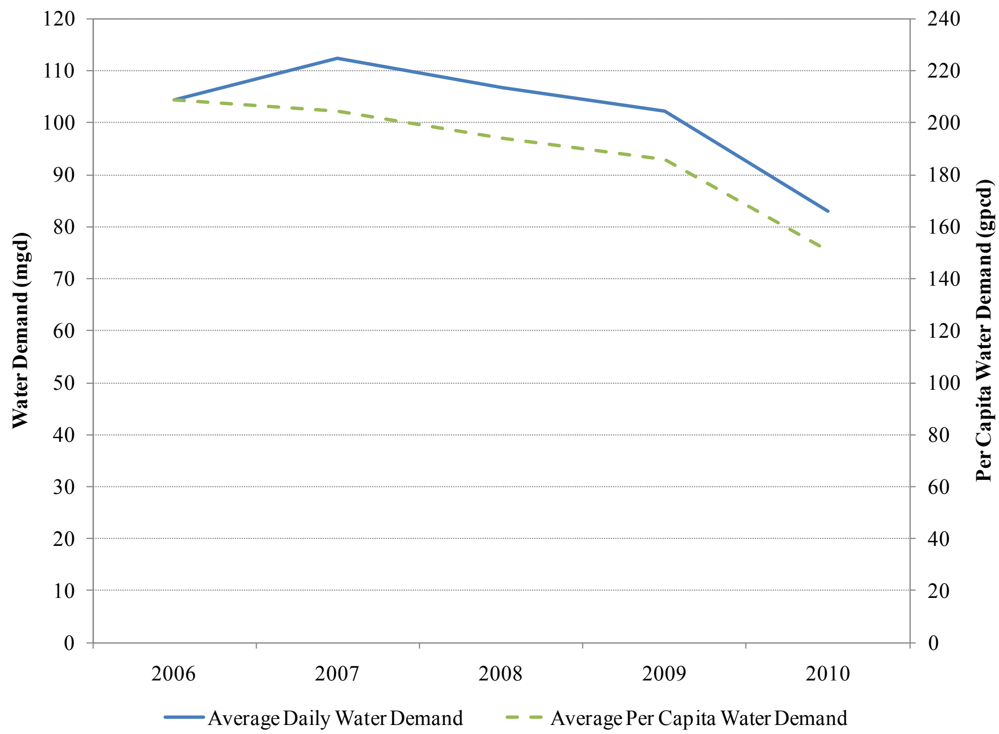


Figure D-3: SNWA Historical Water Use

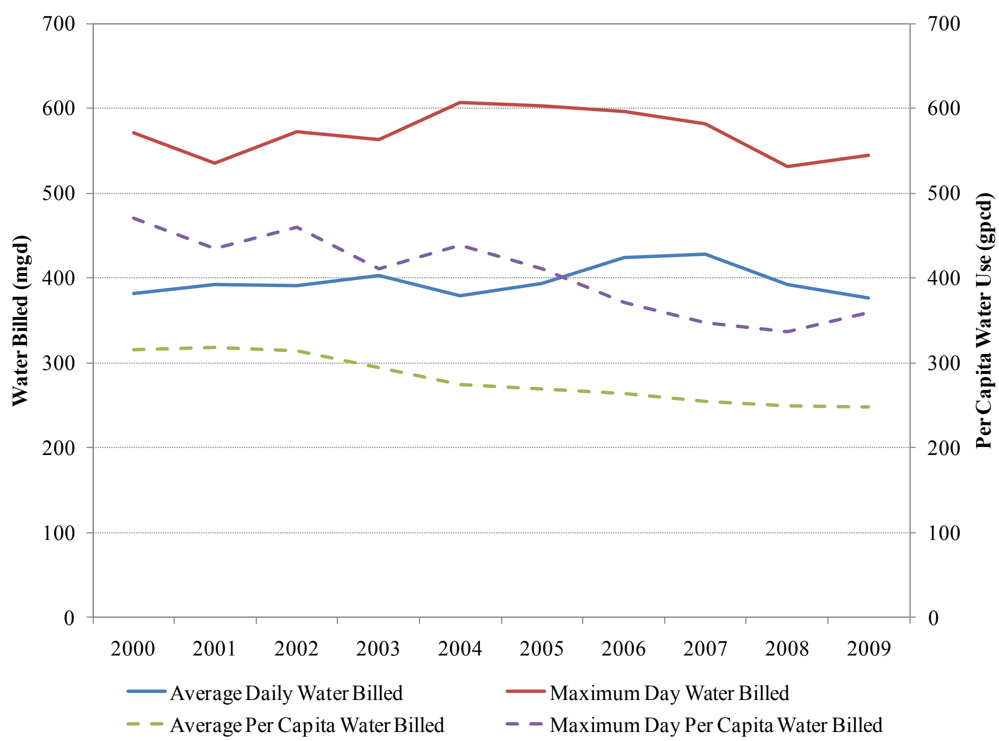


Figure D-4: DW Historical Water Use

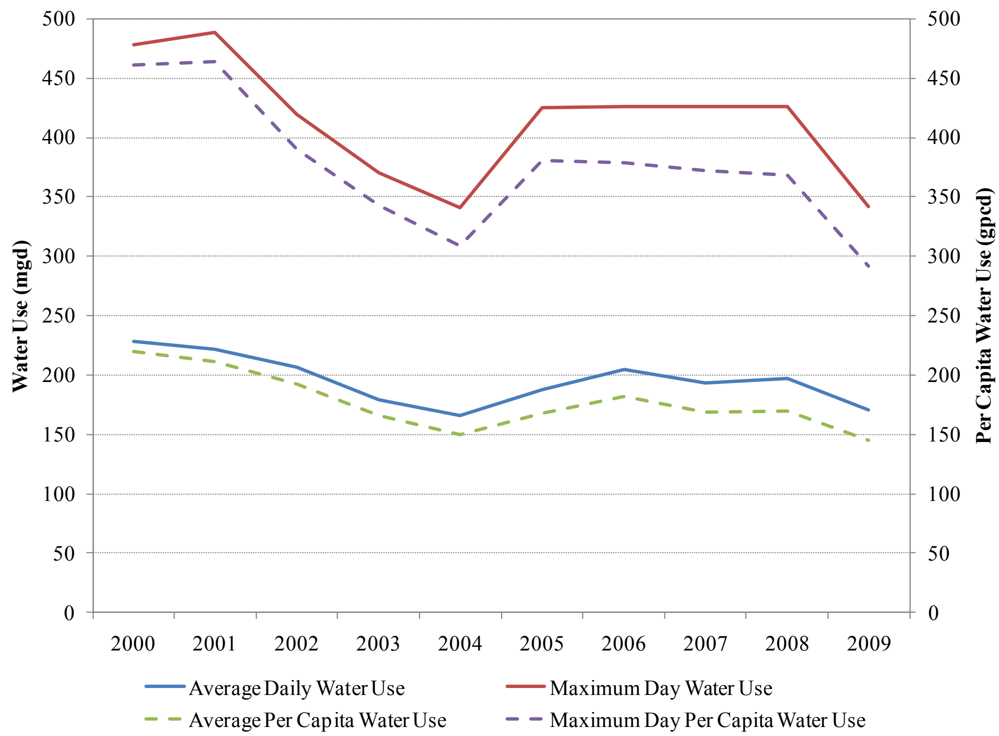


Figure D-5: WMWD Historical Water Use

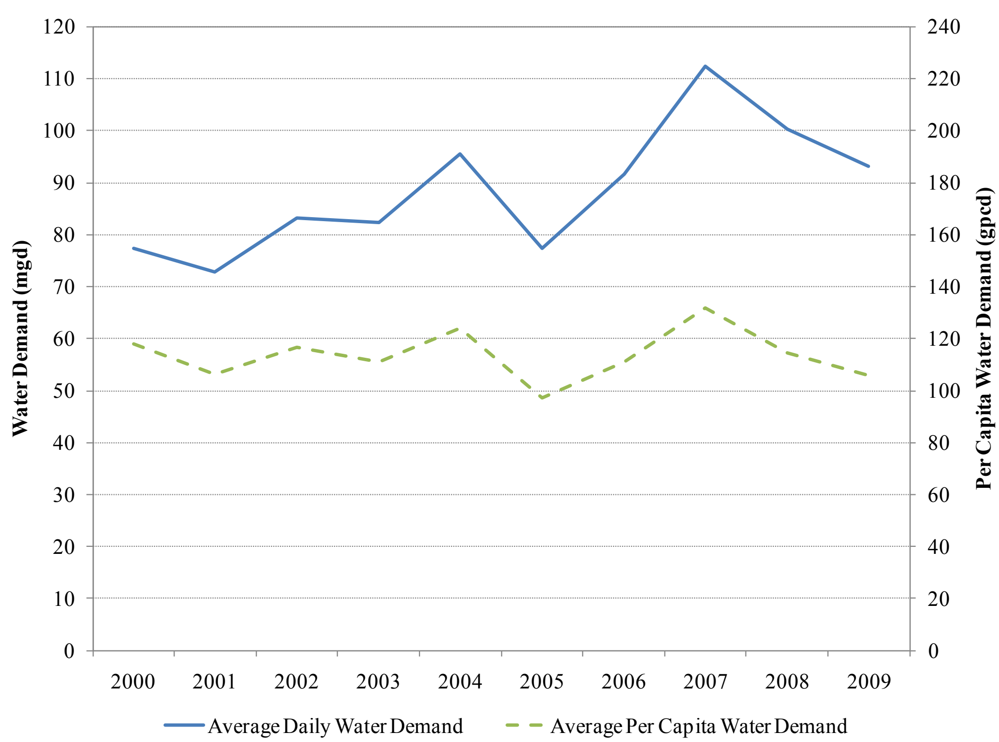
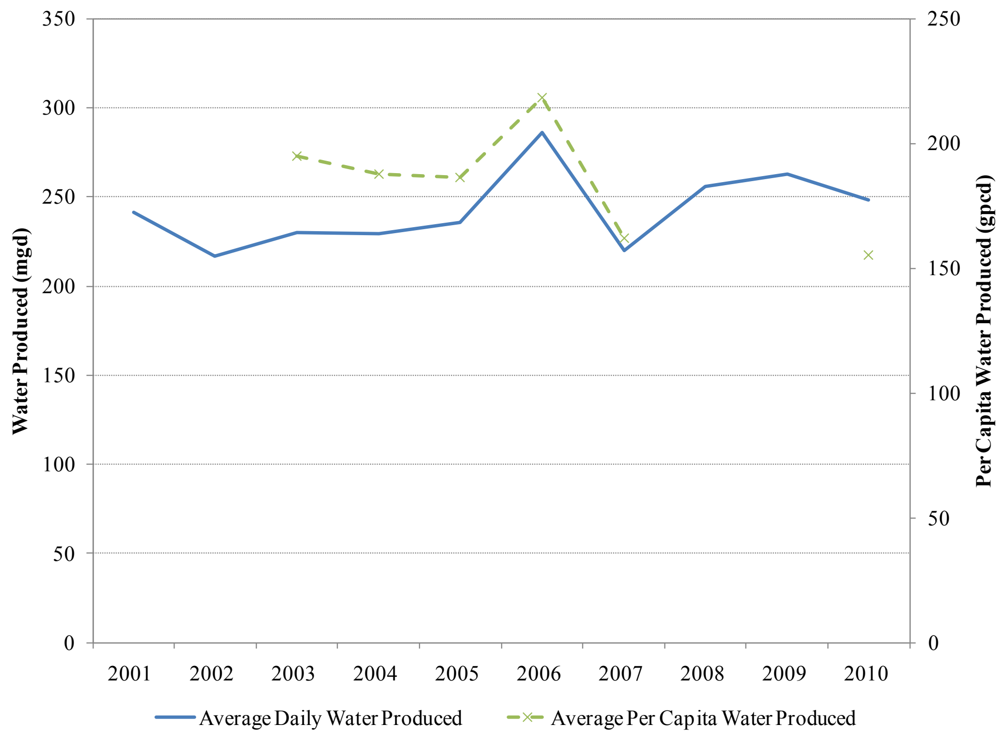


Figure D-6: NTMWD Historical Water Use



D.10. References

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Appendix E:
Potential Water Conservation Measures

TRWD
Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Annual irrigation system analyses/audits/plans for large properties			x							x	x	x	x	
Annual conservation implementation reports	Require large customers (wholesale and retail) to file annual reports on their water use and water conservation measures. 30 TAC 288 already requires retail public water suppliers with 3,300 or more connections to develop water conservation plans and file annual water conservation implementation reports.		x											
Athletic field conservation	Requirements for irrigation system equipment, use of reclaimed water, water budgets, dedicated irrigation meters, nutrient management, soil preparation, leak detection and repair, etc.		x							x			x	x
Athletic field conservation	Rebates/incentives for irrigation system equipment, use of reclaimed water, water budgets, dedicated irrigation meters, nutrient management, soil preparation, leak detection and repair, etc.			x						x			x	x
Boiler and steam systems	Rebates/incentives for optimized condensate recovery; improved water treatment and monitoring to minimize boiler blowdown; and good operation and maintenance programs for steam lines, steam traps, feed pumps, condensers, heat exchangers, and boilers.			x		x			x				x	
Business Partnership Program	Similar to SNWA "Water Conservation Coalition."	SNWA				x			x	x			x	
Car wash	Fundraisers at commercial facilities only		x										x	
Car wash	Requirements for equipment upgrades (e.g., water recirculation equipment, nozzle upgrades, etc.)		x						x				x	
Car wash	Rebates/incentives for equipment upgrades (e.g., water recirculation equipment, nozzle upgrades, etc.)			x					x				x	
Central cooling (other than cooling towers)	Requirements for reuse of cooling water		x							x			x	
Central cooling (other than cooling towers)	Rebates/incentives for reuse of cooling water			x						x			x	
City/utility-wide water efficiency	Water efficiency standard operating procedures, checklist, and reporting for all city/utility departments		x											x
Clothes washers/commercial laundry	Rebates/incentives with multiple tiers based on efficiency. Could apply to SF. On the commercial side, could apply to industrial laundry (hotel, hospital), coin-op, and MF.			x					x		x	x	x	
Clothes washers/commercial laundry	Federal standard. The federal Energy Independence and Security Act of 2007 specified that residential clothes washers manufactured on or after January 1, 2011 must not have water use of more than 9.5 gallons per cubic foot of washer capacity.		x					x	x		x			
Clothes washers/commercial laundry	Local/state clothes washer efficiency standards		x						x		x	x	x	
Clothes washers/commercial laundry	Recycle system requirements		x						x				x	

TRWD
Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Clothes washers/commercial laundry	Recycle system rebates/incentives			x					x				x	
Collecting fuel cell vapor			x										x	
Commercial power washer registration	Require registration and review of BMPs for water use and wastewater control.		x			x							x	
Commercial Food Service & Restaurants	Efficient equipment requirements (food steamers, cookers, ice makers, dipper wells, dish and ware washing, removal of garbage disposals or flow restrictors for garbage disposals, etc.).		x						x				x	x
Commercial Food Service & Restaurants	Efficient equipment rebates/incentives (food steamers, cookers, ice makers, dipper wells, dish and ware washing, removal of garbage disposals or flow restrictors for garbage disposals, etc.).			x					x				x	x
Commercial Food Service & Restaurants	Spray valve incentives/distribution. Include positive shutoff. Texas Health and Safety Code 372.005 specifies commercial pre-rinse spray valve performance standards (maximum 1.6 gpm), effective January 1, 2006.			x					x				x	
Commercial Medical/Dental/Hospital	Requirements for X-ray/digital, sterilizers, HVAC, appliances, dry vacuum, food service, maintenance		x						x				x	x
Commercial Medical/Dental/Hospital	Rebates/incentives for X-ray/digital, sterilizers, HVAC, appliances, dry vacuum, food service, maintenance			x					x				x	x
Commercial & Govt Office Buildings	Requirements for cooling, plumbing, food service, maintenance, alternative sources		x						x				x	x
Commercial & Govt Office Buildings	Rebates/incentives for cooling, plumbing, food service, maintenance, alternative sources			x					x				x	x
Commercial Water-Efficient Equipment Rule	Groups items otherwise described under clothes washers/commercial laundry, commercial food service & restaurants, cooling tower incentives and requirements, replace water-cooled equipment with air-cooled/more efficient equipment, boilet and steam systems, and other measures.		x						x	x			x	
Condensate	Require collection and reuse of air-conditioning condensate		x				x			x	x	x	x	x
Condensate	Rebates/incentives for collection and reuse air-conditioning condensate			x			x			x	x	x	x	x
Conservation water rate structures	Tiered blocks, water budgeting, seasonal/peak rates, etc.		x		x				x	x	x	x	x	
Conversion of supplemental irrigated farmland to dry-land farmland						x								
Cooling tower	Requirements for cooling tower minimum cycles; new towers have conductivity controllers, make-up and blowdown meters; green chemical treatments.		x							x			x	
Cooling tower	Rebates/incentives for cooling tower minimum cycles; new towers have conductivity controllers, make-up and blowdown meters; green chemical treatments.			x						x			x	

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Crop residue management and conservation tillage						x								
Dedicated irrigation meters	Dedicated irrigation meters required for new ICI accounts, over 10,000 sq. ft., etc.		x		x					x			x	
Desalination							x		x	x	x	x	x	x
Dishwasher incentives	Residential (see Commercial Food Service for ICI). The federal Energy Independence and Security Act of 2007 specified that “standard size” dishwashers manufactured on or after January 1, 2010 must not have water use of more than 6.5 gallons per cycle.			x					x		x	x		
Drip irrigation incentives				x						x	x	x	x	
Energy and water conservation	Partnerships with energy providers, etc. Energy reduction measures result in less water for cooling at power plants.							x					x	x
Enhanced enforcement of existing regulations			x							x	x	x	x	x
Enhanced water waste ordinance; move Stage 2 elements to Stage 1			x							x	x	x	x	
Evaporative AC replacement rebates				x						x	x			
Garbage disposals	Requirements for removal of garbage disposals or flow restrictors for garbage disposals.		x						x				x	
Garbage disposals	Rebates/incentives for removal of garbage disposals or flow restrictors for garbage disposals.			x					x				x	
Flushometer bowl and valve retrofits	Requirements		x						x				x	x
Flushometer bowl and valve retrofits	Rebates/incentives			x					x				x	x
Furrow dikes, land leveling, contour farming						x								
Gated and flexible pipe for field water distribution systems				x		x								
General ICI rebate	Capacity buyback. Customer (perhaps after ICI water audit) would propose improvements with detailed information. Improvements could include boiler and steam systems, landscape, refrigeration, rinsing/cleaning, water waste reduction, replacement of once-through cooling equipment, site-specific program, etc. Utility would estimate savings, verify costs, and determine incentive amount. Contract would require customer to maintain savings for a given time period.			x					x	x			x	
Golf course conservation	Similar to SAWS Golf Fore SA program	SAWS				x				x			x	x
Graywater	Requirements for new construction.		x				x			x	x	x	x	
Graywater	Recycling incentives for new and/or existing homes			x			x			x	x	x	x	
Green building ordinance/LEED certification	Similar to Dallas ordinance.		x						x	x			x	x
HOA rules ordinance	Prohibit restrictive covenants that prevent conservation in landscaping and irrigation systems/practices. 2003 HB 645 limited property associations from creating/enforcing rules that undermine water conservation.		x							x	x			

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Home efficiency ratings	Require certain demand management/landscaping measures for new construction. Each conservation measure would be worth a certain number of points. Could incorporate WaterSense certification for new homes. Awards to builders that meet these standards.		x			x					x	x		
Home efficiency ratings	Incentivize certain demand management/landscaping measures for new construction. Each conservation measure would be worth a certain number of points. Could incorporate WaterSense certification for new homes. Awards to builders that meet these standards.			x		x					x	x		
Hose nozzle rebates/distribution	Nozzles with positive shutoff	EBMUD		x						x	x	x	x	
Hose timer rebates/distribution				x						x	x	x	x	
Hot water on demand	Requirements for hot water recirculation systems		x						x		x	x	x	
Hot water on demand	Rebates/incentives for hot water recirculation systems			x					x		x	x	x	
Hot water piping insulation	Requirements for new construction and/or retrofits.		x						x		x	x		
Hot water piping insulation	Rebates/incentives for retrofits			x					x		x	x		
Hotels and Motels	Cooling, plumbing, food service, pool, laundry, landscape design, irrigation, maintenance, alternative sources, staff training. Could include materials from USEPA WAVE program.					x			x	x			x	x
Increasing water prices	As raw water prices increase and these increases get passed to customers, water demand should decrease according to the elasticity of demand.				x			x						
Irrigation system design and installation requirements	System requirements in excess of 30 TAC 344 requirements (e.g., rain shutoff devices, minimum irrigation areas, weather-based irrigation controllers, biennial system audits, drip irrigation in parkway strips, distribution uniformity, soil moisture sensors, maximum irrigated areas, etc.)		x							x	x	x	x	
Irrigation system installation inspection	Cities could implement a landscape irrigation permitting, inspection, and enforcement program (30 TAC 344 already requires for cities with 20,000 people or more).		x							x	x	x	x	
Irrigation system equipment upgrades	Requirements for drip irrigation equipment, rotary nozzles, spray heads with greater distribution uniformity, timers with multiple start times/water budgeting features, etc.		x							x	x	x	x	
Irrigation system equipment upgrades	Rebates/incentives for drip irrigation equipment, rotary nozzles, spray heads with greater distribution uniformity, timers with multiple start times/water budgeting features, etc.			x						x	x	x	x	
Leak detection/repair program for low-income residents						x			x	x	x			
Linear move sprinkler irrigation systems				x										
Lining of district irrigation canals					x									
Lining of on-farm irrigation ditches				x		x								

TRWD
Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Low-flow plumbing fixture laws	1992 National Energy Policy Act, 2009 HB 2667		x						x		x	x	x	x
Low-pressure center pivot sprinkler and drip/micro-irrigation systems				x		x								
On-farm irrigation audit						x								
Parks conservation	Requirements for irrigation system equipment, use of reclaimed water, water budgets, dedicated irrigation meters, nutrient management, soil preparation, swimming pool equipment, water feature equipment, leak detection and repair, efficient fixtures, etc.		x		x					x				x
Pressure reducing valves	Requirement for accounts with pressure > 80 psi		x						x	x	x	x	x	
Pressure reducing valves	Rebates/incentives for accounts with pressure > 80 psi			x					x	x	x	x	x	
Process water	Industrial water treatment. Increased efficiency through improvements in flow rates, pressure, temperature, chemistry, filtration or timing. Metering both inflow and outflow from the system provides the operator information to determine if the system is meeting design efficiencies. Process control is often an area where increased efficiency can be obtained.					x	x		x				x	
Process water	Reuse of process water					x	x		x				x	
Public education (audits/water waste reduction)	Cooling towers					x				x			x	
Public education (audits/water waste reduction)	Irrigation system audits					x				x	x	x	x	
Public education (audits/water waste reduction)	Industrial (indoor/outdoor)					x			x	x			x	
Public education (audits/water waste reduction)	Multi-family (indoor/outdoor)					x			x	x		x		
Public education (audits/water waste reduction)	Municipal/Utility (indoor/outdoor)					x			x	x				x
Public education (audits/water waste reduction)	Single-family (indoor/outdoor)					x			x	x	x			
Public education (audits/water waste reduction)	Self-audit (indoor/outdoor)					x			x	x	x	x	x	
Public education (certification/training/coordination with professional associations)	Car wash certification					x			x				x	
Public education (certification/training/coordination with professional associations)	Cooling tower certification					x				x			x	
Public education (certification/training/coordination with professional associations)	GreenPlumbers program					x			x		x	x	x	
Public education (certification/training/coordination with professional associations)	ICI management and employee programs					x			x	x			x	
Public education (certification/training/coordination with professional associations)	Training for landscape maintenance workers. Setting irrigation time clocks; finding and repairing simple leaks; and proper turf care (fertilizing, mowing, thatch removal, etc.).					x				x	x	x	x	
Public education (certification/training/coordination with professional associations)	Professional irrigators' training course Landscape professionals' certification					x				x	x	x	x	
Public education (certification/training/coordination with professional associations)	Water wise landscape training for staff at retail garden/irrigation supply houses					x				x	x	x	x	

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type: Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Targeted Water Use Categories: Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Public education (certification/training/coordination with professional associations)	Restaurant certification (spray valves, toilets, signage)/Waterwise restaurant program					x			x				x	
Public education (certification/training/coordination with professional associations)	Swimming pool maintenance, use					x				x	x	x		
Public education (certification/training/coordination with professional associations)	Waterwise hotel/motel program					x			x	x			x	
Public education (implementation projects-tied to school capital rehab budget)	Cooling, plumbing, food service, pool, laundry, landscape design, irrigation, maintenance, alternative sources					x			x	x			x	
Public education (demonstration projects)	Model efficient homes					x			x	x	x	x	x	
Public education (demonstration projects)	Rainwater harvesting					x			x	x	x	x	x	
Public education (demonstration projects)	Water wise landscaping					x			x	x	x	x	x	
Public education (general)	Advertisements/program marketing					x			x	x	x	x	x	
Public education (general)	Aggressive, sustained public education program; perhaps contract with professional PR firm					x			x	x	x	x	x	
Public education (general)	Block leader program					x			x	x	x	x		
Public education (general)	Brochures and literature					x			x	x	x	x	x	
Public education (general)	Conservation awards					x			x	x	x	x	x	
Public education (general)	Electronic newsletter					x			x	x	x	x	x	
Public education (general)	ICI newsletter					x			x	x			x	
Public education (general)	Peak day management campaign					x				x	x	x	x	
Public education (general)	Promotional program (free car)					x			x	x	x			
Public education (general)	School education programs					x			x	x	x	x		
Public education (general)	Usage information on water bill					x			x	x	x	x	x	
Public education (general)	Videos and other publications					x			x	x	x	x	x	
Public education (general)	Web page					x			x	x	x	x	x	
Public education (general)	Workshops, presentations, outreach, special events. Could include training classes at retail stores.					x			x	x	x	x	x	
Public education (irrigation)	Irrigation (scheduling, ET requirements, ET/weather data, irrigation calculator)					x				x	x	x	x	
Public education (irrigation)	Customized water budgets for high users					x				x	x	x	x	x
Public education (irrigation)	Water wise landscaping					x				x	x	x	x	
Public education (irrigation)	Soil depth initiative -- promote minimum soil depth for new devleopment to reduce irrigation water needs.					x				x	x	x	x	
Public education (irrigation)	Composting initiative					x				x	x		x	x
Rain/freeze shutoff devices	Requirements		x							x	x	x	x	
Rain/freeze shutoff devices	Rebates/incentives/distribution			x						x	x	x	x	
Rainwater	Rain barrel rebates and distribution			x			x			x	x	x	x	x
Rainwater	Requirements for rainwater harvesting (new construction, retrofits, etc.)		x				x			x	x	x	x	x
Rainwater	Rebates/incentives for rainwater harvesting (new construction, retrofits, etc.)			x			x			x	x	x	x	x

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Reclaimed water	Require reclaimed water (if available) for cooling towers, irrigation, central cooling plants, etc.		x				x		x	x			x	x
Reclaimed water	Decentralized reclaimed water production facilities						x		x	x			x	x
Reclaimed water	Direct reuse of treated effluent						x		x	x			x	x
Reclaimed water	Indirect reuse of treated effluent						x		x	x			x	x
Remote irrigation control	Utility would remotely manage and adjust the irrigation schedule. Incentive could be a special rate on irrigation water.			x						x	x	x	x	
Replace water-cooled equipment with air-cooled/more efficient equipment	Requirements for air compressors, ice machines, refrigeration condensers, x-ray processing equipment, vacuum pumps, hydraulic equipment, etc.		x						x				x	
Replace water-cooled equipment with air-cooled/more efficient equipment	Rebates/incentives for air compressors, ice machines, refrigeration condensers, x-ray processing equipment, vacuum pumps, hydraulic equipment, etc.			x					x				x	
Replacement of irrigation district canals and lateral canals with pipelines					x									
Replacement of on-farm irrigation ditches with pipelines				x		x								
Self-closing faucets	Require installation of automatic (infrared sensor) or manual self-closing faucets		x						x				x	
Self-closing faucets	Rebates/incentives for installation of automatic (infrared sensor) or manual self-closing faucets			x					x				x	
Shower heads, faucet aerators, toilet flappers distribution/replacement/incentives				x					x		x	x	x	
Soil moisture sensors	Requirements for use of soil moisture sensors in conjunction with irrigation controllers		x							x	x	x	x	
Soil moisture sensors	Rebates/incentives for use of soil moisture sensors in conjunction with irrigation controllers			x						x	x	x	x	
Storm water	Requirements for storm water harvesting		x							x	x	x	x	x
Storm water	Rebates/incentives for storm water harvesting			x						x	x	x	x	x
Submetered billing	Requirements for multi-family, industrial submetering and billing. For multi-family, require submetered common areas and no allocated billing on this water. 30 TAC 291 requires most multi-family residential properties constructed after January 1, 2003 to install submeters or individual meters. Multi-family residential properties that bill tenants for submetered or allocated water service must also replace toilets that exceed 3.5 gallons per flush.		x						x			x	x	

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Submetered billing	Rebates/incentives for multi-family , industrial sumetering and billing. 30 TAC 291 requires most multi-family residential properties constructed after January 1, 2003 to install submeters or individual meters. Multi-family residential properties that bill tenants for submetered or allocated water service must also replace toilets that exceed 3.5 gallons per flush.			x					x			x	x	
Surge flow irrigation for field water distribution systems				x		x								
Swimming pool covers	Requirements for swimming pool covers to reduce evaporation.		x							x	x	x	x	
Swimming pool covers	Rebates/incentives for swimming pool covers to reduce evaporation.			x						x	x	x	x	
Swimming pool cartridge filter rebates	Cartridge filters would replace sand/diatomaceous earth filters, which require large amounts of water for backwashing.			x						x	x	x	x	
Toilet leak detection kit distribution				x		x			x		x	x		
Toilets/urinals	Requirements for ULFTs/HETs. Texas Health and Safety Code 372.002 specifies toilet and urinal performance standards (maximum 1.6 gpf for toilets and 1.0 gpf for urinals) for new equipment, effective January 1, 1992. New HB 2667 requires phase-in of 1.28 gpf toilets by 2014.		x						x		x	x	x	
Toilets/urinals	Additional requirements for HETs, dual-flush, retrofit on resale, retrofit kits, direct install, low-flush bags, waterless urinals, etc. Texas Health and Safety Code 372.002 specifies toilet and urinal performance standards (maximum 1.6 gpf for toilets and 1.0 gpf for urinals) for new equipment, effective January 1, 1992. New HB 2667 requires phase-in of 1.28 gpf toilets by 2014.		x						x		x	x	x	
Toilets/urinals	Rebates/incentives for HETs, dual-flush, retrofit on resale, retrofit kits, direct install, low-flush bags, waterless urinals, etc. Texas Health and Safety Code 372.002 specifies toilet and urinal performance standards (maximum 1.6 gpf for toilets and 1.0 gpf for urinals) for new equipment, effective January 1, 1992. New HB 2667 requires phase-in of 1.28 gpf toilets by 2014.			x					x		x	x	x	
Utility/municipal leadership	Apply measures to city/utility facilities				x				x	x				x
Volumetric measurement of irrigation water use			x		x									
Water broom rebates	Reduces water use for hosing down sidewalks, parking areas, etc.	EBMUD		x						x			x	

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Water conservation plan for large customers	Require large customers (wholesale and retail) to develop a water conservation plan. 30 TAC 288 already requires retail public water suppliers with 3,300 or more connections to develop and implement water conservation plans.		x									x	x	x
Water loss analysis/prevention	Annual water audit and tracking of performance indicators. Texas Water Code 16.0121(b) says, "Every five years, a retail public utility providing potable water shall perform and file with the board a water audit computing the utility's most recent annual system water loss."				x									x
Water loss analysis/prevention	Water audit data validation				x				x	x	x	x	x	x
Water loss analysis/prevention	Universal metering		x		x				x	x	x	x	x	x
Water loss analysis/prevention (apparent loss)	Management analyst(s) conduct billing system analysis: identify and resolve billing system data errors, improper classifications, unbilled accounts, etc.				x				x	x	x	x	x	x
Water loss analysis/prevention (apparent loss)	Calibration of master meters				x				x	x	x	x	x	x
Water loss analysis/prevention (apparent loss)	Calibration/replacement of customer meters. Priority on largest water users and meters with high volume. Look at meter types and sizing based on user profile.				x				x	x	x	x	x	x
Water loss analysis/prevention (apparent loss)	Identification and prevention of water theft				x				x	x	x	x	x	x
Water loss analysis/prevention (apparent loss)	Advanced metering: automatic metering infrastructure (AMR or AMI) that detects continuous flow	SNWA, LVVWD			x				x		x	x	x	
Water loss analysis/prevention (real loss)	Billing leak detection				x				x	x	x	x	x	
Water loss analysis/prevention (real loss)	Leak detection and repair: active leak detection, district metered areas, night flow monitoring, passive listening with noise logging systems, etc. Refine procedures to reduce times for leak awareness, location, and repair. Add staff, conduct training.				x									x
Water loss analysis/prevention (real loss)	Continue to implement previous recommendations				x									x
Water loss analysis/prevention (real loss)	Leakage management software software specifically designed to enhance leak detection efforts. Examples include ILMSS LEAKS Suite and Crowder Consulting's NETBASE Water Distribution Management Software. This will improve cost-benefit analyses and targeting of leak detection and repair efforts and assist in pressure management.				x									x
Water loss analysis/prevention (real loss)	Pressure control				x						x	x	x	x
Water loss analysis/prevention (real loss)	Main replacement program (ductile iron)				x				x	x	x	x	x	x
Water softener operating restrictions	Regeneration efficiency and waste discharge standards		x						x		x	x	x	
Water treatment improvements	Recycling of filter backwash, other processes that use less water				x									x

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Potential Water Conservation Strategies

Strategy Name	Description	Example Utilities/ Programs	Strategy Type						Targeted Water Use Categories					
			Regulations/ Policies	Rebates/ Incentives/ Vouchers	Utility/ Government Programs	Public Education/ Outreach	Alternative Water Sources	Other	Indoor	Outdoor/ Seasonal	SF	MF	ICI	Municipal/ Utility
Water waste prohibition	Restricted watering days; limited watering hours (irrigation system, hand watering); maximum runoff distance (50 ft?); prohibit broken/misadjusted irrigation components; athletic field, golf course restrictions; no unattended hoses; no ponding on hard surfaces; no watering during precipitation event or freezing temperatures		x							x	x	x	x	x
Water waste prohibition	No once-through cooling (cooling equipment, ice machines, etc.)		x							x			x	
Water waste prohibition	Restrictions on filling swimming pools (no fill valves, no fill, etc.)		x							x	x	x	x	
Water waste prohibition	Fountain restrictions		x							x	x	x	x	
Water waste prohibition	Hotels reduce laundry		x						x				x	
Water waste prohibition	Hydrant and sewer flushing on emergency basis only		x											x
Water waste prohibition	No construction watering unless reclaimed water		x				x			x			x	
Water waste prohibition	No misters		x							x				
Water waste prohibition	No new connections (with some exceptions)		x								x	x	x	x
Water waste prohibition	No new landscapes		x							x	x	x	x	
Water waste prohibition	Pavement washing restrictions		x							x	x	x	x	
Water waste prohibition	Plant nursery water restrictions		x							x			x	
Water waste prohibition	Ordinance variances suspended		x											x
Water waste prohibition	Restaurant water on request only		x						x				x	
Water waste prohibition	Restricted foundation watering		x							x	x	x	x	
Water waste prohibition	Prohibit unrepaired leaks		x							x	x	x	x	
Water waste prohibition	Vehicle washing restrictions (none, some, hand only, etc.)		x							x	x	x	x	
Water waste prohibition	Water for power production voluntarily reduced		x										x	
Water waste prohibition	Wholesale customers encouraged to comply, reduce leaks, stabilize pressure		x											x
Water wise landscape conversion programs	Convert turf to native plants, etc.			x						x	x	x	x	
Water wise landscape design requirements	(X% native plants, Y% max turf, Z minimum soil depth, soil amendment, turfgrass dormancy, etc.)		x							x	x	x	x	
Weather-based irrigation controllers	Requirements for irrigation controllers that use soil moisture or evapotranspiration data.		x							x	x	x	x	x
Weather-based irrigation controllers	Rebates/incentives for irrigation controllers that use soil moisture or evapotranspiration data.			x						x	x	x	x	x
Wholesale agency assistance programs	Financial and technical support.				x									
Wholesale customer contracts	Institute conservation rate structures, practices, programs with wholesale customers upon contract renewal				x					x				x
Water wise landscaping required for model homes	See EPA's New Single Family Home specs for guidelines.		x							x	x			
Water wise landscape option from homebuilders	See EPA's New Single Family Home specs for guidelines.		x							x	x			
Water wise landscape option required on new homes	See EPA's New Single Family Home specs for guidelines.		x							x	x			

Appendix F:
Water Conservation Strategy Considerations

Table F-1: Water Conservation Strategy Considerations (Adapted from Ref. 6)

Water Conservation Strategy	Characteristics Favorable for Implementation	Characteristics Unfavorable for Implementation
System Water Audit and Water Loss	• Reduce "Unaccounted For" water • Can revise meter testing and repair practices from results • Can determine if unmetered uses are impacting revenues • Can help determine if leak reduction program needed	• Need to have extensive billing, meter, leak, and repair data to perform audit accurately • If the utility has a high infrastructure leakage index, it may take several years to address minor leaks
Water Conservation Pricing	• Discourage inefficient water use • Can reduce water use peaks with inverted block pricing or seasonal rates • Develop long term consumption patterns consistent with cost • Could serve as a revenue stream to fund conservation programs • Customer costs better tracked to usage and small users not subsidizing large users as much • Should provide customers with more detailed bill statements to encourage water conservation	• Public education needed about new rate structure and customer class uses • More complex billing structure • Unit cost per water produced may be higher with water conservation
Prohibition of Wasting Water	• Reduce water waste • Satisfy cooperative customers who are concerned about waste • Reduce peak usage • More efficient use of water	• Consumer education needed on rule • Staffing needed for enforcement and administration • Makes water utility a regulatory body for unwilling customers
Showerhead, Aerator, and Toilet Flapper Retrofit	• Reduce water usage in older construction • May be instituted with kit distribution or ordinance • Relatively inexpensive program	• Applicable to pre-1995 construction – need to determine target areas • Savings would eventually be realized by natural replacement • Need to develop education program and means of distribution • If change-of-ownership ordinance used, must educate realtors and have tracking plan
Residential Toilet Replacement Programs	• Reduce water use in major water use fixture • May institute with rebate, replacement unit, or by ordinance • Relatively inexpensive change • Admin and inspection costs lower for multi-family retrofits	• Need to determine pre-1995 construction and target areas • Savings would eventually be realized by natural replacement • Program must be marketed • Requires warehouse space if retrofit units offered • Staff time needed to administer, and labor cost for installation verification if applicable

Table F-1 Continued: Water Conservation Strategy Considerations (Adapted from Ref. 6)

Water Conservation Strategy	Characteristics Favorable for Implementation	Characteristics Unfavorable for Implementation
Residential Clothes Washer Incentive Program	• Reduces water use in frequently used appliance • Good for water providers with large percentage of residential • Can offer rebate in conjunction with power utility rebate	• Relatively expensive appliance, even with rebate – rebate needs to be set at level to be incentive to more than high end customer • Need to educate public and rebate to increase participation
Hot Water on Demand – Loop Point of Use	• Reduces water waste while waiting for hot water to warm pipes	• Requires retrofit of building with electrical outlets at point of use or recirculation piping • Energy costs may increase
Residential Dishwasher (replace with water-efficient models)	• Reduces water use with more efficient appliance • Requires less energy to use	• Need large market penetration to have influence • Savings may eventually be realized by unit replacement over time • Cost of unit may be twice as much as conventional units
Residential Swimming Pools	• Conserves water through more efficient practices and use of cover	• Need customer base • Cover may be costly add-on to installation • Ordinance enforcement
School Education	• Relatively inexpensive program once designed • Will generate long term behavioral changes • Children can influence family water usage • Can include showerhead/faucet kit distribution in program	• Need good market penetration to have influence • Requires utility staff oversight and outreach efforts • Have to develop expertise and engaging programs that are age appropriate
Water Surveys for Single-Family and Multi-Family Customers	• Reduce water waste and make water use more efficient • Targets indoor and outdoor uses • Target highest users first	• Requires extensive staff time • Volunteer program • Associated costs for water-efficient plumbing fixtures distributed during surveys
Landscape Irrigation Conservation and Incentives	• More efficient landscape watering and long-term reduction in peak water use • Potential change to water-efficient vegetation	• Requires substantial customer base with irrigation systems • Comprehensive irrigation audits require staff or hired contractor • Devices and upgrades may be costly
Water Wise Landscape Design and Conservation Programs	• Reduce peak water usage long-term • Raise awareness • Saves customers time and money	• Education program needed to inform public about designs and market program • Rebate incentive needed to encourage

Table F-1 Continued: Water Conservation Strategy Considerations (Adapted from Ref. 6)

Water Conservation Strategy	Characteristics Favorable for Implementation	Characteristics Unfavorable for Implementation
Athletic Field Conservation	• Reduce daytime water demand and perception of excessive use • Parks and Schools good constituency • Two approaches – incentive/voluntary or ordinance	• Need customer base with irrigated athletic fields • Need stakeholder group to increase participation • Water audits/surveys needed • Need staff or contractor expertise
Golf Course Conservation	• Reduce water use and reduce peak demand • Incentive for course owners since large water demand • Two approaches as above – incentive/voluntary or ordinance • Could offer recycled water as alternative	• Need customer base • Need stakeholder group to increase participation • Water audits/surveys needed • Need staff or contractor expertise
Metering of all new connections and retrofitting of existing connections	• Method to account for all water usage • Increase revenue • Create equity among customers	• Requires proper installation and meter size • Retrofit of some multi-unit customers to separate meters • Staff time for installation and testing
Wholesale agency assistance programs	• Large percentage of water used by wholesale agencies • Providing assistance to agencies will increase water savings • Extend water conservation programs/education further	• Requires stakeholder groups and cooperative participation • Requires staff and administration and possibly additional costs for support
Conservation Coordinator	• Dedicated employee to oversee conservation programs • Efficiency through ongoing analyses • Enhance public image of utility	• Require versatile employee with power or management support to alter program • Support staff may be necessary • May require or need to manage consultants or contractors
Water Reuse	• Utilizes reclaimed water for beneficial use • Reduces potable water use • May be able to permanently remove some customer accounts from potable water base • Recycled water can be used for many applications including landscape, some industrial, and uses where potable is not required	• Requires reclaimed water production • Requires infrastructure for delivery • Stakeholder group needed to encourage participation • Marketing and public education needed • May require more stringent effluent limits
Public Information	• Effective means of educating public and promoting conservation • Reduce water use and waste • Behavioral changes may result in short and long term water savings • Important component with other BMPs	• Need market penetration for water saving results • May need several programs to target specific users • Stakeholder groups needed for effective program • Continued funding commitment needed to maintain water savings
Rainwater Harvesting and Condensate Reuse	• Reduce outdoor irrigation water usage • Encourages efficient use of water outdoors or in processes	• Condensate reuse is typically more beneficial to ICI buildings than residential • May have limited appeal • Depends on climatic factors • Could be costly for existing facilities

Table F-1 Continued: Water Conservation Strategy Considerations (Adapted from Ref. 6)

Water Conservation Strategy	Characteristics Favorable for Implementation	Characteristics Unfavorable for Implementation
Park Conservation	• Reduce water use and reduce peak demand • Incentive for park owners since large water demand • Two approaches – incentive/voluntary or ordinance • Could offer recycled water as alternative	• Need customer base • Need stakeholder group to increase participation • Water audits/surveys needed • Need staff or contractor expertise
Conservation Programs for ICI	• Reduce water use for high water use customer • Targeted program • Customer may gain revenue benefit through conservation • Potential beneficial marketing through award program if offered	• Need customer base • Need stakeholder group to increase participation • Water audits/surveys needed • Rebate cost if offered
Industrial Water Audit	• Increase water use efficiency • Separate water use metering if applicable for processes and grounds • Targets large water users	• Requires extensive staff time • Volunteer program • Requires proactive or cooperative participation from users
Industrial Water Waste Reduction	• Increase water use efficiency • Separate water use metering if applicable for processes and grounds for efficiency • Targets large water users	• Requires extensive staff time • Volunteer program • Requires proactive or cooperative participation from users
Industrial Submetering	• Reduce water waste • Assists large customers in determining where to implement water use reduction measures • Saves customers money	• Need to determine applicable customers • Market to customers • Staff time for audits and recommendations
Cleaning/Sanitation	• Reduce water use by improving efficiency of practices • Customer decrease water cost with efficiency	• Requires customer base • May not be significant use of water • Volunteer program
Rinsing/Cleaning (especially commercial kitchens)	• Reduce water use by improving efficiency of processes • Customer decrease water cost with efficiency • Raise awareness	• Requires customer base (restaurants) • Staff time for audits and education • Volunteer program • Possible contractor administration needed
Commercial Laundries and Laundromats	• Reduce water use with more efficient appliances • Reduce cost to customers	• Requires staff time for audits and education • Market to customers • Volunteer program • Possible contractor administration needed
Swimming Pools and Zoos	• Reduce water waste with limits on filling or require covers • Reduce cost to customers with water use reduction measures • Zoos may use recycle water for some applications	• May require audits • Requires change in practices • May need ordinance enforcement

Table F-1 Continued: Water Conservation Strategy Considerations (Adapted from Ref. 6)

Water Conservation Strategy	Characteristics Favorable for Implementation	Characteristics Unfavorable for Implementation
Water Fountains	• Reduce water use through efficient use or restrictions • Could use recycled water • Customer decrease water cost with efficient fountains • Public perception of water conservation with restrictions	• May not be significant user • Need to determine applicable customers • May need ordinance enforcement
Cooling Towers	• Reduce water use in large water use equipment • Reduce costs to customers from water and energy savings	• Need to determine applicable customers • Market to customers • Staff time for surveys
Cooling Systems (other than Cooling Towers)	• Reduce water waste by eliminating single-pass cooling systems • May be able to use alternative water source such as recycle	• Requires customer base • May not be significant use of water • Volunteer program
Industrial Alternative Sources and Reuse of Process Water	• Reduce potable water use by process changes or recycling process water • May be able to use alternative water source such as recycle or graywater or other	• Requires customer base • May not be significant use of water • Volunteer program
Industrial Water Treatment	• Reduce water waste with more efficient processes • May be able to use alternate water source	• Requires customer base • Need stakeholder group • Volunteer program
Boiler and Steam Systems	• Reduce water waste • Lowers customers' cost	• Requires customer base • May not be significant use of water • Volunteer program
Refrigeration (including Chilled Water)	• Reduce water waste • Could target with incentive program	• Requires customer base • Need stakeholder group and cooperative participation
Once-Through Cooling	• Reduce water waste	• Requires customer base
Management and Employee Programs	• Can supplement other BMPs • Employee involvement can increase effectiveness of programs • Minimal cost	• Requires customer base • Need stakeholder group • Volunteer program
Industrial Landscape	• Reduce water use and peak demand • Lower water bills	• Need stakeholder group increase participation • Could be costly to implement
Industrial Site Specific Conservation	• Reduce water waste • May involve grant or other incentive program • May be eligible for award program	• May require site audit • Need stakeholder group to increase participation • Volunteer program • Requires a long-term commitment

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Appendix G:
TRWD White Paper: Consideration of Limiting Outdoor Irrigation Schedules to Twice-Per-Week

G. TRWD White Paper: Consideration of Limiting Outdoor Irrigation Schedules to Twice-Per-Week

February 16, 2012

The water supplies we depend on are not endless resources. For one thing, drought conditions are just a part of life here in North Texas. And the number of people living in our region is expected to double in the next 50 years. That means the demand for water will certainly rise - and meeting that demand in a sustainable way will be a challenge.

In the past, building a reservoir was a sure answer to increasing water supplies. Today, there are no shortcuts - the alternatives for developing new water supplies are limited, expensive and time consuming. Couple that with the potential for severe droughts (like the one in 2011) and a steadily increasing population and conservation offers the quickest and cheapest way to relieve the strain on water supplies and meet the new water needs of our growing communities.

A good place to start saving water is by changing our outdoor irrigation habits. Outdoor water use, particularly lawn watering, can account for half or more of annual residential water use - and much more than that during the hot, dry Texas summers. In North Texas cities, average summer water demands can spike to more than 80% above average winter consumption (Ref. G1). It's a common scenario observed around the country.

The main culprit is a homeowner's tendency to over-water. Haley et al. (2007) showed that overall homeowners over-watered as much as 2-3 times the amount needed by plants, based on estimates of climate demand (Ref. G2). This study also reported that although homeowners use significantly less water in the winter months, when plant water requirements are at a minimum, they are still prone to over-irrigate.

One successful strategy to lower water use being pursued by communities nationwide is placing limitations on outdoor irrigation to no more than twice per week. The goal is to reduce excessive outdoor watering and water waste, especially during summer months when rain is scarce and demands are high. The savings here in North Texas would be tremendous - millions of gallons of highly treated drinking water per day; billions of gallons per year.

In September 2011, following the declaration of Stage 1 drought restrictions and twice per week watering limitations (Aug. 29, 2011), the water district observed an average decline in daily water demands of eight percent among its Tarrant County customers. Water use declined 35-45 million gallons per day after the restrictions were put in place compared to the daily water demands in the weeks leading up to Stage 1. [A discussion of water savings from TRWD Stage 1 drought response measures is presented in Appendix I.]

A study examining mandatory irrigation schedules during the 2002 Colorado drought found that restrictions were effective and produced significant water savings (Ref. G3). Net savings ranged from 15 to 55 percent on a per capita basis. The greatest savings were achieved by cities implementing the most aggressive restrictions. Cities with twice-a-week schedules reported a savings of 31 percent based on per capita use (Ref. G3).

Similarly in Florida, a literature review by Olmsted (2008) revealed that day-of-the-week watering restrictions were effective, in most cases (Ref. G4). In Hillsborough and Orange counties, utilities reported water use reductions of 17-18 percent; however no reductions were seen in Seminole County (Ref. G4).

In March 2011, the driest dry season in 80 years prompted South Florida water managers to declare a water shortage and impose two-day-per-week watering restrictions. The City of Stuart, Florida, already under a self-imposed two-day-a-week watering schedule in 2010, reported the restrictions were “proving to be water savers” (Ref. G5). Daily consumption in Stuart dropped from 219 to 185 gallons on a per person basis - a water savings of more than 15 percent.

Day-of-week restrictions do not come without their drawbacks. Dukes et al. (2011) assert they may encourage over-watering on the allowed day. And they do not guarantee that water is being applied at the right time, in the right amount. So it is essential that we educate on proper irrigation application rates and scheduling to realize the best savings possible.

Concerns about plant survival in North Texas can be alleviated by the fact that landscapes don’t need to be watered more than once per week during a majority of the year. And oftentimes watering isn’t necessary at all.

The City of Frisco, Texas uses a weather station and rain gauges to provide residents with weekly watering recommendations based on climate conditions - something the Tarrant Regional Water District is working to put in place. During 2010, the city advised Frisco residents that their lawns didn’t need any supplemental irrigation 25 out of 52 weeks (Ref. G6). Any outdoor irrigation taking place during those weeks was above what was required by landscapes and therefore wasteful. In addition, the city only recommended watering more than once per week during three of those weeks.

The situation was quite different for Frisco residents during the record drought of 2011. With rainfall amounts on the decline and heat on the rise, the city recommended a twice-per-week schedule 11 weeks during the year; a once per week schedule during 8 of those weeks; and that Mother Nature provided what landscapes needed the remaining 33 weeks of the year. The message to residents and to water suppliers is clear: we pour way too much water on our landscapes.

Another positive for plant survival using a twice-per-week watering schedule is our clay soil, the dominant soil type throughout the Metroplex. From a gardener’s standpoint, it may be frustrating to work with. But from a landscape standpoint, clay soil retains moisture, which allows for longer spans between irrigation events.

Despite the evidence, placing limits on outdoor irrigation is not an easy choice. But it can also be easily argued that overwatering to the tune of millions of gallons a week isn’t an acceptable choice either.

The Colorado study (Kenney, et al., 2004) suggests that "conservation programs based on mandatory, twice weekly landscape watering restrictions provide an attractive balance between saving water and limiting the impact on customers..." (Ref. G3). But, to ensure the program's success will take a substantial level of commitment. It requires a willingness to enforce restrictions and a huge effort to promote and educate. Halich et al. (2005) showed that in Virginia the intensity in which water use restrictions are implemented clearly had in impact on lowering water use (Ref. G7).

By taking a regional approach to implementing twice-per-week watering restrictions, we can limit confusion and simplify the education of water users across all communities. The Tarrant Regional Water District is committed to reducing water waste and stretching our water supplies to meet the future water needs of our growing communities. Adopting a twice per week watering strategy will be an immense step towards embracing a more responsible use of our water resources.

Appendix G References

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G6. Personal communication with Gary Hartwell, Public Works Director, City of Frisco, May 3, 2011.

G7. Halich, G., Stephenson, K., and Hilmer, C.: The Effectiveness of Mandatory and Voluntary Water-Use Restrictions During Drought, Department of Agricultural and Applied Economics, Virginia Polytechnic Institute and State University, prepared for the American Agricultural Economic Association Annual Meeting, Providence, Rhode Island, July 2005.

Appendix H:
Water Conservation Savings Assumptions

H. Water Conservation Savings Assumptions

For each of the evaluated water conservation measures, assumptions and procedures for estimating water savings are described and documented in this Appendix.

H.1. Toilets, Natural Replacement with HETs

The National Energy Policy Act of 1992 required certain performance standards for plumbing fixtures manufactured after January 1, 1994 (Table H-1). In particular, toilets that meet this standard must be ultra-low-flow toilets (ULFTs) that use 1.6 gallons per flush (gpf) or better. Allowing time for retailers to sell their existing inventories after that date, it is assumed that the new, more efficient plumbing fixtures began to be installed as of 1995.

Table H-1: Performance Standards for Plumbing Fixtures

Plumbing Fixture	1992 National Energy Policy Act Performance Standard	2009 Texas HB 2667 Performance Standard	Units[a]	Range for New Fixtures Installed Since 1995	Range for Older Fixtures (Ref. H1)
Toilets	1.6	1.28	gpf	1.0 - 1.6	3.5 - 7
Urinals	1.0	0.5	gpf	0.0 - 1.0	1.5 - 5
Showerheads	2.5[b]	2.5[b]	gpm	1.5 - 2.5	2.75 - 8
Faucets	2.5[b]	2.2[c]	gpm	1.5 - 2.5	2.75 - 7

[a] "gpf" means gallons per flush, "gpm" means gallons per minute, and "psi" means pounds per square inch.
[b] Measured at 80 pounds per square inch (psi) of water pressure.
[c] Measured at 60 psi. A flow rate of 2.5 gpm at 80 psi is equivalent to a flow rate of 2.2 gpm at 60 psi.

In Texas, this legislation was recently superseded by HB 2667, which requires more restrictive performance standards by 2014 (Table H-1). In particular, toilets for sale on or after January 1, 2014 must be high-efficiency toilets (HETs) that use 1.28 gpf or less.

Single- and Multi-Family Sectors

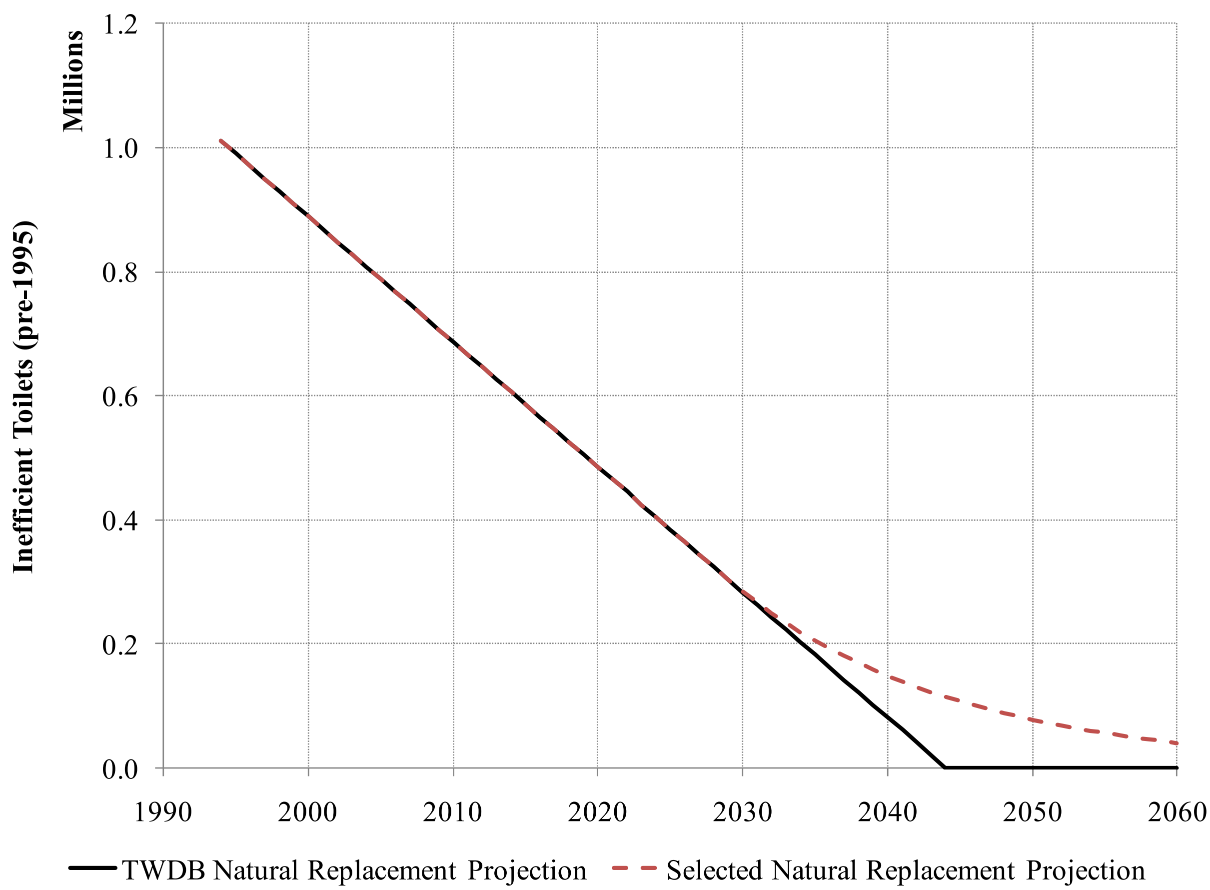
There are more than 519,000 single-family housing units, more than 212,000 multi-family housing units, and more than 12,000 "other" housing units in the service areas of TRWD's primary customers (Ref. H2).[54] Of these, more than 521,000 housing units (approximately 70 percent of the total) were constructed prior to 1995 (Ref. H3). These housing units were constructed with relatively high-flow plumbing fixtures and range in age from at least sixteen years to more than one hundred years.

[54] Single Family = one family detached units and duplexes. Multi-Family = structures with three or more separate units such as apartments, townhouses and condominiums. Other = Mobile home, trailer, houseboat, etc.

The typical useful life of various plumbing fixtures is twenty-five years for toilets, ten to fifteen years for showerheads, and fifteen years for faucets (Ref. H1). Given the housing age statistics presented above, it is likely that a significant portion of the older, high-flow plumbing fixtures have been replaced with more efficient fixtures since 1995.

Assuming 2.27 toilets per single-family unit (Ref. H4) and 1.20 toilets per multi-family unit (Ref. H5), there were an estimated 1.01 million inefficient toilets (of various ages) as of 1995. In its water demand projections for regional water planning, the TWDB has assumed that inefficient toilets will be naturally replaced at a constant rate over 50 years (Figure H-1). It is unrealistic to assume that there will be no inefficient toilets in service after 2045. Therefore, the selected natural replacement curve follows the TWDB curve until 2030, when the selected natural replacement rate was reduced to leave approximately 4 percent of inefficient toilets still in service by 2060.

Figure H-1: Natural Replacement of Residential Toilets



The average natural replacement rate will be more accurate in the long run than in the short run. If a short-term economic forecast projects especially slow or fast growth, it would be appropriate to revise the short-term natural replacement rate accordingly. Although recent economic growth has been relatively slow, economic data from the Texas Comptroller's office indicate an improving Texas economy (Refs. H6 and H7). Therefore, although the economic outlook for the next five years is uncertain, it has been assumed that the natural replacement rate will equal the long-term average rate.

Inefficient toilets typically use 3.5 gallons per flush (gpf) (Ref. H1). Since 1995 or so, these toilets have been naturally replaced with ULFTs (nominal flow rate of 1.6 gpf). Replacement toilets will change from ULFTs to HETs (1.28 gpf) by 2014. In addition, the ULFTs will begin to be naturally replaced by HETs.

A recent evaluation of the flush volume of toilets in homes constructed since 2001, which should have ULFTs or better, indicates a median flush volume of about 1.93 gpf (Ref. H8). Therefore, replacing an inefficient toilet with a ULFT will save 1.57 gpf, replacing an inefficient toilet with an HET will save 2.22 gpf, and replacing a ULFT with an HET will save 0.65 gpf. For each inefficient toilet naturally replaced with an HET, the water savings are 2.22 gpf * 5.05 flushes per resident per day (Ref. H4) * 1.28 residents per toilet = 14.4 gallons per toilet per day or 11.2 gpcd. Compare to 10.5 gpcd (Ref. H1). Similar calculations can be made for the other natural replacement possibilities.

Industrial, Commercial, and Institutional (ICI) Sector

2008 Tarrant County employment figures for all employment categories except outdoor activities (forestry, hunting, fishing, agriculture support, mining, quarrying, oil and gas extraction, and construction) were obtained (Ref. H9). Federal regulations require that each business establishment have a certain minimum number of toilets, depending on the number of employees (Ref. H10). Other categories with ICI toilets include hotels and schools. The number of 2010 Tarrant County hotel rooms and the enrollment figures for Tarrant County ISDs were obtained (Refs. H11 and H12). It is assumed that each hotel room contains one toilet and that schools have the minimum number of toilets recommended by the Uniform Plumbing Code (Ref. H13). Using this information, and assuming that Tarrant County employment, hotel rooms, and school enrollment are directly proportional to the number of residents in the TRWD service area, there were an estimated 67,000 inefficient ICI toilets in Tarrant County as of 1995. This estimate is probably low compared to the actual number, because it neglects several different types of facilities, including theaters, stadiums, hospitals, churches, and others. A natural replacement rate with the same shape as that shown in Figure H-1 was selected for inefficient ICI toilets.

The water savings in gallons per flush from natural replacement in the ICI sector are similar to those in the residential sector. For each inefficient toilet naturally replaced with an HET, the water savings are 2.22 gpf * 1.9 flushes per person per day (Ref. H1) * 11.1 people per toilet (weighted average of several ICI employment categories) = 49.9 gallons per toilet per day. Compare to 49.1 gpcd (Ref. H14). Similar calculations can be made for the other natural replacement possibilities.

H.2. High-Efficiency Toilet (HET) Distribution/Incentives

This measure would provide an incentive to replace existing residential and commercial toilets that use 3.5 gpf or more with HETs that use 1.28 gpf or less. Because all new toilets sold after 2014 must be HETs, water savings from this measure would be realized eventually without the measure. For an inefficient toilet replaced with this measure, the water savings only last until the inefficient toilet would have been replaced anyway.

Single- and Multi-Family Sectors

Inefficient toilets typically use 3.5 gallons per flush (gpf) (Ref. H1), and high-efficiency toilets (HETs) retrofitted with this measure will use 1.28 gpf, the maximum amount allowed by HB 2667. For each toilet that would not be retrofitted without this measure, the water savings are 2.22 gpf * 5.05 flushes per resident per day (Ref. H4) * 1.28 residents per toilet = 14.4 gallons per toilet per day or 11.2 gpcd. Compare to 10.5 gpcd (Ref. H1).

Each year, some of the measure participants would have purchased and installed an HET independently but participated in the program to get the financial benefit. These participants, called "freeriders," would have saved water without the measure. Freeriders are assumed to comprise 31.7 percent of participants (reported freerider percentage for a Los Angeles Department of Water and Power free distribution program for single-family customers, Ref. H15). The projected water savings from this measure account for freeriders and natural replacement.

Industrial, Commercial, and Institutional (ICI) Sector

Inefficient toilets typically use 3.5 gallons per flush (gpf) (Ref. H1), and HETs retrofitted with this measure will use 1.28 gpf, the maximum amount allowed by HB 2667. For each toilet that would not be retrofitted without this measure, the water savings are 2.22 gpf * 1.9 flushes per person per day (Ref. H1) * 11.1 people per toilet (weighted average of several ICI employment categories) = 49.9 gallons per toilet per day. Compare to 49.1 gpcd (Ref. H14).

Freeriders are assumed to comprise 20.6 percent of participants (reported freerider percentage for a Municipal Water District of Orange County free distribution program for multi-family customers, Ref. H15). The projected water savings from this measure account for freeriders and natural replacement.

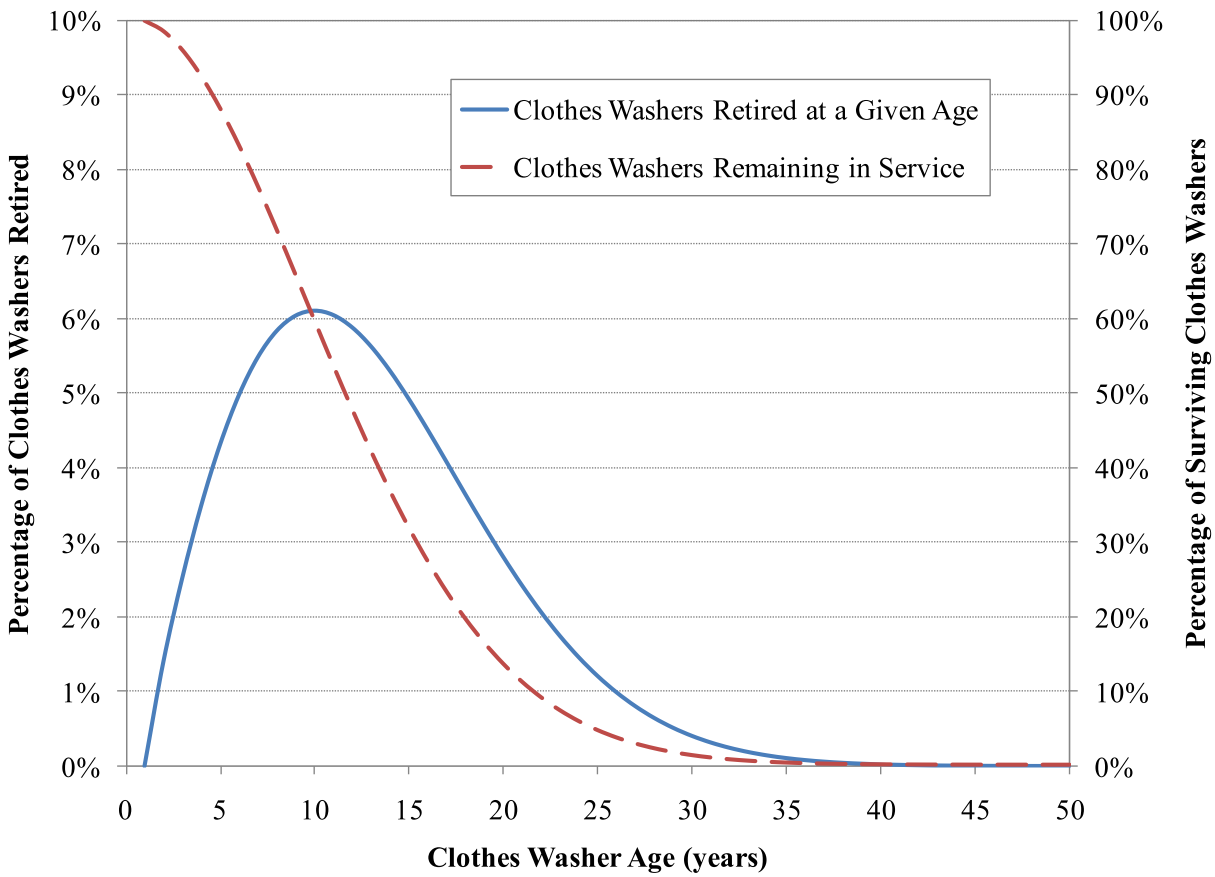
H.3. Residential Clothes Washers, Natural Replacement with HECWs

As of January 1, 2011, all manufactured residential and commercial clothes washers must have a water factor (WF) $\leq$ 9.5 gallons per cycle per cubic foot. The Department of Energy has scheduled progressively more restrictive standards on clothes washer water use over the next several years (Figure 9-1). With each change of standard, it is assumed manufacturers and retailers will take one year to work through inventories of less efficient clothes washers.

Numbers of single-family and multi-family housing units were obtained from the 2000 U.S. Census and are assumed to be proportional to population. Approximately 95.9 percent of single-family households and 39.0 percent of multi-family households have in-unit clothes washers (Ref. H15). About 30 percent of these clothes washers are high-efficiency clothes washers (HECWs) (Ref. H15). Based on these assumptions, there were more than 419,000 low-efficiency residential clothes washers in 2010.

The Department of Energy developed a Weibull distribution to represent the age at which residential clothes washers are retired (Ref. H16). This distribution was adjusted to have an average clothes washer life of 13 years and used to estimate the natural replacement of residential clothes washers over time (Figure H-2).

Figure H-2: Residential Clothes Washer Retirement



The following is an example calculation of water savings from natural replacement of inefficient clothes washers during a year when the WF standard is 9.5 gallons/cycle/ft^3 or better. Inefficient clothes washers have a typical water factor of 11.5 gallons/cycle/ft^3 (Ref. H15). In accordance with federal law, replacement clothes washers will have a water factor of 9.5 gallons/cycle/ft^3 or better. As a conservative assumption, the water savings are 2 gallons/cycle/ft^3. The typical capacity of a conventional clothes washer is 3.5 cubic feet (Ref. H17). In its water savings calculations, the U.S. Department of Energy assumes 392 wash cycles per household per year, based on 2.5 residents per clothes washer (Ref. H18). The number of wash cycles is linearly scaled based on the average single-family residential household size (2.81, estimated from 2000 U.S. Census data) and the average multi-family residential household size (1.83, estimated from 2000 U.S. Census data). For each single-family HECW that would not be retrofitted without this measure, the water savings are 2 gallons/cycle/ft^3 * 3.5 cubic feet * 392 cycles/year * 2.81/2.5 = 3,081 gallons per year. For each multi-family HECW that would not be retrofitted without this measure, the water savings are 2 gallons/cycle/ft^3 * 3.5 cubic feet * 392 cycles/year * 1.83/2.5 = 2,014 gallons per year.

H.4. High-Efficiency Clothes Washer (HECW) Incentives

This measure would provide an incentive to replace existing residential and commercial clothes washers with HECWs having modified energy factor (MEF) ≥ 2.2 and water factor (WF) ≤ 4.5 gallons/cycle/ft^3. HECWs use up to sixty percent less water than conventional machines.

Residential HECWs

The following is an example calculation of water savings during a year when the WF standard is 9.5 gallons/cycle/ft^3 or better. Existing clothes washers are assumed to have a water factor of 9.5 gallons/cycle/ft^3. By federal law this is the maximum allowable water factor after 2010, and actual water factors for older clothes washers may be greater. The typical capacity of a conventional clothes washer is 3.5 cubic feet (Ref. H17). Of the 348 currently available HECW models with the Energy Star designation and water factor ≤ 4.5, the average washer capacity is 3.76 cubic feet, and the average water factor is 3.63 (Ref. H18). In its water savings calculations, the U.S. Department of Energy assumes 392 wash cycles per household per year, based on 2.5 residents per clothes washer (Ref. H18). The number of wash cycles is linearly scaled based on the average single-family residential household size (2.81, estimated from 2000 U.S. Census data) and the average multi-family residential household size (1.83, estimated from 2000 U.S. Census data). For each single-family HECW retrofitted with this measure, the water savings are (9.5 gallons/cycle/ft^3 * 3.5 cubic feet – 3.63 gallons/cycle/ft^3 * 3.76 cubic feet) * 392 cycles/year * 2.81/2.5 = 8,628 gallons per year. For each multi-family HECW that would not be retrofitted without this measure, the water savings are (9.5 gallons/cycle/ft^3 * 3.5 cubic feet – 3.63 gallons/cycle/ft^3 * 3.76 cubic feet) * 392 cycles/year * 1.83/2.5 = 5,638 gallons per year. Compare to 5,085 to 9,000 gallons per year (Ref. H15).

In the last two years of the planning period, available clothes washers will be limited to WF ≤ 8.0, and the savings calculation should be adjusted accordingly.

The Alliance for Water Efficiency says that freeriders are to be expected but that no research has quantified the percentage of freeriders. Freeriders are assumed to comprise 10 percent of participants (Ref. H19). The projected water savings from this measure account for freeriders and last for the effective clothes washer life of 13 years (Ref. H5).

Commercial HECWs

The following is an example calculation of water savings during a year when the WF standard is 9.5 gallons/cycle/ft^3 or better. Existing clothes washers in laundromats and multi-family laundry rooms are assumed to have a water factor of 9.5 gallons/cycle/ft^3; actual water factors for older clothes washers may be greater. The typical capacity of a conventional clothes washer is 3.2 cubic feet (Ref. H20). Of the 83 currently available HECW models with the Energy Star designation and water factor ≤ 4.5, the average washer capacity is 2.99 cubic feet, and the average water factor is 4.47 (Ref. H21). The number of wash cycles per household is the same as for the residential HECWs. For each commercial HECW that would not be retrofitted without this measure, the water savings are (9.5 gallons/cycle/ft^3 * 3.2 cubic feet – 4.47 gallons/cycle/ft^3 * 2.99 cubic feet) * 392 cycles/year/household / 2.5 people per household = 2,671 gallons per year per person. The Alliance for Water Efficiency reports savings estimates of 25,000 to 51,000 gallons per year per washer (Ref. H15). It is assumed that 10 people use each washer each day, which corresponds to water savings of 26,710 gallons per washer per year. This level of use results in an average of 4.3 cycles per washer per day. Compare to 3 to 8 cycles per washer per day (Ref. H15).

In the last four years of the planning period, available top-loading clothes washers will be limited to WF ≤ 8.5, and the savings calculation should be adjusted accordingly.

Freeriders are assumed to comprise 10 percent of participants (same as residential). The projected water savings from this measure account for freeriders and last for the effective clothes washer life of 8 years (Ref. H5).

H.5. Pre-Rinse Spray Valve Retrofits

In 2005, the Texas Legislature passed HB 2428, which required that new commercial pre-rinse spray valves (PRSVs) for sale in Texas beginning January 1, 2006, must use no more than 1.6 gallons per minute (gpm). This measure would replace existing pre-rinse spray valves (PRSVs) that use 3 gpm or more with efficient PRSVs that use 1.6 gpm or less. Because all new PRSVs sold after 2005 must use a maximum of 1.6 gpm, most of the water savings from this measure would be realized eventually without the measure. For an inefficient PRSV replaced with this measure, the water savings only last until the inefficient PRSV would have been replaced anyway.

It was estimated from U.S. Census data that there were 2,941 food service establishments; elementary and secondary schools; junior colleges; colleges, universities, and professional schools; and hotels and motels in Tarrant County in 2005. In addition, it is assumed that this Census-based estimate misses 46 percent of establishments with PRSVs.[55] With 1.14 PRSVs per food service establishment (Ref. H22), it is estimated that there were 4,895 inefficient PRSVs in Tarrant County at the beginning of 2006.

Assuming an effective PRSV life of 5 years (Ref. H23) and assuming that 80 percent of inefficient PRSVs will be replaced by 2011 (2006 + effective PRSV life) requires an average PRSV replacement rate of 27.52 percent of inefficient PRSVs each year. Based on this assumption and Fort Worth's replacement of 1,099 inefficient PRSVs in 2008, it is projected that only 211 inefficient PRSVs will still be operational by 2013, the beginning of the planning period; more than 94 percent of the PRSVs with flow rates greater than 1.6 gpm will have been replaced.

[55] Fort Worth replaced 1,099 PRSVs in 2008, but no longer seeks out participants in its SpraySmart program because of the difficulty of finding more inefficient PRSVs. The number of PRSVs replaced in 2008 corresponds to about 640 Fort Worth residents per replacement PRSV. Extrapolating this to the service area of the primary customers, there must have been at least 2,571 inefficient PRSVs installed at the beginning of 2008. The 46 percent adjustment achieves this value.

Inefficient PRSVs typically use 2.92 gallons per minute (gpm) (Ref. H22), and efficient PRSVs retrofitted with this measure will use 1.28 gpm, the flow rate corresponding to the Niagara Conservation N2180, the PRSV distributed by the Fort Worth SpraySmart program. The average PRSV usage time is assumed to be 1.56 hours per day. For each PRSV that would not be retrofitted without this measure, the water savings are 1.64 gpm * 60 minutes per hour * 1.56 hours usage per day = 124 gallons per PRSV per day or 56,007 gallons per PRSV per year. Compare to 50,000 gallons per PRSV per year (Ref. H23).

Freeriders are assumed to comprise 10 percent of participants. The projected water savings from this measure account for freeriders and natural replacement.

Additional savings could be achieved by retrofitting with PRSVs that use less than 1.6 gpm. In a recent study by an EPA contractor, PRSVs with flow rates from 1.0 to 1.25 gpm appeared to perform adequately (Ref. H24).

H.6. ICI Customer Water Audits

This measure addresses potential water savings from indoor ICI customer water audits only; savings from ICI customer irrigation audits are described in Section H.10. In addition, many ICI customers will participate in the site-specific ICI incentives program to implement major recommendations from the customer water audits. Savings from implementation of major recommendations are described in Section H.7.

Using the average commercial and industrial water use percentage (35.8 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future ICI water demands were estimated. With the assumption that 85 percent of ICI water use is indoor water use, future ICI indoor water demands were estimated. Based on U.S. Census County Business Patterns data, there were approximately 34,083 business establishments in Tarrant County with indoor water use in 2008, for a ratio of one business establishment for every 48.3 residents. Based on this information, the average indoor water use for business establishments is 48.3 residents per business * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 35.8% * 85% = 2,579 gallons per day (gpd).

This measure targets the top ten percent of ICI water users. Based on experience with another utility, a typical top ten percent ICI water customer uses 5.74 times as much water as the average ICI water customer. Finally, it is assumed that a participating customer would save 2 percent of their indoor water use by fixing leaks, changing habits, or making other changes as a direct result of the indoor water audit (without participating in the site-specific ICI incentives measure). Therefore, indoor water savings from each ICI customer water audit are 2,579 gpd * 5.74 * 2% = 296 gpd. The projected water savings last 5 years.

H.7. Site-Specific ICI Incentives

This measure follows up on the ICI customer water audit in Section H.6, providing funding for implementation of major audit recommendations. Water savings are estimated in exactly the same way, except that participating customers are assumed to save 13 percent of their indoor water use. Therefore, indoor water savings for each participant are 2,579 gpd * 5.74 * 13% = 1,925 gpd. The projected water savings are last for 5 years. Compare to 5 years (Austin), 10 years (Southern Nevada Water Authority), and 20 years (Denver).

The combined water savings from the ICI indoor water audit and the site-specific ICI incentives measures are 2% + 13% = 15% = 2,221 gpd. Compare to actual 8 percent savings including irrigation improvements (Ref. H25) and projected 10 to 35 percent savings for implemented recommendations, including irrigation improvements (Ref. H26).

A survey of water conservation measures for small-medium sized ICI establishments at the Alliance for Water Efficiency Resource Library found a range of water savings (Ref. H27). For example: 102 gpd for a commercial ice maker, up to 894 gpd for a new two-compartment boilerless steamer in a restaurant, 1,243 gpd for a new medical/dental steam sterilizer, and up to 2,742 gpd for an x-ray film processing unit.

H.8. Cooling Tower Incentives

Cooling towers recirculate cooling water for a number of cycles before disposal of the water. The number of cycles is the ratio of the makeup water volume to the blowdown water volume. For a given number of cycles, n, the makeup water required for a cooling tower is the (evaporated water volume) * n / (n-1)

This measure would provide an incentive for ICI customers with existing cooling towers to install equipment (makeup and blowdown meters, conductivity controllers, pH controllers, etc.) that lead to 5 cycles or more and reduced cooling water use. This measure achieves savings over and above the minimum requirement of 4 cycles in the model conservation ordinance (Section H.20).

The average cooling tower size is assumed to be 371 tons (Ref. H28), and the average operating time is assumed to be 2,061 hours per year (based on data from Ref. H28 projected to TRWD service area using information from Ref. H29). Cooling towers evaporate approximately 1.80 gallons of water per ton per hour (Ref. H28).

Water use at 4 cycles of concentration is 371 tons/tower * 2,061 hrs/yr * 1.80 gal/ton/hr * 4 / 3 / 365 days/yr = 5,028 gal/tower/day. Water use at 5 cycles of concentration is 371 tons/tower * 2,061 hrs/yr * 1.80 gal/ton/hr * 5 / 4 / 365 days/yr = 4,714 gal/tower/day. Therefore, increasing from 4 to 5 cycles saves 314 gal/tower/day, or 114,697 gal/tower/yr. The projected water savings last 5 years, the approximately life of a conductivity controller (Ref. H15).

Compared to the Alliance for Water Efficiency's (AWE's) estimate of 209,880 gal/tower/yr (Ref. H15), this is a conservative estimate. However, the AWE estimate most likely involves a greater increase in the number of cycles.

The water savings are adjusted based on assumed 20 percent freeridership.

H.9. ICI Recognition Program

This measure would recognize ICI customers that meet certain water conservation criteria. Recognition could take many forms, including public commendation and using TRWD's water conservation web site to promote the customer's water-saving achievements and offer coupons to the customer's business. For the purpose of estimating potential water savings, it is assumed that the TRWD measure would be modeled after the Tucson WaterSmart Business Program, with four levels of recognition:

- Copper: meet current codes (retrofit older building to current standards) and develop Water Management Plan (WMP)
- Silver: 10 percent or better reduction in water use and start to implement WMP
- Gold: 20 percent or better reduction in water use and fully implement WMP
- Platinum: 30 percent or better reduction in water use and remain within water budget

Using the average commercial and industrial water use percentage (35.8 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future ICI water demands were estimated. Based on U.S. Census County Business Patterns data, there were approximately 34,083 business establishments in Tarrant County with indoor water use in 2008, for a ratio of one business establishment for every 48.3 residents. Based on this information, the average total water use for business establishments is 48.3 residents per business * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 35.8% = 3,035 gpd. Using the definitions above, recognized businesses will save 304 gpd (Silver), 607 gpd (Gold), or 911 gpd (Platinum). No savings are assumed for businesses that receive Copper recognition. The projected water savings last 5 years.

H.10. Irrigation System Evaluations

Single-Family Sector

Using the average residential water use percentage (61.5 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future residential water demand was estimated. Assuming that the average overall seasonal water use percentage (41.9 percent from Figure 4-5) also applies to residential irrigation use, future seasonal residential water demand was estimated. According to 2005 land-use information obtained from the North Central Texas Council of Governments, 95.33 percent of residential acreage is single-family lots. Assuming that 95.33 percent of residential acreage is single-family lots, and assuming that irrigation water use is evenly distributed by acreage, future single-family irrigation water demands were estimated. In the 2000 U.S. Census, the TRWD service area had one single-family housing unit for every 3.1 total residents. Maintaining this ratio, the future numbers of single-family housing units was estimated.

Based on this information, the average outdoor water use for a single-family household is 3.1 service area residents per single-family unit * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 61.5% * 41.9% * 95.33% = 134 gpd.

This measure targets the top 25 percent of single-family water users. Based on experience with another utility, a typical top 25 percent multi-family water customer uses 3.26 times as much water as the average multi-family water customer. Finally, it is assumed that participating single-family customers will save 10 percent of their outdoor water use due to irrigation water audits (Ref. H5). Therefore, outdoor water savings from each multi-family customer water audit are 134 gpd * 3.26 * 10% = 43.6 gpd. Compare to 33.9 gpd (Ref. H15) and 42-55 gpd with most of the savings from outdoor water use (Ref. H30).

The projected water savings last 3 years (Refs. H5 and H14).

Multi-Family Sector

This measure addresses potential water savings from multi-family housing irrigation water audits only; savings from indoor audits are described in Section H.6.

Using the average residential water use percentage (61.5 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future residential water demand was estimated. Assuming that the average overall seasonal water use percentage (41.9 percent from Figure 4-5) also applies to residential irrigation use, future seasonal residential water demand was estimated. According to 2005 land-use information obtained from the North Central Texas Council of Governments, 95.33 percent of residential acreage is single-family lots. Assuming that 4.67 percent of residential acreage is multi-family lots, and assuming that irrigation water use is evenly distributed by acreage, future multi-family irrigation water demands were estimated.

In the 2000 U.S. Census, the TRWD service area had one multi-family housing unit for every eight total residents. Maintaining this ratio, the future numbers of multi-family housing units was estimated. Finally, it is assumed that there are 50 multi-family housing units per complex (Ref. H5).

Based on this information, the average outdoor water use for a multi-family housing complex is 8.0 service area residents per multi-family unit * 50 multi-family units per complex * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 61.5% * 41.9% * 4.67% = 847 gpd.

Ordinarily, this measure would target the top 25 percent of multi-family water users. However, because there is a large property annual irrigation system analysis requirement in the Model Conservation Ordinance measure (Section J.20), this measure targets the top 50 percent of multi-family water users to avoid double-counting of projected water savings. Based on experience with another utility, a typical top 50 percent multi-family water customer uses 2.02 times as much water as the average multi-family water customer. Finally, it is assumed that participating multi-family customers will save 15 percent of their outdoor water use due to the irrigation water audits. Therefore, outdoor water savings from each multi-family customer water audit are 847 gpd * 2.02 * 15% = 256 gpd. The projected water savings last 3 years (Refs. H5 and H14).

ICI Sector

This measure addresses potential water savings from ICI irrigation water audits only; savings from indoor audits are described in Section H.6.

Using the average commercial and industrial water use percentage (35.8 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future ICI water demands were estimated. With the assumption that 15 percent of ICI water use is irrigation water use, future ICI irrigation water demands were estimated. Based on U.S. Census County Business Patterns data, there were approximately 34,083 business establishments in Tarrant County with indoor water use in 2008, for a ratio of one business establishment for every 48.3 residents. Based on this information, the average irrigation water use for business establishments is 48.3 residents per business * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 35.8% * 15% = 455 gpd.

Ordinarily, this measure would target the top 25 percent of ICI water users. However, because there is a large property annual irrigation system analysis requirement in the Model Conservation Ordinance measure (Section J.20), this measure targets the top 50 percent of ICI water users to avoid double-counting of projected water savings. Based on experience with another utility, a typical top 50 percent ICI water customer uses 1.97 times as much water as the average ICI water customer. Finally, it is assumed that participating ICI customers will save 15 percent of their outdoor water use due to the irrigation water audits. Therefore, outdoor water savings from each multi-family customer water audit are 455 gpd * 1.97 * 15% = 135 gpd. The projected water savings last 3 years (Refs. H5 and H14).

H.11. Irrigation System Incentives

This measure would provide an incentive to residential and ICI customers to retrofit their existing irrigation systems with water-conserving equipment. Qualifying equipment may include drip irrigation equipment, spray heads with greater distribution uniformity, rainfall shutoff sensors, weather-based irrigation controllers, and other devices.

Single-Family Sector

Estimated water savings for the single-family sector are based on replacement of inefficient spray heads with rotary spray heads and installation of rainfall shutoff sensors. Based on the relative costs and irrigated areas, it was estimated that including weather-based irrigation controllers in this measure would reduce the overall cost-effectiveness.

Using the average residential water use percentage (61.5 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future residential water demand was estimated. Assuming that the average overall seasonal water use percentage (41.9 percent from Figure 4-5) also applies to residential irrigation use, future seasonal residential water demand was estimated. According to 2005 land-use information obtained from the North Central Texas Council of Governments, 95.33 percent of residential acreage is single-family lots. Assuming that 95.33 percent of residential acreage is single-family lots, and assuming that irrigation water use is evenly distributed by acreage, future single-family irrigation water demands were estimated. In the 2000 U.S. Census, the TRWD service area had one single-family housing unit for every 3.1 total residents. Maintaining this ratio, the future numbers of single-family housing units was estimated.

Based on this information, the average outdoor water use for a single-family household is 3.1 service area residents per single-family unit * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 61.5% * 41.9% * 95.33% = 134 gpd.

Single-family customers with automatic irrigation systems use 1.47 times as much irrigation water as other single-family customers (Ref. H31). Assuming that 60 percent of single-family households have automatic irrigation systems, the average automatic irrigation system uses 154 gpd.

Rotary Spray Heads

Replacing an existing spray head with 55 percent distribution uniformity (Ref. H32) with a rotary spray head with 71 percent distribution uniformity (Ref. H33) would achieve 22.5 percent water savings. Therefore, irrigation water savings for each participating single-family customer are 149 gpd * 22.5% = 33.5 gpd. Assuming that each system requires replacement of 25 spray heads (Ref. H14), this translates to water savings of 0.0015 acre-feet per year (ac-ft/yr) per spray head. This is less than half of the 0.0040 ac-ft/yr water savings projected in two recent plans (Refs. H14 and H34).

The water savings are adjusted based on assumed 10 percent freeridership. The projected water savings last 10 years, the approximately life of a rotary spray head (Ref. H14).

Rainfall Shutoff Sensors

A rainfall shutoff sensor turns off the irrigation system when there has been a given amount of rainfall. Typically, the shutoff rainfall amount is adjustable.

The shutoff of an automatic irrigation system was simulated using 2007 through 2011 climatic data and various scheduling and shutoff assumptions. Assuming a shutoff setting of 6 mm (approximately 0.25 inches) of rainfall, the expected savings is 10 percent of irrigation water use in a typical year. Therefore, the projected water savings are 154 gpd * 10% = 15.4 gpd, or 5,605 gallons per year.

The water savings are adjusted based on assumed 10 percent freeridership. The projected water savings last 10 years, the approximately life of a rainfall shutoff sensor (Ref. H35).

Multi-Family and ICI Sectors

Estimated water savings for the multi-family and ICI sectors are based on replacement of standard irrigation controllers with weather-based irrigation controllers and installation of rainfall shutoff sensors. Based on the relative costs and irrigated areas, it was estimated that including rotary spray heads in this measure would reduce the overall cost-effectiveness.

Using the average residential water use percentage (61.5 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future residential water demand was estimated. Assuming that the average overall seasonal water use percentage (41.9 percent from Figure 4-5) also applies to residential irrigation use, future seasonal residential water demand was estimated. According to 2005 land-use information obtained from the North Central Texas Council of Governments, 95.33 percent of residential acreage is single-family lots. Assuming that 4.67 percent of residential acreage is multi-family lots, and assuming that irrigation water use is evenly distributed by acreage, future multi-family irrigation water demands were estimated.

In the 2000 U.S. Census, the TRWD service area had one multi-family housing unit for every eight total residents. Maintaining this ratio, the future numbers of multi-family housing units was estimated. Finally, it is assumed that there are 50 multi-family housing units per complex (Ref. H5).

Based on this information, the average outdoor water use for a multi-family housing complex is 8.0 service area residents per multi-family unit * 50 multi-family units per complex * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 61.5% * 41.9% * 4.67% = 847 gpd.

Using the average commercial and industrial water use percentage (35.8 percent from Figure 4-2) and projected average day water demand for the four primary customers (Figure 5-2), future ICI water demands were estimated. With the assumption that 15 percent of ICI water use is irrigation water use, future ICI irrigation water demands were estimated. Based on U.S. Census County Business Patterns data, there were approximately 34,083 business establishments in Tarrant County with indoor water use in 2008, for a ratio of one business establishment for every 48.3 residents. Based on this information, the average irrigation water use for business establishments is 48.3 residents per business * 175.8 gpcd (the current five-year average per capita water demand from Figure 4-3) * 35.8% * 15% = 455 gpd.

Assuming that 10.8 percent of irrigation systems for this sector belong to multi-family customers (estimated from U.S. Census data and assuming 50 multi-family units per multi-family complex (Ref. H5)), the average irrigation water use for the ICI sector is 522 gpd. It is further assumed that multi-family and ICI customers with automatic irrigation systems use 1.47 times as much irrigation water as other multi-family and ICI customers (similar to single-family customers) and that 60 percent of multi-family complexes and ICI establishments have in-ground irrigation systems. Therefore the average ICI automatic irrigation system uses 570 gpd.

Weather-Based Irrigation Controllers

Water savings from retrofitting a weather-based irrigation controller are approximately 6.1 percent of irrigation use (Ref. H36). Therefore, irrigation water savings for the average participating multi-family/ICI customer are 570 gpd * 6.1% = 34.7 gpd.

The water savings are adjusted based on assumed 10 percent freeridership. The projected water savings last 10 years, the approximately life of a weather-based irrigation controller (Ref. H14).

Rainfall Shutoff Sensors

As discussed in a previous section, water savings from installing a rainfall shutoff sensor are expected to be 10 percent of irrigation water use. Therefore, irrigation water savings for a multifamily customer are 570 gpd * 10% = 57 gpd.

The water savings are adjusted based on assumed 10 percent freeridership. The projected water savings last 10 years, the approximately life of a rainfall shutoff sensor (Ref. H35).

H.12. Rainwater Harvesting Incentives

This measure would provide an incentive to new residential and ICI construction to install and use equipment to capture rainfall from rooftops and use the water for non-potable purposes, including irrigation, car-washing, and toilet flushing.

Single-Family Sector

A water balance was simulated for a 1,750 square foot roof, 85 percent collection efficiency, 550 gallon storage tank, 60 percent irrigation system distribution uniformity, 70 percent rainfall efficiency, and typical evapotranspiration and rainfall data for Tarrant County. From the water balance, it is estimated that each unit would save about 7,746 gallons per year, or 21.2 gpd.

The water savings are adjusted based on assumed 10 percent freeridership. The projected water savings last 15 years, the approximately life of rainwater harvesting equipment (Ref. H5).

With the system described above, a 0.54 inch rainfall will fill a 550 gallon tank. In a typical year, enough rain falls in July and August to fill a 550 gallon tank about 4 times each month. It is reasonable to assume that the resident will empty the tank (irrigate) 4 times and that there will be 4 rainfall events to refill the storage. Larger tanks will require fewer irrigation/fill cycles to make maximum use of the available rainfall.

Although a smaller storage tank would be less expensive, it would require an unreasonable number of rainfall events to operate efficiently. For example, with a 1,750 square foot roof and collection efficiency of 85 percent, a 0.22 inch rainfall will fill a 200 gallon tank. Making maximum use of the available rainfall would require more than 10 irrigation/fill cycles per month during the summer. It is unreasonable to expect that there would be 10 significant rainfall events in a summer month, so some of the captured rainfall would overflow from the tank and not be used for irrigation.

Using this analysis as a guide, it appears that maximum efficiency requires at least 0.31 gallons of storage per square foot of roof area.

ICI Sector

A water balance was simulated for a 50,000 square foot roof, 85 percent collection efficiency, 15,000 gallon storage tank, 60 percent irrigation system distribution uniformity, 70 percent rainfall efficiency, and typical evapotranspiration and rainfall data for Tarrant County. From the water balance, it is estimated that each unit would save about 212,204 gallons per year, or 21.2 gpd.

The water savings are adjusted based on assumed 10 percent freeridership. The projected water savings last 15 years, the approximately life of rainwater harvesting equipment (Ref. H5).

With a similar analysis to that described for the single-family sector, it appears that maximum efficiency requires at least 0.31 gallons of storage per square foot of roof area. In addition, it should be verified that a beneficial use exists for the available water. In a normal year, the ICI system described above would capture enough water to meet all irrigation needs for 0.78 acres.

H.13. Irrigation Limits: Maximum 2 Times per Week

In coordination with the wholesale customers, this measure would develop an ordinance that limits irrigation to a maximum of two times per week, year-round. Several utilities have implemented permanent or temporary restrictions on the maximum number of watering days per week (Table H-2). For permanent restrictions, reported or projected savings range from 5 to 15.5 percent of annual water use and 2.1 to 17 percent of peak water use. For drought restrictions, reported savings range from 6.6 to 26 percent of annual water use.

TRWD implemented Stage 1 drought response measures, primarily consisting of twice-weekly irrigation limits, from August 29, 2011 through May 3, 2012. As described in Appendix I, TRWD experienced water savings of approximately 8.5 percent during Stage 1. During Stage 1, there was a well-publicized need to reduce water use and extend the life of the available water supply. Without this urgency, it is unlikely that permanent twice-weekly irrigation limits would achieve the same level of water savings. Considering this and the information reported in Table H-2, it has been assumed that a permanent twice-weekly irrigation limit will save 4 percent of annual water use.

The projected water savings are based on the projected average day water demand for the four primary customers (Figure 5-2) and the additional assumption that 90 percent of residents will comply with the twice-weekly irrigation limitation. Based on this information, the potential average water savings for 2013 are 313 mgd * 4% * 90% = 11.3 mgd.

Table H-2: Summary of Savings Estimates from Twice-Weekly Irrigation Limits at Other Utilities

Source	Time Period	Type of Restriction	Maximum Irrigation Days per Week[a]	Annual Savings	Peak Savings	Adjusted for Other Factors?	Note
City of Austin (Ref. Austin H37)	May-Sep 2008	Permanent	2	n/a	5-9 mgd	Yes	Based on projected peak day demand of 240 mgd, this represents 2.1-3.8 percent peak savings.
City of Austin (Ref. H38)	May-Sep 2009	Permanent	2	n/a	13.3 mgd	Yes	Assuming that the projected peak day demand increases at 1.87 percent per year, the long-term population growth rate, this represents 5.4 percent peak savings.
Lower Colorado River Authority, West Travis County Regional Water System (Ref. H39)	Jun-Sep 2008	Permanent	2	n/a	17 percent	No	Other factors that influenced water use included weather, conservation rates, and WaterIQ public education.
South Florida Water Management District (Ref. H40)	Projection	Permanent	3/2	5-10 percent	n/a	Yes	Some portions of the service area have a thrice-weekly irrigation limit; others have a twice-weekly irrigation limit. Projection for permanent measures based on drought experience reported below.
City of Stuart, FL (Ref. H41)	2010	Permanent	2	15.5 percent		No	Water use changed from 219 gpcd in 2007 to 185 gpcd in 2010.

Table H-2 Continued: Summary of Savings Estimates from Twice-Weekly Irrigation Limits at Other Utilities

Source	Time Period	Type of Restriction	Maximum Irrigation Days per Week[a]	Annual Savings	Peak Savings	Adjusted for Other Factors?	Note
City of Aurora, CO (Ref. H42)	5/15/2002-10/31/2002 5/1/2004-10/31/2004	Drought	3/2/0/other	12 percent	n/a	Yes	
South Florida Water Management District (Ref.H43)	Mar 2007-Apr 2009	Drought	3/2/1	6.6-26 percent, depending on the county	n/a	No	Estimated savings from the once-weekly irrigation limit were greater than those for the twice-weekly irrigation limit. Estimated savings from the twice-weekly irrigation limit were greater than those for the three-times-weekly irrigation limit. Other factors that influenced water use included drought surcharges, education, and degree of enforcement.

[a] During drought restrictions, utilities varied the maximum number of irrigation days from 3 days to 0 days, depending on the severity of the drought and the need for more water savings.

H.14. Public Education (ET Watering Requirements)

For this measure, TRWD will install a local weather station and recommend weekly irrigation amounts to its customers based on local rainfall and evapotranspiration data.

Using the projected average day water demand for the four primary customers (Figure 5-2), and the average overall seasonal water use percentage (41.9 percent from Figure 4-5), future seasonal water demand was estimated.

It is assumed that 2 percent of customers will implement the recommended weekly irrigation amounts. It is also assumed that existing customers irrigate to achieve zero turf stress (turf quality factor 1.00, Ref. H44) and that the recommended irrigation amounts will achieve low turf stress (turf quality factor 0.80, Ref. H44). For participating customers, this will result in a water savings of 20 percent of irrigation water use.

Based on this information, the potential water savings for 2013 are 313 mgd * 41.9% * 2% * 20% = 0.52 mgd.

H.15. Golf Course Conservation and Reuse

This measure would recognize golf courses that achieve certain levels of water conservation and publicize their accomplishments. Water conservation achievements may include limiting irrigation to a percentage of plant evapotranspiration requirements, developing water budgets, conducting irrigation system evaluations, tracking and reporting monthly water use, installing an irrigation meter and rain sensors, designating priority areas requiring irrigation, following daily watering times, developing a drought management plan, using reclaimed water, improving soils, native/drought-tolerant landscaping in non-course areas, using zoned irrigation, not watering rough areas, and other measures.

For purposes of estimating water savings, it is assumed that TRWD will model its program after the San Antonio Water System's Golf Fore SA program. This program has four levels of achievement:

- Level 1: Irrigate with potable water at 100 percent of plant evapotranspiration (ET) requirement
- Level 2: Irrigate with potable water at 90 percent of ET requirement
- Level 3: Irrigate with 50 percent reclaimed water at 80 percent of ET requirement
- Level 4: Irrigate with 90 percent reclaimed water at 70 percent of ET requirement

Based on typical evapotranspiration and rainfall data for Tarrant County, 65 percent irrigation system distribution uniformity, 70 percent rainfall efficiency, and overseeding with ryegrass at 24.1 percent of golf courses (average for Southeast region, Ref. H45), it is estimated that a golf course requires approximately 23 inches of irrigation water in a typical year. Recent average annual irrigation water use at the private Links at Waterchase Golf Course in Fort Worth is approximately 30.8 inches, and recent average annual irrigation water use at Arlington's municipal Ditto Golf Course is approximately 12.1 inches. Averaging these water use statistics, it is assumed that the average Tarrant County golf course uses 21.4 inches per year of irrigation water. This is conservative compared to the average irrigation water use for a golf course in the Southeast region, which includes Texas (29.0 inches per year, Ref. H45).

Therefore, the measure is estimated to save the following percentages of golf course irrigation use with potable water:

- Level 1: 0.0 percent
- Level 2: 10.4 percent
- Level 3: 63.5 percent
- Level 4: 94.4 percent

Assuming that the average golf course contains 9.9 acres per hole (estimated from Tarrant Appraisal District data) and irrigates two-thirds of this area (Ref. H45), the water savings for an 18-hole golf course that participates in Level 2 of the measure are 21.4 inches per year / 12 inches per foot * 10.4% * 18 holes * 9.9 acres per hole * 2/3 = 22.1 ac-ft/yr.

Some golf courses do not buy potable water from TRWD customers but instead buy raw water from TRWD. These golf courses could also participate in this measure, but no savings are estimated for them.

Natural Implementation of Golf Course Reuse

In the absence of the golf course conservation measure, some existing golf courses will naturally convert from using raw or potable water to using reclaimed water. Two golf courses, Ditto Golf Course in Arlington and Texas Star Golf Course in Euless, recently connected to Fort Worth's new reclaimed water pipeline from the Village Creek Wastewater Treatment Plant and started irrigating with reclaimed water. The reduction in potable water use at these golf courses is not included in previous water use statistics, so it represents water savings. Assuming that one course will achieve Level 3 savings (as defined above) and one course will achieve Level 4 savings, the water savings from these measures are 21.4 inches per year / 12 inches per foot * (63.5% + 94.4%) * 18 holes * 9.9 acres per hole * 2/3 = 334.7 ac-ft/yr.

H.16. Model Landscape Ordinance

In coordination with the wholesale customers, TRWD would develop a model landscape ordinance and encourage the customers to adopt the ordinance. The model landscape ordinance could include the following elements for new construction:

- Limit on turf areas in all new landscapes. Turf grass requires more water than native grasses and low-water-use plants.
- Requirement for low-water-use landscaping in other areas.

- Minimum soil depths and soil amendments. Soil that retains water increases irrigation efficiency.
- Turf grass summer dormancy capability.

EPA WaterSense reported water use differences for low-water-use plants compared to turf grass of 54 percent (Marin County, California), 54 percent (Irvine, California), 76 percent (Las Vegas, Nevada), and 18 to 50 percent (seven cities in Colorado) (Ref. H46). The Handbook of Water Conservation (Ref. H1) reports literature values of 20 to 50 percent water savings from replacing turf grass with low-water-use plants or grass.

Using the projected average day water demand for the four primary customers (Figure 5-2), and the average overall seasonal water use percentage (41.9 percent from Figure 4-5), future seasonal water demand was estimated. For the year 2012, which is used as a baseline from which to estimate the seasonal demand from new construction, overall seasonal water is projected to be 306.3 mgd * 41.9% = 128.4 mgd. The next year, 2013, the overall seasonal water demand is projected to be 312.7 * 41.9% = 131.0 mgd, and the seasonal water demand from new construction is estimated to be 131.0 mgd – 128.4 mgd = 2.7 mgd.

Assuming that the ordinance mandates that one-third of irrigated areas (new construction) will contain low-water-use plantings and that these plantings will reduce irrigation water use by 30 percent compared to turf grass, the estimated water savings are 1/3 * 30% = 10% of total irrigation water use. If 75 percent of new landscapes comply with the ordinance, the water savings in year 2013 are estimated to be 2.7 mgd * 10% * 75% = 0.20 mgd. The projected water savings last 10 years.

No water savings are estimated based on other possible elements of the model landscape ordinance, so actual savings may be greater than estimated.

H.17. Water Loss Reduction

To minimize water loss, TRWD would invite customers to workshops on conducting regular water system audits, developing and tracking performance indicators, improving validation of water loss performance data, conducting active leak detection, and speeding up needed repairs. TRWD would encourage its customers to perform these actions for their water systems and would request periodic water loss reports.

The average TRWD customer has nonrevenue water of 84 gallons per connection per day (from utility profiles). Assuming that 74 percent of nonrevenue water is real water loss (based on examples from Ref. H47), real water loss is 61.9 gal/conn/day, or 10.8 percent of total water diverted. Achieving a real water loss target of 10 percent of total water diverted would save approximately 4.4 gal/conn/day. With 2.57 people per connection (Ref. H48), the potential savings are about 1.7 gpcd. Assuming that 25 percent of customers achieve the target real water loss, the estimated water savings are 0.43 gpcd.

It will likely take the customer utilities time to implement improved water loss prevention strategies as a result of this educational measure. Therefore, it is assumed that the customers will ramp up to the full savings over three years. The projected water savings last one year.

H.18. Water Use Reduction Due to Increase in Real Price

It is anticipated that TRWD's future additional water sources will be more expensive in real terms than its existing water supply. Water use is somewhat elastic, meaning that an increase in the real water price will result in less water use. In addition, water use is more elastic in the long run than the short run, as it can take time for people to respond to real price changes. It is assumed that the short term elasticity is -0.127 (Ref. H49) and that the long-term elasticity is -0.24 (Ref. H50). In other words, a real price increase of 10 percent will result in a long-term decrease in water use of 2.4 percent. The short-term elasticity is assumed to reflect customer response in the first year after a real price increase, and the long-term elasticity is assumed to reflect customer response in future years.

TRWD's proposed revenue fund budget projects in-district wholesale water rates through 2022 (Ref. H51). These rates include the impact of TRWD's Integrated Pipeline Project. The real annual changes in the projected wholesale water rates were estimated by normalizing for inflation (1.8 percent per year, the difference between 20-year nominal and real treasury interest rates, Ref. H52). The projected future water demand (Figure 5-2) was revised using the projected real changes in water price and the short- and long-term elasticities. The difference in the projected water demands is the water savings associated with real price increases. For year 2013, the projected water savings are 2.27 mgd. Projected water savings from this measure are permanent.

The analysis of water savings does not account for unrelated customer rate increases or increases in TRWD's real water price after 2022.

H.19. Wholesale Customer Assistance

This measure would provide an incentive for wholesale customers to develop water conservation measures that are tailored for their local service areas. For evaluation purposes, it is assumed that this strategy would yield 100 ac-ft of new savings in each year of the five-year planning period. Since it is up to the customers to propose and implement measures, the savings from this measure are very uncertain.

The projected water savings last 5 years. The Lower Colorado River Authority has a similar program, and they assumed that the water savings would last approximately 8.2 years (Ref. H14).

H.20. Model Conservation Ordinance

In coordination with the wholesale customers, TRWD would develop a model water conservation ordinance and encourage the customers to adopt the ordinance. Among other requirements, the model ordinance could include the following elements:

- Annual irrigation system analysis for athletic fields, golf courses, large users, and large properties.
- Commercial dining facility requirements:
  - Serve water only upon request
  - Positive shutoff on pre-rinse spray wands
  - Flow restrictors for garbage disposals
- Minimum number of cycles for cooling tower operation
  - More stringent standard if potable water is used for makeup water.
  - Less stringent standard if recycled water is used for makeup water.
- Condensate collection for new construction

Savings from each of these elements are estimated as described in the following sections.

Large Property Annual Irrigation System Analysis

The City of San Antonio implemented a similar ordinance in 2005 (Ref. H53) and projected annual savings from this element to be 515 ac-ft/yr. Using the projected population ratio between the TRWD service area and San Antonio and assuming 50 percent compliance with the regulation, the year 2013 savings are projected to be 0.33 mgd.

Commercial Dining Facility Requirements

The City of San Antonio projected annual savings from this element to be 664 ac-ft/yr. Using the projected population ratio between the TRWD service area and San Antonio and assuming 50 percent compliance with the regulation, the year 2013 savings are projected to be 0.43 mgd.

Minimum Number of Cooling Tower Cycles

The City of San Antonio projected annual savings from this element to be 250 ac-ft/yr. Using the projected population ratio between the TRWD service area and San Antonio and assuming 75 percent compliance with the regulation, the year 2013 savings are projected to be 0.24 mgd.

Condensate Collection for New Construction

The City of San Antonio projected annual savings from this element to be 165 ac-ft/yr. Using the following ratios between the TRWD service area and San Antonio and assuming 75 percent compliance with the regulation, the year 2013 savings are projected to be 0.14 mgd:

- Projected population,
- Annual average humidity (ratio of 99.3 percent), and
- Cooling degree days (ratio of 87.3 percent).

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Appendix I: Water Savings from TRWD Stage 1 Drought Response Measures

I. Water Savings from TRWD Stage 1 Drought Response Measures

I.1. Introduction

TRWD implemented Stage 1 drought response measures, primarily twice-weekly irrigation limits, from August 29, 2011 through May 3, 2012. During Stage 1, retail customers were allowed to irrigate on the following days:

- Residential (even addresses): Wednesday and Saturday
- Residential (odd addresses): Thursday and Sunday
- Commercial and Industrial: Tuesday and Friday
- No irrigation allowed on Monday

Using daily TRWD water delivery data from January 1, 2011 through April 30, 2012 and climatic, economic, and demographic data from the same period, Stage 1 water savings were estimated for the four major customers as a whole and for Fort Worth, Arlington, and Mansfield individually.

I.2. Predictor Variables

For each entity, a water use model was constructed using a stepwise regression analysis to identify statistically significant predictor variables. The regression analysis considered 35 potential predictor variables (Table I-1). The variables representing the Stage 1 irrigation limits were defined as follows:

$$\text{Watering Restrictions} = \begin{Bmatrix} \text{PET, during Stage 1} \\ 0, \text{otherwise} \end{Bmatrix}$$

$$\text{Mon} = \begin{Bmatrix} \text{PET, Mondays during Stage 1} \\ 0, \text{otherwise} \end{Bmatrix}$$

PET = warm season turfgrass water requirement (in) calculated from evapotranspiration data from the Dallas Agrilife Center

I.3. Four Major Customers Daily Water Use Model

The daily water use model developed for the four major customers as a group is shown in Table I-2. Twelve predictor variables were significant at the 95 percent probability level; these are shown from most significant (cooling degree days) to least significant (100 degree days). Both Stage 1 variables were statistically significant and are included in the model. The coefficient of determination (R^2) for the model is 0.942, and the root-mean-square error is 28.9 mgd. Figures I-1 and I-2 compare the predictions of the water use model to actual TRWD deliveries and show the goodness of fit.

Table I-1: Potential Predictors of Stage 1 Water Use

Number	Variable Name	Units	Source
1	Water Restrictions	-	TRWD
2	Mon	-	TRWD
3	Water & Sewer Bill	$	Customers
4	Soil Moisture	in	TRWD
5	Maximum Temperature	ºF	NOAA[a]
6	Minimum Temperature	ºF	NOAA
7	Average Temperature	ºF	NOAA
8	Wet Bulb Temperature	ºF	NOAA
9	1-Day Lag Average Temperature	ºF	NOAA
10	2-Day Lag Average Temperature	ºF	NOAA
11	Dew Point Temperature	ºF	NOAA
12	Heating Degree Days	ºF	NOAA
13	Cooling Degree Days	ºF	NOAA
14	4-Mo. Cooling Degree Days	ºF	NOAA
15	Wind Speed	mph	NOAA
16	Cloud Cover	-	NOAA
17	Rainfall	in	NOAA
18	1-Day Lag Rainfall	ºF	NOAA
19	2-Day Lag Rainfall	ºF	NOAA
20	100 Degree Days	-	NOAA
21	Days Since Any Rainfall	-	NOAA
22	Days Since 0.25" Rainfall	-	NOAA
23	Population	capita	NCTCOG[b]
24	Median Family Income	$	U.S. Department of Housing and Urban Development
25	Metro Business Cycle Index	-	Dallas Federal Reserve
26	Total Wages	$	Texas Workforce Commission
27	Non-Farm Employment	capita	Dallas Federal Reserve
28	DFR Unemployment Rate	%	Dallas Federal Reserve
29	Employment	capita	Bureau of Labor Statistics
30	Gross Retail Sales	$	Texas Comptroller
31	BLS Unemployment Rate	%	Bureau of Labor Statistics
32	Unemployment	capita	Bureau of Labor Statistics
33	Labor Force	capita	Bureau of Labor Statistics
34	S&P 500 Index	-	
35	Housing Starts	-	St. Louis Federal Reserve

[a] National Oceanic and Atmospheric Administration. NOAA climate data were obtained for the Dallas-Fort Worth International Airport, Arlington Municipal Airport, Fort Worth Alliance Airport, Fort Worth Meacham Airport, and Fort Worth Naval Air Station weather stations and averaged for use in the forecast model.

[b] North Central Texas Council of Governments

Table I-2: Four Major Customers Daily Water Use Model

Term	Estimate*	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%	Abs(t Ratio)
Intercept	-57.75213	51.42351	-1.12	0.262	-158.7989	43.294645	1.12
Cooling Degree Days	5.5899374	0.306153	18.26	<.0001	4.98835	6.1915248	18.26
4-Mo. Cooling Degree Days	0.0502378	0.003755	13.38	<.0001	0.0428588	0.0576168	13.38
Days Since 0.25" Rainfall	1.0500306	0.120284	8.73	<.0001	0.8136731	1.2863882	8.73
Watering Restrictions	-115.639	17.17209	-6.73	<.0001	-149.382	-81.896	6.73
Cloud Cover	-2.936526	0.47419	-6.19	<.0001	-3.868305	-2.004746	6.19
Mon	-142.3474	27.57245	-5.16	<.0001	-196.527	-88.16776	5.16
Soil Moisture	-59.90767	12.16921	-4.92	<.0001	-83.82007	-35.99527	4.92
2-Day Lag Average Temperature	0.6330649	0.137931	4.59	<.0001	0.362032	0.9040978	4.59
Days Since Any Rainfall	1.2061472	0.3068	3.93	<.0001	0.6032875	1.8090069	3.93
S&P 500 Index	0.1521413	0.039067	3.89	0.0001	0.075375	0.2289075	3.89
Housing Starts	0.0126433	0.003463	3.65	0.0003	0.0058392	0.0194474	3.65
100 Degree Days	23.633731	6.617842	3.57	0.0004	10.629725	36.637737	3.57

*Equation is:
-57.75213 + 5.5899374*Cooling Degree Days + 0.0502378*4-Mo. Cooling Degree Days + ...

Figure I-1: Four Major Customers Daily Water Use Model Predictions

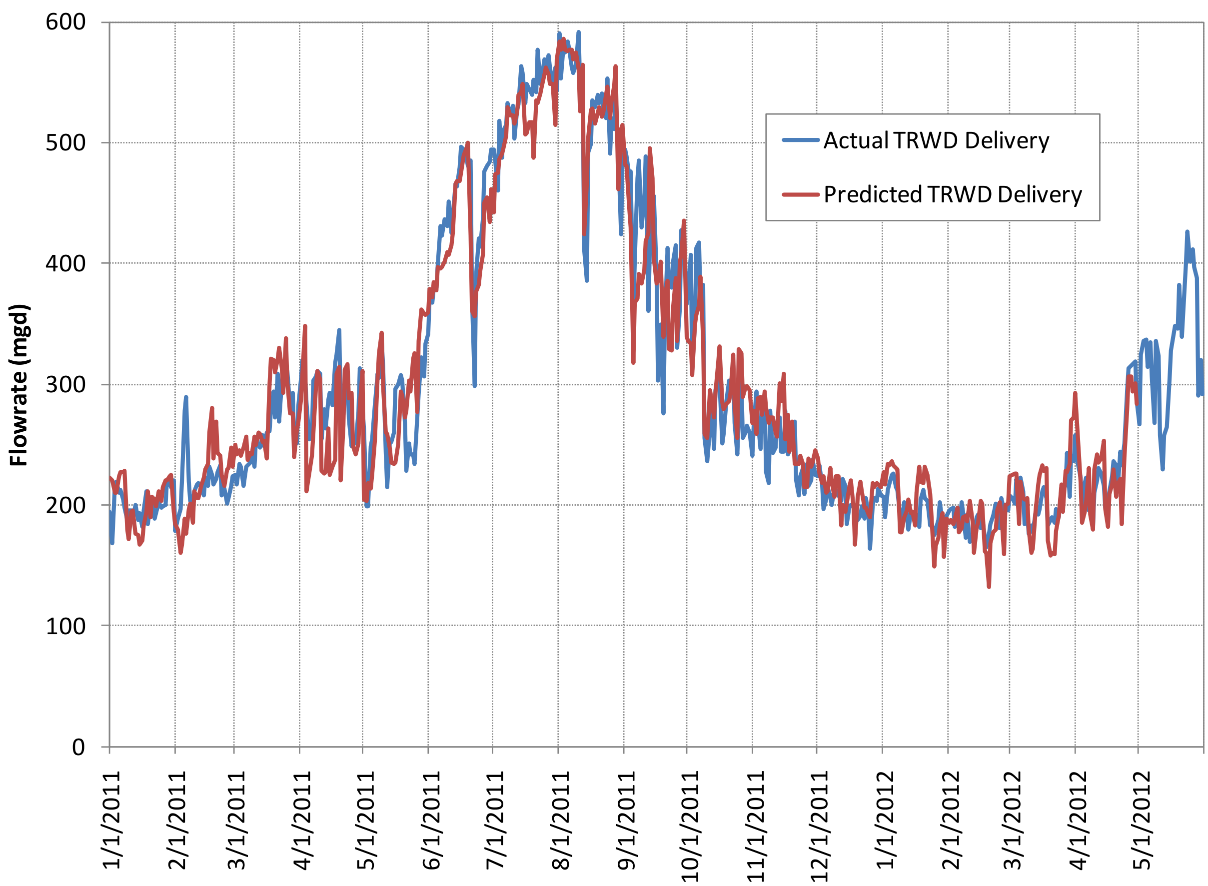
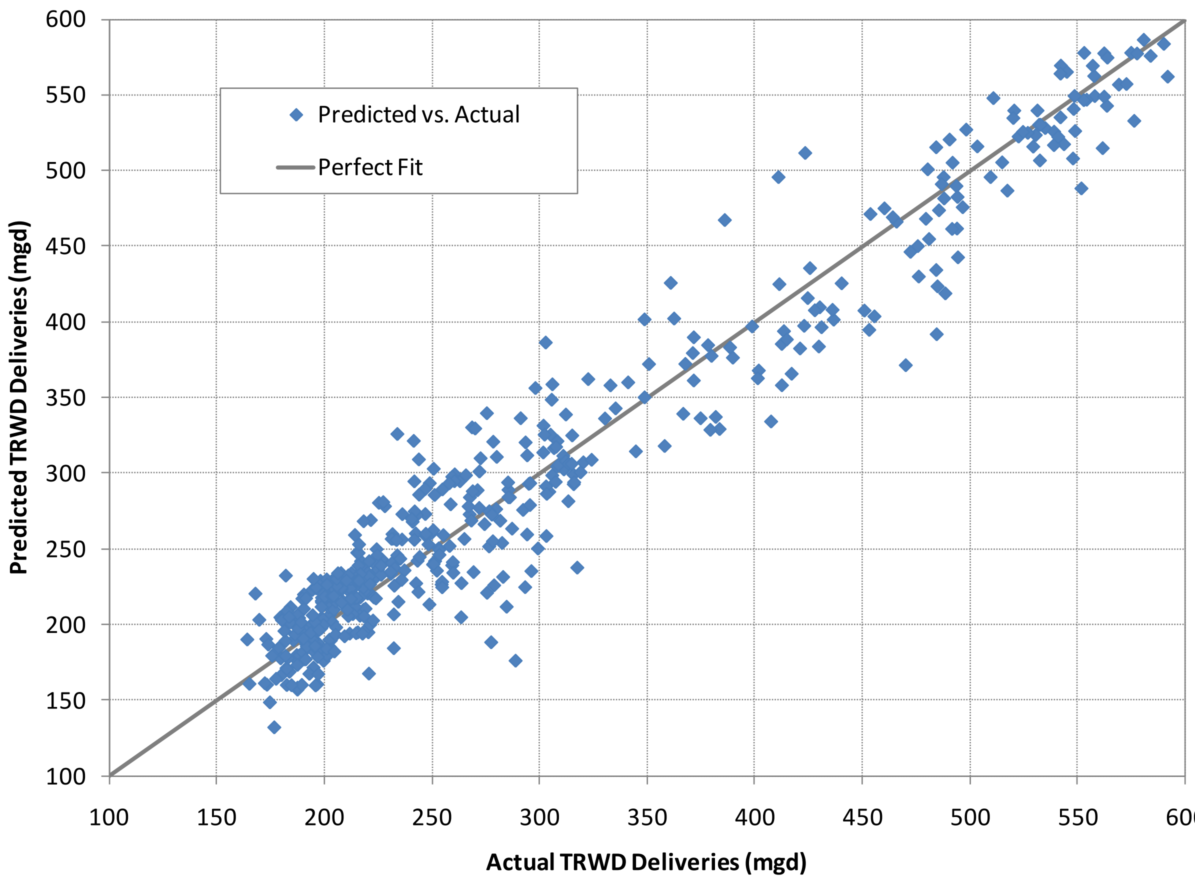


Figure I-2: Four Major Customers Daily Water Use Model Goodness of Fit



By zeroing out the coefficients of the Stage 1 variables, this model can be used to predict what water use would have been without the Stage 1 drought response measures. The difference between predicted deliveries without irrigation restrictions and predicted deliveries with irrigation restrictions is the estimated water savings during Stage 1 (Figure I-3).

I.4. Individual Water Use Models

Water use models were also developed for Fort Worth, Arlington, and Mansfield (Tables I-3 through I-5). These models have similar goodness of fit to the overall model described in the previous section.

I.5. Summary of Results

Predicted Stage 1 water savings are shown in Tables I-6 and I-7. In the service area of the four major customers, the water savings from the Stage 1 measures is estimated to be 5.76 billion gallons, or about 8.5 percent of the water that would have been delivered without the Stage 1 drought response measures.

Figure I-3: Four Major Customers Water Savings

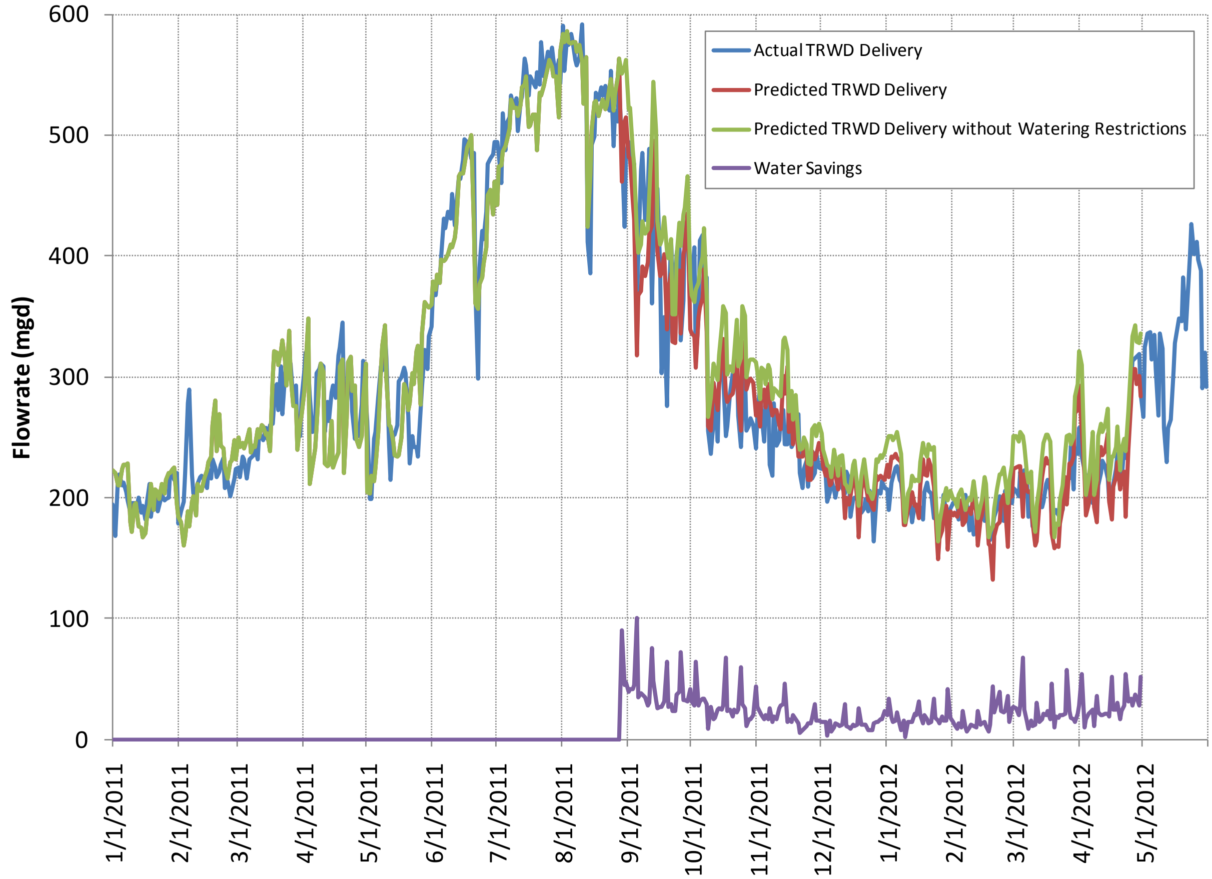


Table I-3: Fort Worth Daily Water Use Model

Term	Estimate*	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%	Abs(t Ratio)
Intercept	-13.50267	33.84057	-0.4	0.6901	-79.99912	52.993771	
Cooling Degree Days	3.3200146	0.200988	16.52	<.0001	2.9250746	3.7149545	16.52
4-Mo. Cooling Degree Days	0.0309102	0.002469	12.52	<.0001	0.0260581	0.0357623	12.52
Days Since 0.25" Rainfall	0.5597827	0.077635	7.21	<.0001	0.4072299	0.7123355	7.21
Watering Restrictions	-73.03513	11.37101	-6.42	<.0001	-95.37907	-50.69119	6.42
Cloud Cover	-1.823292	0.306909	-5.94	<.0001	-2.426366	-1.220218	5.94
Soil Moisture	-44.01933	8.053895	-5.47	<.0001	-59.84517	-28.19349	5.47
Mon	-82.4555	18.89128	-4.36	<.0001	-119.5767	-45.33428	4.36
2-Day Lag Average Temperature	0.3897908	0.089865	4.34	<.0001	0.2132064	0.5663752	4.34
Housing Starts	0.0083747	0.002247	3.73	0.0002	0.0039585	0.0127908	3.73
100 Degree Days	16.220314	4.3716	3.71	0.0002	7.6301554	24.810472	3.71
Days Since Any Rainfall	0.7310239	0.201379	3.63	0.0003	0.3353149	1.1267328	3.63
S&P 500 Index	0.0852619	0.025704	3.32	0.001	0.0347533	0.1357706	3.32

*Equation is:

-13.50267 + 3.3200146*Cooling Degree Days + 0.0309102*4-Mo. Cooling Degree Days + …

Table I-4: Arlington Daily Water Use Model

Term	Estimate*	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%	Abs(t Ratio)
Intercept	718.95952	120.3612	5.97	<.0001	482.45074	955.46829	5.97
4-Mo. Cooling Degree Days	0.012354	0.000776	15.91	<.0001	0.0108285	0.0138794	15.91
Cooling Degree Days	0.9576366	0.069618	13.76	<.0001	0.8208378	1.0944355	13.76
Watering Restrictions	-33.99733	4.415274	-7.7	<.0001	-42.67331	-25.32135	7.7
Arlington Water & Sewer Bill	-23.03329	3.228848	-7.13	<.0001	-29.37795	-16.68863	7.13
Days Since 0.25" Rainfall	0.2034395	0.028653	7.1	<.0001	0.1471373	0.2597418	7.1
Non-Farm Employment	0.0005877	9.15E-05	6.42	<.0001	0.0004079	0.0007674	6.42
S&P 500 Index	0.0516507	0.008104	6.37	<.0001	0.0357263	0.0675752	6.37
Cloud Cover	-0.623319	0.105767	-5.89	<.0001	-0.831151	-0.415488	5.89
Days Since Any Rainfall	0.3332084	0.06911	4.82	<.0001	0.1974075	0.4690092	4.82
Mon	-28.12338	6.305891	-4.46	<.0001	-40.51441	-15.73236	4.46
Housing Starts	0.0025191	0.000737	3.42	0.0007	0.0010703	0.0039678	3.42
1-Day Lag Rainfall	-1.845064	0.941781	-1.96	0.0507	-3.695655	0.0055281	1.96

*Equation is:
718.95952 + 0.012354*4-Mo. Cooling Degree Days + 0.9576366*Cooling Degree Days + …

Table I-5: Mansfield Daily Water Use Model

Term	Estimate*	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%	Abs(t Ratio)
Intercept	3.3408552	0.559229	5.97	<.0001	2.2419753	4.4397351	5.97
Cooling Degree Days	0.2723428	0.018578	14.66	<.0001	0.2358369	0.3088488	14.66
4-Mo. Cooling Degree Days	0.0014736	0.000118	12.5	<.0001	0.001242	0.0017051	12.5
Cloud Cover	-0.175166	0.02793	-6.27	<.0001	-0.230049	-0.120283	6.27
2-Day Lag Average Temperature	0.0375359	0.007925	4.74	<.0001	0.021963	0.0531088	4.74
Rainfall	0.9491223	0.269809	3.52	0.0005	0.418949	1.4792955	3.52
100 Degree Days	1.3146082	0.380122	3.46	0.0006	0.567672	2.0615443	3.46
Days Since 0.25" Rainfall	0.0322313	0.009335	3.45	0.0006	0.0138884	0.0505743	3.45
Days Since Any Rainfall	0.0477818	1.46E-02	3.27	0.0012	0.0190653	0.0764984	3.27
Mon	-4.084377	1.620303	-2.52	0.012	-7.268259	-0.900495	2.52
Watering Restrictions	-2.362677	0.952459	-2.48	0.0135	-4.23425	-0.491103	2.48
Housing Starts	0.0005015	0.000203	2.48	0.0136	0.0001036	0.0008995	2.48
Soil Moisture	-1.658868	0.705828	-2.35	0.0192	-3.045815	-0.271921	2.35

*Equation is:
3.3408552 + 0.2723428*Cooling Degree Days + 0.0014736*4-Mo. Cooling Degree Days + …

Table I-6: Stage 1 Water Savings Estimates

Service Area	Actual TRWD Deliveries during Stage 1 (mg)	Estimated TRWD Deliveries during Stage 1 (mg)	Estimated Water Savings during Stage 1 (mg)		
			Upper 95% Confidence Interval	Most Likely	Lower 95% Confidence Interval
Big 4 Total	61,881	62,168	7,523	5,764	4,005
Fort Worth	40,705	40,916	4,767	3,594	2,422
Arlington	12,452	12,451	2,053	1,610	1,167
Mansfield	2,145	2,158	224	125	26

Table I-7: Stage 1 Percentage Water Savings Estimates

Service Area	Estimated Water Savings during Stage 1		
	Upper 95% Confidence Interval	Most Likely	Lower 95% Confidence Interval
Big 4 Total	10.79%	8.48%	6.05%
Fort Worth	10.43%	8.08%	5.59%
Arlington	14.16%	11.45%	8.57%
Mansfield	9.39%	5.47%	1.20%

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Appendix J:
Unit Cost and Benefit Assumptions

J. Unit Cost and Benefit Assumptions

For each of the evaluated water conservation measures, assumptions and procedures for estimating costs and benefits are described and documented in this Appendix.

Unless otherwise specified, costs and benefits are expressed in terms of 2011 dollars.

Where budget information is presented in future year dollars, an inflation factor of 1.8 percent per year is used (the difference between 20-year nominal and real treasury interest rates, Ref. J1). Present values are calculated using an assumed real discount factor of 3.0 percent per year (Refs. J2 and J3).

The hourly rate for technical staff members, including salary and benefits, is assumed to be $40.47 ($84,183 per year). The hourly rate for program staff members, including salary and benefits, is assumed to be $29.43 ($61,224 per year).

Benefits are calculated using the following marginal cost information:

- Water treatment: $546 per million gallons (mg). This is a population-weighted average for the four primary customers. Fort Worth's reported cost is $612/mg (Ref. J4), Mansfield's reported cost is $671/mg, Arlington's reported cost is $390/mg, and TRA's reported cost is $408/mg.
- Wastewater treatment: $337 per mg (for measures that return flow to the wastewater collection system). This is a population-weighted average for the four primary customers. Fort Worth's cost is approximately $346/mg (population-weighted average of reported costs for the Fort Worth Village Creek system (Ref. J4) and TRA's Denton Creek Regional Wastewater System). The reported cost of $322/mg for TRA's Central Regional Wastewater System applies to Arlington, Mansfield, and TRA.
- Pumping: Before 2030, a cost of $321 per mg is avoided by pumping less water from Richland-Chambers reservoir. This cost is estimated from the Richland-Chambers pumping cost in the 2011 Region C Water Plan (Ref. J5).

There are also avoided costs associated with deferral or downsizing of planned future water supplies based on a reduction in water demands through water conservation. Construction of these water supplies is expected to be a cooperative effort between TRWD and other agencies (Section 5.3). Since other agencies might not be able to defer construction of new facilities, it is assumed, for the purpose of evaluating the cost-effectiveness of potential water conservation measures, that TRWD will downsize its share of each planned future water supply, resulting in avoided costs for debt service, raw water pumping, operation and maintenance, and raw water purchases (Table J-1).

New reservoirs (and raw water transmission facilities with sufficient terminal storage) must be sized to meet annual water demand during a severe drought, when demand is expected to peak. Therefore, the amount by which future water supplies could be downsized depends on projected water conservation savings during a severe drought. However, the potential water conservation savings described in Table 10-3 are based on average water demand. During a severe drought, seasonal water use will be greater than during average water demand periods, and conservation savings from irrigation- and cooling-related conservation measures will be reduced.

Table J-1: Unit Costs for Planned Future Water Supplies

Planned Future Water Supply	Year	Unit Costs ($/mg)			
		Debt Service	Raw Water Pumping	O&M	Raw Water Purchase
Marvin Nichols Reservoir (Phase 1)	2030	$2,531	$556	$293	$0
Marvin Nichols Reservoir (Phase 2)	2050	$1,452	$556	$166	$0
Toledo Bend Reservoir (Phase 1)	2050	$2,354	$944	$289	$106
Oklahoma Water	2060	$2,109	$401	$280	$158

Planned future water supplies and unit costs taken from Ref. 1. The division of costs for Marvin Nichols Reservoir between Phase 1 and Phase 2 is assumed from the description of the project and the cost estimate in Ref. 1. Unit costs inflated to 2011 dollars.

The 2011 water use data (Figures 4-3 and 4-5) can be used to derive a reasonable estimate of projected water conservation savings during a severe drought. The annual per capita water use (196.1 gpcd) was about 12 percent higher than the five-year running average (175.8 gpcd), and 49.6 percent of the water supplied was used for seasonal purposes. Assuming that the base water use (defined in Section 4.5) remains unchanged during a drought, the 2011 seasonal water use was about 23 percent greater than average. This ratio could be higher for more severe drought conditions. For the purpose of a benefit-cost analysis to estimate the cost-effectiveness of the potential water conservation measures, it is assumed that, during a severe drought, seasonal water use will be about 25 percent greater than average and that irrigation- and cooling-related water conservation savings will be 80 percent (or 1/1.25) of those shown in Table 10-3.[56]

Although there may also be benefits associated with deferring or downsizing improvements to water treatment plants, water distribution systems, wastewater treatment plants, and wastewater collection systems, these benefits are not accounted for.

Some measures (e.g., irrigation system incentives) do not avoid wastewater treatment costs, because irrigation does not return flow to the wastewater system.

Unless otherwise specified, benefits from avoided water treatment and wastewater treatment are calculated based on 100 percent of the estimated water savings.

In addition, it is assumed that TRWD and its wholesale customers will fund the water conservation measures through their operating budgets and that no measures will be financed over time. For example, the full cost of high-efficiency toilets retrofitted in Year 1 will be incurred in Year 1.

[56]This estimate is only for examining the cost-effectiveness of the various potential water conservation measures and should not be used for design or construction of water supply facilities.

A more complicated example is the site-specific ICI incentives and wholesale customer assistance. For these measures, it is assumed that TRWD will set aside the full projected incentive amount in the year that TRWD agrees to provide the incentive but that TRWD will pay the incentive in installments over time, based on actual, proven water savings.

Measure-specific cost and benefit information is presented in the following sections.

J.1. Toilets, Natural Replacement with HETs

There is no cost to TRWD or its wholesale customers for this measure, since the HET retrofits occur at owner expense.

J.2. High-Efficiency Toilet (HET) Distribution/Incentives

Single- and Multi-Family Sectors

The unit cost of a residential HET is assumed to be $86. This is the average of Arlington's reported costs for regular HETs ($76) and Americans with Disabilities Act compliant HETs ($96). The assumed costs are lower than Fort Worth's reported costs for regular HETs ($96.31) and Americans with Disabilities Act compliant HETs ($124.92).

For comparison, Santa Clara Valley Water District ($125), Contra Costa Water District ($125), five Portland-area providers (up to $100), and Denver Water ($75) offer rebates for HET retrofits. The San Antonio Water System offer free toilets to residents (and businesses).

Each incentive requires approximately 15 minutes of program staff time for voucher processing, for a staff cost of about $7 per incentive. Therefore, the total unit cost for each incentive is about $93.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

ICI Sector

The unit cost of an ICI HET is assumed to be about $200. Each incentive requires approximately 15 minutes of program staff time for voucher processing, for a staff cost of about $7 per incentive. Therefore, the total unit cost for each incentive is $207 (Ref. J6).

Planning and development of this measure is assumed to require 320 hours of technical staff time.

J.3. Residential Clothes Washers, Natural Replacement with HECWs

There is no cost to TRWD or its customers for this measure, since the HECW retrofits occur at owner expense.

J.4. High-Efficiency Clothes Washer (HECW) Incentives

Residential HECWs

The incentive for a residential HECW is $100. For comparison, Austin (up to $100), Albuquerque Bernalillo County Water Authority ($100), Contra Costa Water District ($100), Denver Water ($100), and Western Municipal Water District ($85) offer similar rebates.

The lowest-priced residential clothes washers offered for sale at sears.com were surveyed for washer characteristics (Table J-2). For clothes washers with WF ≤ 4.5, the average capacity and water factor are similar to universe of such washers (see discussion in Appendix H). At the low end of the market, water-efficient top-loading washers cost about $203 more than inefficient washers, and water-efficient front-loading washers cost about $311 more than inefficient washers. Therefore, it appears that a $100 incentive, coupled with lower water and water heating costs, could induce residential buyers to choose a water-efficient clothes washer.

Table J-2: Summary of Residential Clothes Washer Characteristics

Washer Type	Water Use Efficiency	Count[a]	Average Capacity (ft^3)	Average Price	Average Water Factor (gal/cycle/ft^3)
Top-Load	WF > 6.0	7	3.57	$472	9.50
Top-Load	WF ≤ 4.5	10	3.71	$675	3.70
Front-Load	WF ≤ 4.5	10	3.56	$783	3.31

[a] For each washer type and efficiency class, the 10 lowest-priced, standard-size residential clothes washers offered for sale at sears.com were surveyed (Ref. J7). Only 7 such washers were offered for sale in the top-load, WF > 6.0 class.

Each incentive requires approximately 15 minutes of program staff time for processing of applications, for a staff cost of about $7 per incentive. Therefore, the total unit cost for each incentive is about $107.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

Commercial HECWs

The incentive for a commercial HECW is $210. For comparison, Contra Costa Water District ($220), San Francisco Public Utilities Commission ($200), Denver Water ($150), Santa Clara Valley Water District ($125), and East Bay Municipal Utility District ($75-$125) offer similar rebates.

Each incentive requires approximately 15 minutes of program staff time for processing of applications, for a staff cost of about $7 per incentive. Therefore, the total unit cost for each incentive is about $217.

J.5. Pre-Rinse Spray Valve Retrofits

Each direct installation of a pre-rinse spray valve requires approximately 20 minutes of program staff time to schedule an appointment and keep records and 40 minutes of technical staff time for installation, for a staff cost of about $37 per retrofit. The total unit cost for directly installing a pre-rinse spray valve will be $145 (reported Fort Worth cost) Compare to $146 (inflated from Ref. J8). Older studies suggest a range of costs from $150 to $217 (Ref. J9).

Planning and development of this measure is assumed to require 320 hours of technical staff time.

J.6. ICI Customer Water Audits

Each ICI customer water audit requires approximately 40 hours of technical staff time for contacting customers, conducting site visits, identifying potential improvements, and reporting findings, for a staff cost of $1,619 per audit.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

J.7. Site-Specific ICI Incentives

The annual cost of each incentive is $300 per acre-foot of actual water savings (Ref. J6). Denver ($301), Southern Nevada Water Authority ($261 to $815), and Austin ($179) offer similar incentives. It has been assumed that the lifetime cost of each incentive (annual cost * measure life) is budgeted during the year that the incentive is given.

Each incentive requires approximately 20 hours of technical staff time for application review, for a staff cost of $809 per incentive.

Planning and development of this measure is assumed to require 480 hours of technical staff time.

J.8. Cooling Tower Incentives

The incentive for a cooling tower conductivity controller is $500. Denver Water ($500) and Metropolitan Water District of Southern California ($625) offer similar incentives.

Each incentive requires approximately 6 hours of technical staff time for application review and installation verification, for a staff cost of $243 per incentive.

No cost is included for verification of savings (modeled after Denver Water's Cooling Tower Conductivity Control Equipment Rebate program). The following factors should help TRWD achieve the projected water savings without verification:

- The projected water savings of 114,697 gallons per unit per year (Appendix H) is much less than the Alliance for Water Efficiency's estimate of 209,880 gallons per unit per year (Ref. J9).
- Presumably, customers that choose to participate in the cooling tower incentives measure are motivated to increase their number of cycles to save water and sewer costs. If the participants shoulder a significant percentage of the cost, they may be more motivated to use the controller to achieve water savings. The rebate amount should be limited to a portion of the actual conductivity controller cost. The cost of conductivity controllers ranges from about $750 for a basic model to $3,200 or more for a model that controls conductivity, pH, and chemical feeds. The participant will pay additional costs to install and program the controller.

Therefore, the total unit cost for each incentive is $743. Planning and development of this measure is assumed to require 320 hours of technical staff time.

J.9. ICI Recognition Program

Recognition of each participant requires approximately 32 hours of technical staff time for application review and conservation plan review, for a staff cost of $1,295 per participant.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

An assumed 85 percent of the estimated water use reduction will result from changes in indoor water use. Therefore, the benefit from avoided wastewater treatment applies to 85 percent of the estimated water savings.

J.10. Irrigation System Evaluations

Single-Family Sector

Each single-family irrigation system audit requires approximately 48 minutes of program staff time for marketing and scheduling appointments and 2 hours of technical staff time for conducting site visits, identifying potential improvements, and reporting findings, for a staff cost of $104 per audit. This staff time is similar to that used in Ref. J10. Other references suggest staff costs of $80 (Ref. J6) and $95 (Ref. J9).

Planning and development of this measure is assumed to require 320 hours of technical staff time.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

Multi-Family and ICI Sectors

Each multi-family/ICI irrigation system audit requires approximately 48 minutes of program staff time for marketing and scheduling appointments and 5.2 hours of technical staff time for conducting site visits, identifying potential improvements, and reporting findings, for a staff cost of $234 per audit. This staff time is similar to that used in Ref. J10.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

J.11. Irrigation System Incentives

Single-Family Sector

The incentive for a rotary spray head is $5. Denver Water offers the same rebate, and the Lower Colorado River Authority is planning to offer a $4 rebate (Ref. J6).

The incentive for a rainfall shutoff sensor is $50. Compare to rebates of $25 (McKinney), $50 (Austin, Allen, Plano, Fairview), or $75 (Round Rock).

Each incentive requires approximately 15 minutes of program staff time for processing of applications, for a staff cost of about $7 per incentive. Assuming 25 heads per participant (Ref. J6), the total cost for each incentive is about $132.

Planning and development of this measure is assumed to require 540 hours of technical staff time.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

Multi-Family and ICI Sectors

The incentive for a weather-based irrigation controller is $100, similar to Denver Water's $100 rebate. As in the residential sector, the incentive for a rainfall shutoff sensor is $50.

Each incentive requires approximately 15 minutes of program staff time for processing of applications, for a staff cost of about $7 per incentive. Therefore, the total cost for each incentive is about $107.

Planning and development of this measure is assumed to require 540 hours of technical staff time.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

J.12. Rainwater Harvesting Incentives

Single-Family Sector

The incentive for a residential rainwater harvesting system is calculated from the following formula:

Unit cost ($/gal) = 0.06500 * storage (gal) ^ (0.53534) * roof area (sq. ft.) ^ (0.55178)

For a 550 gallon tank and a roof area of 1,750 square feet, this is about $0.21 per gallon, or a rebate of $117. Austin offers $0.50 to $1.00 per gallon, depending on the system design.

Each incentive requires approximately 45 minutes of program staff time for processing of applications and 1 hour of technical staff time for installation verification, for a staff cost of about $63 per incentive. Therefore, for a 550 gallon system, the total cost for an incentive is about $180.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

ICI Sector

The incentive for a commercial rainwater harvesting system is calculated from the following formula:

Unit cost ($/gal) = 0.01757 * storage (gal) ^ (0.51463) * roof area (sq. ft.) ^ (0.68914)

with a maximum rebate of $5,000. For a 15,000 gallon tank and a roof area of 50,000 square feet, this would be about $0.29 per gallon, or a rebate of $4,287. Austin offers $0.50 to $1.00 per gallon, depending on the system design.

Each incentive requires approximately 45 minutes of program staff time for processing of applications and 8 hours of technical staff time for installation verification, for a staff cost of $346 per incentive. Therefore, for a 550 gallon system, the total cost for an incentive is $4,633.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

J.13. Irrigation Limits: Maximum 2 Times per Week

It is assumed that the cost to TRWD to develop the ordinance and encourage its wholesale customers to adopt the ordinance is $200,000 in staff time for existing TRWD staff members. Developing this ordinance is an intensive process requiring much coordination with the wholesale customers.

The experiences of the Cities of Austin and Los Angeles were used to project the level of enforcement effort required to enforce a twice-weekly irrigation limit.

City of Austin Enforcement

Austin has implemented frequency limits on its customers according to different water management conditions:

- Permanent: Commercial and multi-family residential customers limited to twice per week.
- Stage 1 (May through September): Single-family residential customers limited to twice per week.
- Stage 2 (when the combined lake storage levels of Lake Travis and Lake Buchanan reach 900,000 acre-feet): All customers limited to once per week.

Recently, Austin has had the following watering restrictions:

- Stage 1: May 1, 2011 through September 5, 2011
- Stage 2: September 6, 2011 through July 15, 2012
- Stage 1: July 16, 2012 through September 3, 2012
- Stage 2: Began September 4, 2012.

Austin Water employees patrol the city to identify violations and respond to citizen tips, support enforcement proceedings, and handle variance requests. In 2011, the City of Austin used the following employees for enforcement (Ref. J11):

- Patrol: 2 FTEs and 1 temporary employee year-round. Temporary employees and overtime pay for existing Austin Water employees in the summer.
- Support: 3 FTEs

Typical estimated enforcement costs associated with these employees range from $320,000 to $380,000 per year. Since Austin has approximately 200,000 water accounts, this range corresponds to $1.60 to $1.90 per account per year. Two factors may make this a somewhat high estimate for the TRWD service area:

- Austin was in Stage 2 during part of 2011. Austin's Stage 2 is a more restrictive condition than that proposed for TRWD, and Austin expended additional enforcement effort to achieve compliance with the once weekly irrigation limit.
- Austin currently uses a court-based enforcement method, which requires substantial staff time for testimony and documentation. As discussed in Section 11.6, a service rule enforcement method is recommended in the TRWD service area. The Southern Nevada Water Authority member agencies use this enforcement method, and Austin is considering code revisions to move toward service rule enforcement (Ref. J12).

City of Los Angeles Enforcement

In response to the California drought, Los Angeles amended its Water Conservation Ordinance on August 14, 2008 to add permanent water waste prohibitions and to restrict irrigation frequency during new "conservation phases." The Los Angeles Department of Water and Power (LADWP) implemented Phase III of its Water Conservation Ordinance, which limits irrigation for all customers to two days per week, on June 1, 2009.

LADWP uses 15 FTEs to enforce the water waste prohibitions and irrigation limits (Ref. J13). Assuming program staff salary of $61,224 per year (as discussed in an earlier section), this would correspond to an enforcement budget of about $918,000, or about $1.35 per account per year.

TRWD Customer Cities Enforcement

It is assumed that the wholesale customer enforcement costs are $1.35 per water account per year. In year 2013, it is projected that there will be about 630,000 single-family, multi-family, and ICI accounts, for an enforcement cost of about $850,000.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

J.14. Public Education (ET Watering Requirements)

Purchase of a complete weather station and LoggerNet 4.1 datalogger support software will cost about $5,921 (Ref. J14). It is assumed that installing the weather station and the software will also cost $5,921. Based on $800 annual calibration cost (Ref. J14), $240 annual phone line cost (Ref. J14), and assumed additional annual operating costs of 10 percent of the purchase cost, annual operating costs will be $1,632.

Analysis of the weather data and distribution of associated recommended watering times requires approximately 8 hours per week of technical staff time, for an annual staff cost of $16,837.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

J.15. Golf Course Conservation and Reuse

Planning and development of this measure is assumed to require 320 hours of technical staff time. Recruiting participants and reviewing participant records requires approximately 160 hours of technical staff time each year, for an annual staff cost of $6,476.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

Natural Implementation of Golf Course Reuse

Reclaimed water use at the Ditto Golf Course or Texas Star Golf Course has already been implemented, so there is no additional cost to TRWD or its wholesale customers.

J.16. Model Landscape Ordinance

It is assumed that the cost to TRWD to develop the ordinance and encourage its wholesale customers to adopt the ordinance will be approximately $200,000 in staff time for existing TRWD staff members. Developing this ordinance is an intensive process requiring much coordination with the wholesale customers.

It is also assumed that wholesale customers will review plans and inspect installations using 6 hours of technical staff time (about $243) for each new ICI or multi-family landscape and 6 hours of technical staff time for each group of 5 new single-family landscapes. Based on these costs and projected growth, it is projected that the potential wholesale customers' enforcement costs in 2013 are about $773,000 in technical staff time.

Enforcement costs could be reduced if one or more of the following methods are used instead of inspecting each new landscape:

- Require contractors to certify compliance.
- Require a licensed landscape architect to certify compliance.
- Conduct random spot checks of landscape installations.

However, reducing the number of inspections may also reduce compliance.

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

J.17. Water Loss Reduction

Developing and presenting an annual water loss workshop to the wholesale customers requires approximately 500 hours of technical staff time, for an annual staff cost of $20,236. It is anticipated that bringing in experts in different aspects of water loss reduction to assist with the workshops will cost an additional $10,000 per year. This measure also includes the purchase of $75,000 worth of leak detection equipment for use by TRWD's wholesale customers and $30,000 per year in funding for leak detection technical training.

Since the estimated water use reduction would result from improvements to the water treatment and distribution system upstream of the retail customer, there is no benefit from avoided wastewater treatment.

J.18. Water Use Reduction Due to Increase in Real Price

There is no cost to TRWD or its wholesale customers for this measure, since the retail customers decrease their water use on their own initiative in response to real price increases.

It is anticipated that water use reductions will result from changes to all manner of water uses. Therefore, it is assumed that 58.1 percent (100 percent minus 41.9 percent, the five-year average seasonal water use from Figure 4-5) of the estimated water use reduction will result from changes in indoor water use. Therefore, the benefit from avoided wastewater treatment is applied to 58.1 percent of the estimated water savings.

J.19. Wholesale Customer Assistance

The annual cost for each incentive is $300 per acre-foot of actual water savings (Ref. J6). Each incentive requires annual staff time of approximately 2.8 hours of technical staff time per acre-foot of water savings for review of conservation achievements and confirmation of water savings, for a staff cost of about $113 per incentive. Therefore, the total annual cost for this measure is about $413 per acre-foot of actual water savings. It has been assumed that the lifetime cost of each incentive (annual cost * measure life) is budgeted during the year that the incentive is given.

Planning and development of this measure is assumed to require 320 hours of technical staff time.

It is anticipated that water use reductions will result from changes to all manner of water uses. Therefore, it is assumed that 58.1 percent (100 percent minus 41.9 percent, the five-year average seasonal water use from Figure 4-5) of the estimated water use reduction will result from changes in indoor water use. Therefore, the benefit from avoided wastewater treatment is applied to 58.1 percent of the estimated water savings.

J.20. Model Conservation Ordinance

It is assumed that the cost to TRWD to develop the ordinance and encourage its wholesale customers to adopt the ordinance is approximately $300,000 in staff time for existing TRWD staff members. Developing this ordinance is an intensive process requiring much coordination with the wholesale customers.

San Antonio Water System Enforcement

The experience of the San Antonio Water System (SAWS) was used to project the level of enforcement effort necessary to enforce a water conservation ordinance (Ref. J15).

SAWS uses the following approximate staffing levels for enforcement:

- 0.25 FTE to send out reminder letters about the large property irrigation system checkup requirement and then process the irrigation checkups as they are submitted.
- Currently no FTEs are dedicated to enforcing the cooling tower requirements. To date, customer that work with the customer service department to document appropriate cycles of concentration are eligible for a special sewer rate. SAWS is considering mandatory cooling tower registration and may dedicate time for compliance spot checks in the future.
- Up to 2.5 FTEs (actually five police officers that work no more than 1,000 hours per year) patrol the city for water waste, help with customer education, and write citations where necessary. SAWS uses a court-based compliance method. In non-drought years, the officers work less than 1,000 hours per year.
- 0.80 FTE to provide administrative follow-up on commercial water waste complaints and support of the police officers.
- Most of the other requirements of San Antonio's water conservation ordinance fall under inspections by existing FTEs in other city departments.

In summary, SAWS uses up to 3.5 FTEs for enforcement of the water conservation ordinance. SAWS has approximately 363,000 connections, or almost 104,000 connections per enforcement FTE. Extrapolating this example to the TRWD service area, and adding additional time for spot checks of cooling tower compliance, suggests as many as 7 FTEs for 2013.

Large Property Annual Irrigation System Analysis

Since the estimated water use reduction would result from changes in outdoor water use and since there is no flow to the wastewater treatment plant from outdoor water use, there is no benefit from avoided wastewater treatment.

Commercial Dining Facility Requirements

Wholesale customers will use existing staff (health inspectors, building inspectors, etc.) to identify existing dining facilities without positive shutoffs on rinse valves and without flow restrictors on garbage disposals and to enforce provisions for new dining facilities.

Minimum Number of Cooling Tower Cycles

A local building or plumbing inspector would determine the presence of conductivity controllers and makeup and blowdown meters prior to occupancy or after improvements. Local utility personnel would verify operation at four or more cycles of concentration by evaluating makeup and blowdown meter data or by measuring the conductivity of the makeup and blowdown water. It is anticipated that enforcement personnel would conduct spot checks rather than attempting to review every cooling tower every year.

Condensate Collection for New Construction

Wholesale customers will use existing staff (e.g., building inspectors) to enforce provisions for condensate collection for new construction.

No benefit from avoided wastewater treatment has been credited.

Based on the assumptions described above and using the SAWS experience, the potential wholesale customers' enforcement/review cost for 2013 for the model water conservation ordinance is about $477,000. These costs are based on enforcing the entire San Antonio water conservation ordinance. Depending on which elements are actually selected for the TRWD model water conservation ordinance measure and how they are implemented, the potential enforcement costs may vary.

In addition, enforcement costs could potentially be reduced with a service rule enforcement model.

Appendix J References

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J15. Personal communication with Karen Guz, San Antonio Water System Water Conservation Manager, December 15, 2011.

Appendix K:
Customer Water Conservation Program Survey

Water Conservation Program Survey

Tarrant Regional Water District is in the final stages of completing a 5 year strategic water conservation plan with Alan Plummer and Associates. Part of this plan includes several water conservation programs to be implemented over the next 5 years. In order to prioritize the recommended conservation programs so TRWD customers receive the most benefit, we are asking you to complete this short survey to let us know which conservation measures, programs, or incentives are already being implemented in your community.

Please return this survey by February 24 to Dean Minchillo by email, fax, or mail:
Email: dean.minchillo@trwd.com
Fax: 817.720.4398
Mail: TRWD, attention Dean Minchillo, 800 E. Northside Drive, Fort Worth, Texas, 76102

Yes	No	Conservation Program	Comment/Addition Information
		Conservation education: ☐ Brochures ☐ Bill Stuffers/inserts ☐ Mail-outs ☐ Workshops ☐ Presentations ☐ Media messages (TV, Newsprint, Magazines) ☐ Other: ____________________________	
		No outdoor watering between 10 and 6	
		Water conservation product give-away or rebates: low-flow showerheads, faucet aerators, shower timers, leak detection kits, other.	
		Low-flow toilet rebates, giveaways, incentives	
		Irrigation system checkups, evaluations or audits (commercial and/or residential)	
		Irrigation system retrofit rebates: spray heads, controllers, pressure regulation, rain sensors, other	
		Industrial, institutional, commercial water audits (indoor and outdoor)	
		Pre-rinse spray valves	
		Native landscape/turf replacement rebates or incentives	
		Clothes washer rebates or incentives	

		Landscape ordinance for new development	
		Rainwater collection or rain barrel rebates, giveaways, incentives	
		Water conservation rate structure (increasing block rate)	Number of tiers: Highest rate per 1000 gallons:
		Water loss inspection and repair program	
		Water waste ordinance?	
		Number of conservation staff:	Part-time: Full-Time:

Survey completed by: ____

Community completed for: ____

TRWD Customer Water Conservation Program Survey

Entity	Conservation Education							10 to 6 Time-of-Day Watering	Giveaways/Rebates	High-Efficiency Toilets	Irrigation System Checks	Irrigation System Retrofits	CII Audits	Spray Valves	Native Plant Turf Rebates	Clothes Washers	Landscape Ordinance	Rainwater Collection	Rate Structure		Water Loss Inspection	Water Waste	Number of Conservation Staff		Comments and Additional Information
	brochures	bill incerts	mail-outs	workshops	presentations	media	other												Tiers	Highest per 1000			Part Time	Full Time	
Aledo, City of	x	x						yes	no	no	no	no	no	no	no	no	yes	no	yes		yes	yes	0	0	
Arlington, City of	x	x	x	x	x	x	x	yes	yes*	yes	yes	no	no	no	no	no	no	yes	5	4.08	no	no		1	Showerheads by exchange only, shower timers and leak tabs at events. 6 "make a barrel" events in last 2.5 years.
Azle, City of	x	x				x		yes	no	no	no	no	no	no	no	no	yes	no	3	5.10	yes	yes	0	0	10 till 8
Benbrook, City of								no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	0	0	See Benbrook Water Authority
Bethesda WSC			x				x	yes	yes	no	no	no	no	no	no	no	no	no	yes		yes	no		21	I believe the staff number is everyone in the office.
Burleson, City of	x	x			x			yes	no	no	no	no	no	no	no	no	yes	no	3	4.75	no	yes	0	0	Brochures handed out; messages on utility bills; presented at Rotary Club
Edgecliff Village, Town of	x	x	x				x	yes	no	no	no	no	yes	no	no	no	yes	no	yes		yes	yes		4	
Euless, City of	x	x				x		yes	no	no	no	no	no	no	no	no	yes	no	5	4.96	no	yes	1		
Grand Prairie, City of	x	x	x	x	x	x	x	yes	yes	no	yes	yes	no	no	no	no	yes	yes	3	5.43	yes	yes		1	
Hurst, City of		x				x	x	yes	no	no	no	no	no	no	no	no	yes	no	no		yes	yes	1		
Keller, City of	x	x						no	no	no	no	no	no	no	no	no	no	no	6	5.33	no	no	1		
Kennedale, City of	x	x	x		x			yes	no	no	no	no	no	no	no	no	yes	no	no		no	no	0	0	
North Richland Hills, City of	x	x	x		x	x	x	yes	yes*	no	no	no	yes	no	no	no	yes	no	2	3.84	yes	no	0	0	WaterWise Program and educational booths. CII audits are indoor only.
Northlake, Town of		x						yes	no	no	no	no	no	no	no	no	yes	no	3	4.95	yes	yes	0	0	
Richland Hills, City of		x						yes	no	no	no	no	no	no	no	no	yes	no	?		yes	yes	0	0	
River Oaks, City of		x		x	x	x		no	no	no	yes	no	yes	no	no	no	yes	no	yes		yes	yes	7		
Saginaw, City of	x	x			x		x	yes	no	no	yes	no	yes	no	no	no	yes	no			yes	no		5	
Southlake, City of	x		x	x	x	x	x	yes	yes*	no	yes	yes	no	no	no	no	yes	no	5	4.42	yes	yes	0.05		Moisture meters, spray nozzle, shower timer. Water waste in ordinance.
Trophy Club MUD 1	x	x	x	x	x			yes	yes	no	yes	no	no	no	no	no	no	no	5	3.50	no	yes			
Westover Hills, Town of				x	x			no	no	no	no	no	no	no	no	no	no	no	4	5.25	yes	no	0	0	
Westworth Village, City of		x						yes	no	no	no	no	no	no	no	no	yes	no	2	3.97	no	no	0	0	

* See comments and additional information.

Did Not Receive Completed Surveys from:

Benbrook Water Authority
Crowley, City of
Dalworthington Gardens, City of
Everman, City of
Forest Hill, City of
Haltom City, City of
Haslet, City of
Johnson County SUD
Lake Worth, City of
Lakeside, City of
Pantego, Town of
Roanoke, City of
Sansom Park, City of
Trophy Club, City of
Watauga, City of
Westlake, City of
White Settlement, City of

Appendix L:
Projected Benefits of Downsizing/Deferring Planned Future Water Supplies

L. Projected Benefits of Downsizing/Deferring Planned Future Water Supplies

The 2011 Region C Water Plan (Ref. 1) recommends several future TRWD water supply sources (described in Section 5.3). Of these future sources, the following projects (with associated implementation dates) are currently not in the design and/or construction phases:

- 2030: Marvin Nichols Reservoir (Phase 1)
- 2050: Marvin Nichols Reservoir (Phase 2)
- 2050: Toledo Bend Reservoir (Phase 1), and
- 2060: Oklahoma water

With implementation of the recommended water conservation measures, either TRWD's share of these projects could be downsized or entire projects could be deferred. Cost information for these supplies is shown in Table L-1.

Since water demands and water savings were only projected through 2060, and since the downsizing benefit was reported for each water conservation measure, the downsizing benefit used in the benefit-cost analysis in Section 10.5 and Appendix M only considers avoided costs through 2060. This level of detail is sufficient to identify cost-effective water conservation measures and to prioritize their implementation, but it does not include avoided costs over the life cycle of the downsized/deferred facilities.

A more complete opinion of the avoided costs from downsizing/deferring future water supply facilities is presented in the following sections. The avoided costs are presented as totals by future water supply project and by TRWD customer but are not broken down by water conservation measure. [57]

L.1. Projected Benefit of Downsizing of Future Water Supplies

During a severe drought, it is assumed that irrigation- and cooling-related water conservation savings will be 80 percent of those shown in Table 10-3 (see discussion on page 103). Therefore, with implementation of the recommended water conservation strategies, TRWD's share of the future sources could potentially be downsized by as much as the following amounts (Table L-1):

- Marvin Nichols Reservoir (Phase 1) – 34.0 percent,
- Marvin Nichols Reservoir (Phase 2) – 3.5 percent,
- Toledo Bend Reservoir (Phase 1) – 3.5 percent, and
- Oklahoma water – 13.5 percent.

[57] Avoided costs presented in this appendix are only for examining the cost-effectiveness of the overall recommended implementation plan and should not be used for design or construction of water supply facilities.

Assuming a real discount rate of 3 percent per year (Refs. 32 and 33) and comparing the impact of downsizing the projects over 50 years of project operations,[58] the projected present value of downsizing these future projects is approximately $670 million (Table L-1). This benefit includes projected debt service and operating costs. Further assuming that similar per capita water savings occur in each TRWD customer service area, the projected benefit is broken down by primary customer (Table L-2).[59]

L.2. Projected Benefit of Deferring Future Water Supplies

During a severe drought, it is assumed that irrigation- and cooling-related water conservation savings will be 80 percent of those shown in Table 10-3 (see discussion on page 103). Therefore, with implementation of the recommended water conservation strategies, each of the planned future supplies could potentially be deferred by as many as 9 years.

Assuming a real discount rate of 3 percent per year (Refs. 32 and 33) and comparing the impact of deferring the projects over 50 years of project operations, the projected present value of deferring these future projects is approximately $777 million (Table L-1). This benefit includes projected debt service and operating costs. Further assuming that similar per capita water savings occur in each TRWD customer service area, the projected benefit is broken down by primary customer (Table L-3).

Overall, the projected benefit from deferring the future water supplies is about 16 percent greater than the projected benefit from downsizing the future water supplies. However, construction of these water supplies is expected to be a cooperative effort between TRWD and other agencies (Section 5.3). Since these agencies may have urgent water needs, TRWD may not be able to defer construction.

[58] The useful life of some of the transmission facilities.

[59] No population projections were available beyond 2060 for the primary customers. Therefore, for each customer, it was assumed that the ratio of the customer service population to the total “Big 4” customer service population remains fixed at its projected 2060 value after 2060.

Table L-1: Projected Benefits of Downsizing/Deferring Planned Future Water Supplies

	Project Information	Planned Future Water Supplies[a]					
		2030 Marvin Nichols Reservoir Phase 1	**2050** Marvin Nichols Reservoir Phase 2	**2050** Toledo Bend Reservoir Phase 1	**2060** Oklahoma Water	**Total**	**Notes**
[A]	Annual Yield[a] (ac-ft/yr)	140,000	140,000	100,000	50,000	430,000	
	Annual Costs[a] ($/mg)						
[B]	Debt Service[b]	$2,531	$1,452	$2,354	$2,109		
[C]	Power	$556	$556	$944	$401		
[D]	O&M	$293	$166	$289	$280		
[E]	Raw Water Purchase	$0	$0	$106	$158		
[F]	*Subtotal*	*$3,380*	*$2,174*	*$3,692*	*$2,948*		[B]+[C]+[D]+[E]
[G]	Projected Water Savings During a Severe Drought[c] (mgd)	42.5	50.0		56.0		
[H]	Incremental Water Savings[d] (mgd)	42.5	7.5		6.0	56.0	
[I]	Incremental Water Savings[d] (ac-ft/yr)	47,648	8,395		6,747	62,790	[H]*conversion factors
[J]	Potential Downsize Percentage[e]	34.0%	3.5%	3.5%	13.5%	14.6%	[I]/[A] for each year
[K]	Present Value of Downsizing[f,g] ($ millions)	$592	$21	$26	$31	$670	
[L]	Potential Deferral[e] (yrs)	9	9	9	9		
[M]	Present Value of Deferral[f] ($ millions)	$406	$143	$174	$54	$777	

[a] Planned future water supplies, annual yields, and unit costs taken from Ref. 1. Unit costs shown in 2011 dollars.
[b] Assumes debt financed at 6 percent per year for 30 years, as in Ref. 1.
[c] Assumes that only 80 percent of the average irrigation- and cooling-based water savings are realized during a severe drought.
[d] For 2030, projected water savings since implementation of the Strategic Plan. For successive years, projected water savings since the last project.
[e] Based on implementation of the recommended water conservation measures. The potential downsize percentages and deferral years are preliminary estimates for use in examining the cost-effectiveness of the overall water conservation implementation plan and should not be used for design or construction of water supply facilities.
[f] Comparison made after 50 years of operation of each project, since this is the useful life of the some of the transmission facilities. Assumes that full usage of Marvin Nichols Reservoir (Phase 1), Marvin Nichols Reservoir (Phase 2), and Toledo Bend Reservoir (Phase 1) is phased in over 20 years. Assumes that full usage of Oklahoma water is phased in over 10 years. Assumes a real discount rate of 3 percent per year. Benefits shown as present values in 2011 dollars.
[g] In Table 10-6, the comparison is made in 2060 without regard to the life of the each project. This results in a somewhat lower estimate of the avoided costs from downsizing planned future water supplies; however, this level of detail is sufficient to identify cost-effective water conservation measures and to prioritize their implementation.

Table L-2: Projected Downsizing Benefits by Primary Customer

Customer	Projected Benefits ($ millions)				
	2030 Marvin Nichols Reservoir Phase 1	2050 Marvin Nichols Reservoir Phase 2	2050 Toledo Bend Reservoir Phase 1	2060 Oklahoma Water	Total
Arlington	$100.4	$3.1	$3.7	$4.3	$111.6
Mansfield	$45.0	$1.4	$1.7	$2.0	$50.0
TRA	$27.2	$1.0	$1.2	$1.4	$30.8
Fort Worth	$419.4	$16.0	$19.4	$23.3	$478.0
TOTAL	$592.0	$21.4	$26.0	$31.0	$670.4

NOTES:
1. Based on implementation of the recommended water conservation measures. Benefits shown as present values in 2011 dollars.
2. Total benefits from Table L-1.
3. Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4. Fort Worth information includes its wholesale customer service area.

Table L-3: Projected Deferral Benefits by Primary Customer

Customer	Projected Benefits ($ millions)				
	2030 Marvin Nichols Reservoir Phase 1	2050 Marvin Nichols Reservoir Phase 2	2050 Toledo Bend Reservoir Phase 1	2060 Oklahoma Water	Total
Arlington	$68.9	$20.6	$24.9	$7.5	$121.9
Mansfield	$30.9	$9.3	$11.3	$3.4	$54.9
TRA	$18.7	$6.6	$8.0	$2.5	$35.7
Fort Worth	$287.9	$106.6	$129.3	$40.3	$564.0
TOTAL	$406.3	$143.0	$173.5	$53.7	$776.5

NOTES:
1. Based on implementation of the recommended water conservation measures. Benefits shown as present values in 2011 dollars.
2. Total benefits from Table L-1.
3. Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4. Fort Worth information includes its wholesale customer service area.

Appendix M:
Breakdown of Projected Benefits from the Recommended Implementation Plan by Primary Customer

M. Breakdown of Projected Benefits from the Recommended Implementation Plan by Primary Customer

Since water demands and water savings were only projected through 2060, and since the downsizing benefit was reported for each water conservation measure, the downsizing benefit used in the benefit-cost analysis in Section 10.5 only considers avoided costs through 2060.[60] This level of detail is sufficient to identify cost-effective water conservation measures and to prioritize their implementation. With the assumption that each city experiences the same per capita water savings for each recommended measure, the following tables break down by primary customer the projected long-term benefits from the recommended implementation plan (Table 10-6).

[60] An analysis that considers project life cycles is presented in Appendix L.

Projected Water Savings, 2013-2060
TRWD Strategic Water Conservation Plan
(million gallons)

WATER SAVINGS	Arlington	Mansfield	TRA	Fort Worth*	Total
Active Measures	68,844	17,418	31,024	274,740	392,027
Passive Measures	91,818	22,986	42,759	360,365	517,928
TOTAL	**160,662**	**40,404**	**73,783**	**635,106**	**909,955**

Present Value of Avoided Costs, 2013-2060
TRWD Strategic Water Conservation Plan
($ million)

ALL MEASURES	Arlington	Mansfield	TRA	Fort Worth*	Total
Water Treatment O&M	$29.367	$11.728	$14.253	$169.251	$224.599
Wastewater Treatment O&M	$11.332	$2.734	$5.110	$46.286	$65.462
Raw Water Power	$26.153	$6.219	$12.035	$98.302	$142.708
Operating Subtotal	*$66.851*	*$20.681*	*$31.397*	*$313.839*	*$432.768*
Debt Service	$87.178	$23.162	$39.833	$383.185	$533.358
TOTAL	**$154.029**	**$43.843**	**$71.230**	**$697.025**	**$966.127**

ACTIVE MEASURES ONLY	Arlington	Mansfield	TRA	Fort Worth*	Total
Water Treatment O&M	$12.824	$5.163	$6.062	$74.923	$98.973
Wastewater Treatment O&M	$0.867	$0.191	$0.393	$3.307	$4.758
Raw Water Power	$11.476	$2.733	$5.183	$43.433	$62.825
Operating Subtotal	*$25.166*	*$8.088*	*$11.638*	*$121.664*	*$166.555*
Debt Service	$32.255	$8.783	$14.443	$145.422	$200.903
TOTAL	**$57.422**	**$16.870**	**$26.081**	**$267.086**	**$367.458**

PASSIVE MEASURES ONLY	Arlington	Mansfield	TRA	Fort Worth*	Total
Water Treatment O&M	$16.543	$6.565	$8.190	$94.328	$125.626
Wastewater Treatment O&M	$10.465	$2.543	$4.717	$42.979	$60.704
Raw Water Power	$14.677	$3.486	$6.852	$54.869	$79.883
Operating Subtotal	*$41.685*	*$12.593*	*$19.760*	*$192.176*	*$266.213*
Debt Service	$54.922	$14.379	$25.390	$237.763	$332.455
TOTAL	**$96.607**	**$26.972**	**$45.150**	**$429.939**	**$598.668**

* Includes wholesale service area.

NOTES:

1) Avoided costs shown as present values in 2011 dollars. Assumes 3 percent annual real discount rate.
2) Avoided costs estimated through 2060.
3) Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4) The raw water power costs in 2011 dollars are $321/mg between 2013 and 2029 and $556/mg after 2030.
5) Avoided debt service costs based on downsizing TRWD's share of Marvin Nichols Reservoir by 19.7 percent, downsizing TRWD's share of the Toledo Bend Reservoir Phase 1 project by 9.5 percent, and downsizing TRWD's share of the Oklahoma water project by 16.1 percent.
6) Marginal unit costs for water and wastewater treatment are (2011 $/mg):

2011 MARGINAL UNIT COSTS	Arlington	Mansfield	TRA	Fort Worth	Overall
Water Treatment O&M	$390	$671	$408	$612	$546
Wastewater Treatment O&M	$322	$322	$322	$346	$337

Projected Water Savings, City of Arlington
TRWD Strategic Water Conservation Plan

WATER SAVINGS	2013 (mgd)	2014 (mgd)	2015 (mgd)	2016 (mgd)	2017 (mgd)	2013-2060 (mg)
Active Measures	0.12	2.93	3.09	3.34	3.56	68,844
Passive Measures	0.87	1.13	1.65	2.28	2.93	91,818
TOTAL	**0.99**	**4.06**	**4.74**	**5.62**	**6.49**	**160,662**

Present Value of Avoided Costs, City of Arlington
TRWD Strategic Water Conservation Plan
($ million)

ALL MEASURES	2013	2014	2015	2016	2017	2013-2060
Water Treatment O&M	$0.141	$0.537	$0.607	$0.696	$0.779	$29.367
Wastewater Treatment O&M	$0.057	$0.096	$0.134	$0.181	$0.229	$11.332
Raw Water Power	$0.110	$0.436	$0.494	$0.568	$0.638	$26.153
Operating Subtotal	*$0.307*	*$1.069*	*$1.234*	*$1.446*	*$1.646*	*$66.851*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$87.178
TOTAL	**$0.307**	**$1.069**	**$1.234**	**$1.446**	**$1.646**	**$154.029**

ACTIVE MEASURES ONLY	2013	2014	2015	2016	2017	2013-2060
Water Treatment O&M	$0.016	$0.382	$0.391	$0.410	$0.423	$12.824
Wastewater Treatment O&M	$0.000	$0.019	$0.022	$0.028	$0.036	$0.867
Raw Water Power	$0.013	$0.314	$0.322	$0.338	$0.349	$11.476
Operating Subtotal	*$0.029*	*$0.715*	*$0.735*	*$0.775*	*$0.809*	*$25.166*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$32.255
TOTAL	**$0.029**	**$0.715**	**$0.735**	**$0.775**	**$0.809**	**$57.422**

PASSIVE MEASURES ONLY	2013	2014	2015	2016	2017	2013-2060
Water Treatment O&M	$0.125	$0.155	$0.216	$0.287	$0.356	$16.543
Wastewater Treatment O&M	$0.057	$0.077	$0.112	$0.153	$0.193	$10.465
Raw Water Power	$0.096	$0.122	$0.171	$0.230	$0.288	$14.677
Operating Subtotal	*$0.278*	*$0.354*	*$0.499*	*$0.670*	*$0.837*	*$41.685*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$54.922
TOTAL	**$0.278**	**$0.354**	**$0.499**	**$0.670**	**$0.837**	**$96.607**

NOTES:
1) Avoided costs shown as present values in 2011 dollars. Assumes 3 percent annual real discount rate.
2) Avoided costs estimated through 2060.
3) Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4) The raw water power costs in 2011 dollars are $321/mg between 2013 and 2029 and $556/mg after 2030.
5) Avoided debt service costs based on downsizing TRWD's share of Marvin Nichols Reservoir by 19.7 percent, downsizing TRWD's share of the Toledo Bend Reservoir Phase 1 project by 9.5 percent, and downsizing TRWD's share of the Oklahoma water project by 16.1 percent.
6) Marginal unit costs for water and wastewater treatment are (2011 $/mg):

2011 MARGINAL UNIT COSTS	Arlington
Water Treatment O&M	$390
Wastewater Treatment O&M	$322

Projected Water Savings, City of Mansfield
TRWD Strategic Water Conservation Plan

WATER SAVINGS	2013 (mgd)	2014 (mgd)	2015 (mgd)	2016 (mgd)	2017 (mgd)	2013-2060 (mg)
Active Measures	0.02	0.48	0.52	0.58	0.63	17,418
Passive Measures	0.12	0.16	0.25	0.37	0.49	22,986
TOTAL	**0.14**	**0.64**	**0.77**	**0.94**	**1.12**	**40,404**

Present Value of Avoided Costs, City of Mansfield
TRWD Strategic Water Conservation Plan
($ million)

ALL MEASURES	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.031	$0.145	$0.168	$0.199	$0.229	$11.728
Wastewater Treatment O&M	$0.009	$0.016	$0.023	$0.031	$0.040	$2.734
Raw Water Power	$0.015	$0.069	$0.080	$0.095	$0.110	$6.219
Operating Subtotal	*$0.055*	*$0.229*	*$0.271*	*$0.325*	*$0.379*	*$20.681*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$23.162
TOTAL	**$0.055**	**$0.229**	**$0.271**	**$0.325**	**$0.379**	**$43.843**

ACTIVE MEASURES ONLY	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.004	$0.108	$0.113	$0.121	$0.128	$5.163
Wastewater Treatment O&M	$0.000	$0.003	$0.004	$0.005	$0.006	$0.191
Raw Water Power	$0.002	$0.052	$0.054	$0.058	$0.062	$2.733
Operating Subtotal	*$0.007*	*$0.163*	*$0.171*	*$0.184*	*$0.196*	*$8.088*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$8.783
TOTAL	**$0.007**	**$0.163**	**$0.171**	**$0.184**	**$0.196**	**$16.870**

PASSIVE MEASURES ONLY	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.027	$0.036	$0.055	$0.077	$0.100	$6.565
Wastewater Treatment O&M	$0.009	$0.013	$0.019	$0.026	$0.034	$2.543
Raw Water Power	$0.013	$0.017	$0.026	$0.037	$0.048	$3.486
Operating Subtotal	*$0.049*	*$0.066*	*$0.100*	*$0.141*	*$0.182*	*$12.593*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$14.379
TOTAL	**$0.049**	**$0.066**	**$0.100**	**$0.141**	**$0.182**	**$26.972**

NOTES:

1) Avoided costs shown as present values in 2011 dollars. Assumes 3 percent annual real discount rate.
2) Avoided costs estimated through 2060.
3) Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4) The raw water power costs in 2011 dollars are $321/mg between 2013 and 2029 and $556/mg after 2030.
5) Avoided debt service costs based on downsizing TRWD's share of Marvin Nichols Reservoir by 19.7 percent, downsizing TRWD's share of the Toledo Bend Reservoir Phase 1 project by 9.5 percent, and downsizing TRWD's share of the Oklahoma water project by 16.1 percent.
6) Marginal unit costs for water and wastewater treatment are (2011 $/mg):

2011 MARGINAL UNIT COSTS	**Mansfield**
Water Treatment O&M	$671
Wastewater Treatment O&M	$322

Projected Water Savings, TRA Tarrant County System
TRWD Strategic Water Conservation Plan

WATER SAVINGS	2013 (mgd)	2014 (mgd)	2015 (mgd)	2016 (mgd)	2017 (mgd)	2013-2060 (mg)
Active Measures	0.06	1.35	1.42	1.53	1.63	31,024
Passive Measures	0.48	0.60	0.84	1.13	1.42	42,759
TOTAL	**0.54**	**1.95**	**2.26**	**2.66**	**3.05**	**73,783**

Present Value of Avoided Costs, TRA Tarrant County System
TRWD Strategic Water Conservation Plan
($ million)

ALL MEASURES	2013	2014	2015	2016	2017	2013-2060
Water Treatment O&M	$0.083	$0.273	$0.305	$0.347	$0.386	$14.253
Wastewater Treatment O&M	$0.026	$0.044	$0.061	$0.083	$0.105	$5.110
Raw Water Power	$0.059	$0.209	$0.235	$0.269	$0.300	$12.035
Operating Subtotal	*$0.168*	*$0.526*	*$0.602*	*$0.699*	*$0.791*	*$31.397*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$39.833
TOTAL	**$0.168**	**$0.526**	**$0.602**	**$0.699**	**$0.791**	**$71.230**

ACTIVE MEASURES ONLY	2013	2014	2015	2016	2017	2013-2060
Water Treatment O&M	$0.008	$0.184	$0.188	$0.197	$0.203	$6.062
Wastewater Treatment O&M	$0.000	$0.009	$0.010	$0.013	$0.016	$0.393
Raw Water Power	$0.006	$0.144	$0.148	$0.155	$0.160	$5.183
Operating Subtotal	*$0.014*	*$0.337*	*$0.346*	*$0.364*	*$0.379*	*$11.638*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$14.443
TOTAL	**$0.014**	**$0.337**	**$0.346**	**$0.364**	**$0.379**	**$26.081**

PASSIVE MEASURES ONLY	2013	2014	2015	2016	2017	2013-2060
Water Treatment O&M	$0.075	$0.089	$0.117	$0.151	$0.183	$8.190
Wastewater Treatment O&M	$0.026	$0.036	$0.052	$0.070	$0.089	$4.717
Raw Water Power	$0.053	$0.065	$0.087	$0.114	$0.140	$6.852
Operating Subtotal	*$0.154*	*$0.189*	*$0.256*	*$0.335*	*$0.412*	*$19.760*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$25.390
TOTAL	**$0.154**	**$0.189**	**$0.256**	**$0.335**	**$0.412**	**$45.150**

NOTES:

1) Avoided costs shown as present values in 2011 dollars. Assumes 3 percent annual real discount rate.
2) Avoided costs estimated through 2060.
3) Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4) The raw water power costs in 2011 dollars are $321/mg between 2013 and 2029 and $556/mg after 2030.
5) Avoided debt service costs based on downsizing TRWD's share of Marvin Nichols Reservoir by 19.7 percent, downsizing TRWD's share of the Toledo Bend Reservoir Phase 1 project by 9.5 percent, and downsizing TRWD's share of the Oklahoma water project by 16.1 percent.
6) Marginal unit costs for water and wastewater treatment are (2011 $/mg):

2011 MARGINAL UNIT COSTS	TRA
Water Treatment O&M	$408
Wastewater Treatment O&M	$322

Projected Water Savings, City of Fort Worth*
TRWD Strategic Water Conservation Plan

WATER SAVINGS	2013 (mgd)	2014 (mgd)	2015 (mgd)	2016 (mgd)	2017 (mgd)	2013-2060 (mg)
Active Measures	0.35	8.60	9.21	10.09	10.90	274,740
Passive Measures	2.09	2.89	4.46	6.43	8.53	360,365
TOTAL	**2.44**	**11.49**	**13.67**	**16.52**	**19.43**	**635,106**

Present Value of Avoided Costs, City of Fort Worth*
TRWD Strategic Water Conservation Plan
($ million)

ALL MEASURES	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.515	$2.352	$2.714	$3.180	$3.625	$169.251
Wastewater Treatment O&M	$0.176	$0.304	$0.428	$0.588	$0.755	$46.286
Raw Water Power	$0.270	$1.233	$1.425	$1.672	$1.909	$98.302
Operating Subtotal	*$0.961*	*$3.890*	*$4.567*	*$5.439*	*$6.289*	*$313.839*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$383.185
TOTAL	**$0.961**	**$3.890**	**$4.567**	**$5.439**	**$6.289**	**$697.025**

ACTIVE MEASURES ONLY	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.074	$1.761	$1.829	$1.942	$2.034	$74.923
Wastewater Treatment O&M	$0.000	$0.060	$0.069	$0.090	$0.119	$3.307
Raw Water Power	$0.039	$0.923	$0.960	$1.021	$1.071	$43.433
Operating Subtotal	*$0.112*	*$2.743*	*$2.858*	*$3.053*	*$3.224*	*$121.664*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$145.422
TOTAL	**$0.112**	**$2.743**	**$2.858**	**$3.053**	**$3.224**	**$267.086**

PASSIVE MEASURES ONLY	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.441	$0.591	$0.885	$1.237	$1.591	$94.328
Wastewater Treatment O&M	$0.176	$0.245	$0.359	$0.498	$0.637	$42.979
Raw Water Power	$0.231	$0.310	$0.465	$0.651	$0.838	$54.869
Operating Subtotal	*$0.849*	*$1.146*	*$1.709*	*$2.386*	*$3.066*	*$192.176*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$237.763
TOTAL	**$0.849**	**$1.146**	**$1.709**	**$2.386**	**$3.066**	**$429.939**

* Includes wholesale service area.

NOTES:
1) Avoided costs shown as present values in 2011 dollars. Assumes 3 percent annual real discount rate.
2) Avoided costs estimated through 2060.
3) Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4) The raw water power costs in 2011 dollars are $321/mg between 2013 and 2029 and $556/mg after 2030.
5) Avoided debt service costs based on downsizing TRWD's share of Marvin Nichols Reservoir by 19.7 percent, downsizing TRWD's share of the Toledo Bend Reservoir Phase 1 project by 9.5 percent, and downsizing TRWD's share of the Oklahoma water project by 16.1 percent.
6) Marginal unit costs for water and wastewater treatment are (2011 $/mg):

2011 MARGINAL UNIT COSTS	**Fort Worth**
Water Treatment O&M	$612
Wastewater Treatment O&M	$346

Projected Water Savings, TRWD Service Area
TRWD Strategic Water Conservation Plan

WATER SAVINGS	2013 (mgd)	2014 (mgd)	2015 (mgd)	2016 (mgd)	2017 (mgd)	2013-2060 (mg)
Active Measures	0.54	13.36	14.25	15.54	16.72	392,027
Passive Measures	3.56	4.79	7.19	10.20	13.38	517,928
TOTAL	**4.10**	**18.14**	**21.44**	**25.74**	**30.09**	**909,955**

Present Value of Avoided Costs, TRWD Service Area
TRWD Strategic Water Conservation Plan
($ million)

ALL MEASURES	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.770	$3.306	$3.794	$4.422	$5.019	$224.599
Wastewater Treatment O&M	$0.268	$0.461	$0.646	$0.884	$1.130	$65.462
Raw Water Power	$0.454	$1.947	$2.234	$2.604	$2.956	$142.708
Operating Subtotal	*$1.492*	*$5.714*	*$6.674*	*$7.910*	*$9.105*	*$432.768*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$533.358
TOTAL	**$1.492**	**$5.714**	**$6.674**	**$7.910**	**$9.105**	**$966.127**

ACTIVE MEASURES ONLY	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.102	$2.434	$2.521	$2.670	$2.788	$98.973
Wastewater Treatment O&M	$0.000	$0.090	$0.104	$0.135	$0.177	$4.758
Raw Water Power	$0.060	$1.433	$1.484	$1.572	$1.642	$62.825
Operating Subtotal	*$0.162*	*$3.958*	*$4.109*	*$4.377*	*$4.608*	*$166.555*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$200.903
TOTAL	**$0.162**	**$3.958**	**$4.109**	**$4.377**	**$4.608**	**$367.458**

PASSIVE MEASURES ONLY	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2060**
Water Treatment O&M	$0.668	$0.872	$1.273	$1.752	$2.231	$125.626
Wastewater Treatment O&M	$0.268	$0.371	$0.542	$0.749	$0.953	$60.704
Raw Water Power	$0.394	$0.514	$0.750	$1.032	$1.314	$79.883
Operating Subtotal	*$1.330*	*$1.756*	*$2.565*	*$3.533*	*$4.497*	*$266.213*
Debt Service	$0.000	$0.000	$0.000	$0.000	$0.000	$332.455
TOTAL	**$1.330**	**$1.756**	**$2.565**	**$3.533**	**$4.497**	**$598.668**

NOTES:

1) Avoided costs shown as present values in 2011 dollars. Assumes 3 percent annual real discount rate.
2) Avoided costs estimated through 2060.
3) Assumes that similar per capita water savings (gpcd) occur in each TRWD customer service area.
4) The raw water power costs in 2011 dollars are $321/mg between 2013 and 2029 and $556/mg after 2030.
5) Avoided debt service costs based on downsizing TRWD's share of Marvin Nichols Reservoir by 19.7 percent, downsizing TRWD's share of the Toledo Bend Reservoir Phase 1 project by 9.5 percent, and downsizing TRWD's share of the Oklahoma water project by 16.1 percent.
6) Marginal unit costs for water and wastewater treatment are (2011 $/mg):

2011 MARGINAL UNIT COSTS	**Overall**
Water Treatment O&M	$546
Wastewater Treatment O&M	$337

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Appendix N:
Data Collection and Management

N. Data Collection and Management

TRWD collected data necessary to evaluate the potential for TRWD water conservation from its four primary customers and their customers. These data are reported and analyzed in Chapter 4. Going forward, TRWD should continue to collect and maintain similar water conservation planning data.

During collection of data, the following issues became apparent:

- Planning data are collected from the wholesale customers only on an as-needed basis, and some planning data were not available.
- There are no standard protocols for calculating planning data, and some reporting procedures can be improved.
- There is no centralized database, and there are no standard formats for the exchange of planning data.

N.1. Data Collection

Currently, at the beginning of each planning project, water use data must be requested separately from each wholesale customer. Other data (such as demographic and land use data) must also be obtained from various sources. TRWD has been working to establish information collection procedures with the wholesale customers, but nonetheless, some utility profiles, water conservation plans, and water conservation implementation reports were not available. Additional effort is necessary to communicate the importance of participation in regional water conservation planning, to identify the "keepers of the data," and to establish routine data collection. Routine collection of planning data would mean that any time TRWD wanted to perform water conservation analysis, the necessary data would be available, and no additional requests for data would be necessary. In addition, TRWD would begin to develop a long historical record for the planning data, allowing identification and tracking of long-term trends.

N.2. Standard Protocols and Improved Reporting Procedures

Each wholesale customer tracks water use in different ways, using different calculation procedures. In addition, reporting procedures can be improved. As an example, the following issues were observed in the provided utility profiles:

- Some utility profiles were missing data.
- In different sections, the utility profile form 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 does not offer guidance on this point.

- The utility profile form requests monthly water diverted (or treated) for the last 5 years. Some utilities reported monthly water sales instead.
- It is not always clear whether multi-family residential water use is included in the residential sector or the commercial sector.
- 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.
- Reported water volumes on some of the utility profiles were internally inconsistent. Examples include:
    - More water sold than diverted. Several utilities reported one or more years where the water sold was greater than the water diverted (or treated).
    - “Water loss” less than the difference between water diverted (or treated) and water sold. As discussed above, part of the problem may be the inconsistency between labels and definitions on the utility profile form.
    - Total water diverted (or treated) is not always the same in both places where this information is requested.
- Reported numbers of connections on one utility profile were internally inconsistent. The total number of connections was reported, and percentages were reported for each water use sector, but the percentages did not add to 100 percent.

N.3. Centralized Databases

Once routine data collection is established and standardized calculation protocols and improved reporting procedures are established, TRWD will regularly receive a large amount of planning data. Establishment of centralized databases will assist in water conservation planning.

Standard Formats

Different utilities use different spreadsheet and database formats to track water use statistics and to store customer billing records, making it difficult to combine data into a centralized database. Files from different utilities may not have the same structure (field names, tracked quantities, time intervals, units, etc.). Even different files from the same utility may not have exactly the same structure. Some utilities do not store historical data for an extended period of time.

Additional effort is necessary to coordinate reporting of data from the wholesale customers in formats that TRWD can easily incorporate into centralized databases. Ideally, all wholesale customers would report data to TRWD using the same data formats, but this may not be feasible in the short-term. At a minimum, a given wholesale customer should report data using the same format from month to month, and TRWD may have to develop queries or procedures to transform the reported data into standard formats.

Suggested data types and file structures for the centralized database are shown in Section N.4.

Linkage of Water Use Data and GIS

TRWD should consider developing and maintaining a GIS water consumption database for use in targeting, tracking implementation, and assessing the effectiveness of water conservation measures. The GIS database would link retail customer billing records by account (monthly water use, customer type), appraisal district information by parcel (lot size, building age), U.S. Census information by Census block (persons per household), weather data (temperature, precipitation, evapotranspiration), utility data (water price), and aerial photographs.

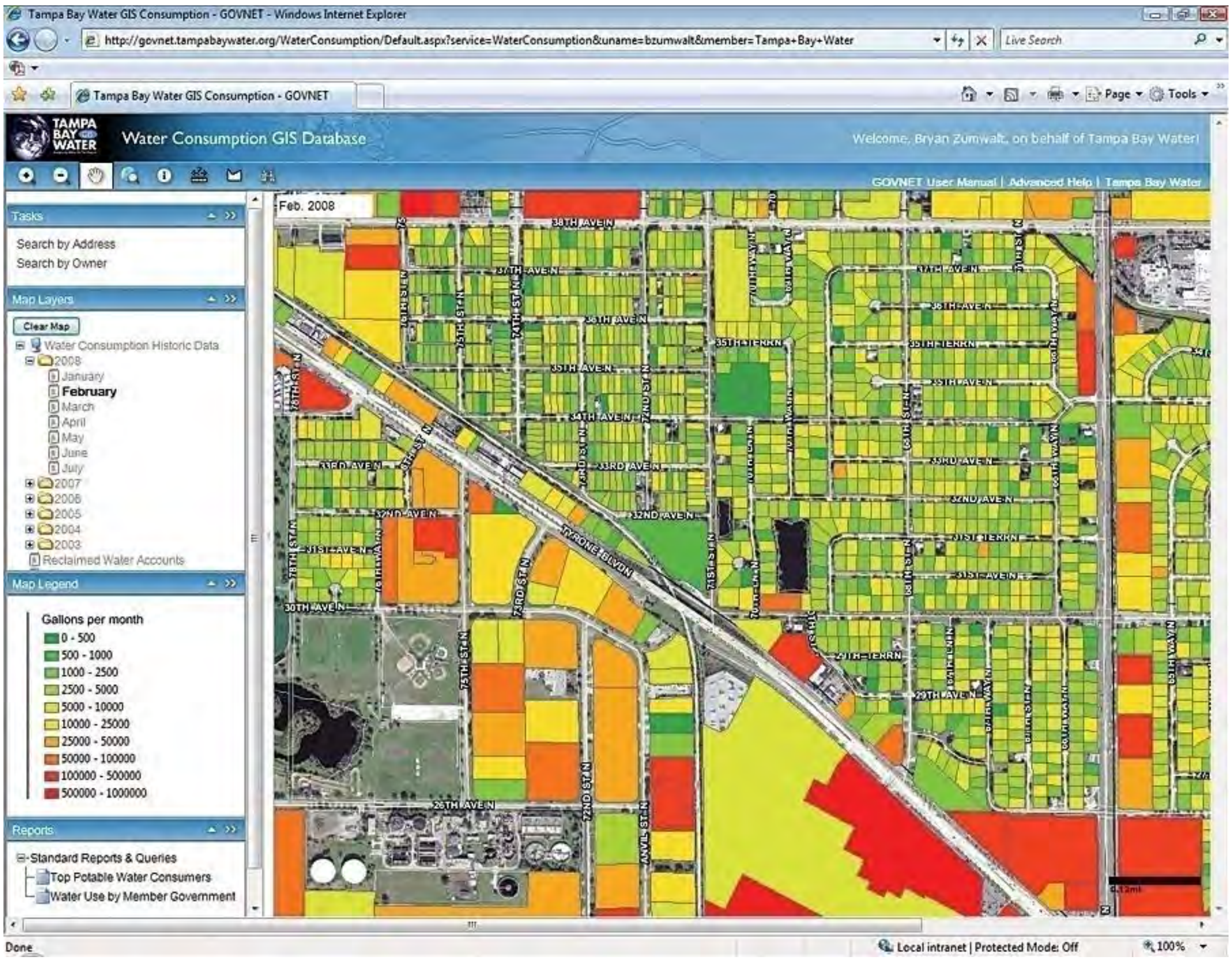
Development of a GIS water consumption database would be a long-term project, requiring extensive coordination with the wholesale customers to coordinate reporting of customer billing records on a monthly basis. The result would be an unparalleled tool for local water conservation planning and analysis, water demand forecasting, and water system planning. As an example of how this database could be used to further water conservation, consider accounts with excessive irrigation water use:

- Measure Targeting: Using the monthly water use records and the parcel sizes, TRWD would query the database to identify all accounts in the TRWD service area with seasonal water use that is much greater than turf grass water requirements (estimated from evapotranspiration data). TRWD or its wholesale customers would contact these customers and offer a free irrigation system evaluation to verify that the irrigation system is in proper working order, to check for leaks, to measure irrigation uniformity, to recommend a watering schedule that is appropriate for the site plant types and soil conditions, and to suggest other improvements that could increase irrigation efficiency and reduce water use and customer water bills. The recommendations from the irrigation system evaluation could lead the customer to participate in other irrigation conservation measures, such as incentives for smart irrigation controllers or other equipment upgrades.
- Implementation Tracking: TRWD would update and maintain data showing each customer that participated in the irrigation system evaluations (and other measures as applicable), the date that the evaluation was performed, and other relevant information.
- Effectiveness Analysis: After completion of the irrigation system evaluations, TRWD would track monthly water use for the participating customers, estimate water savings on a “before and after” basis, and estimate the cost-effectiveness of the irrigation system evaluations.

All of the targeting, tracking, and analysis in this example can be performed using existing tools and information, but the necessary data are currently scattered across many wholesale customer utilities and database formats, making a coordinated, efficient effort very difficult.

Tampa Bay Water (a regional water authority that provides potable water to approximately 2.5 million people) created a GIS water consumption database called GOVNET to analyze where and how potable water is used in the region (Figure N-1). The database consists of monthly customer billing data since 1998 from six retail water utilities with over a half million accounts, all geocoded to physical parcels. Using GOVNET, water conservation managers can "view, analyze, and query time-series water consumption data at various resolutions (regional, city, neighborhood, street, parcel)" and retrieve water demand charts, graphs, and statistics at user-defined intervals.

Figure N-1: Tampa Bay Water GOVNET Screen Shot



Source: ESRI, Tampa Bay Water Deploys GIS to Model Potable Water Distribution: ArcNews Online, Winter 2008/09, URL: http://www.esri.com/news/arcnews/winter0809articles/tampa-bay-water.html.

N.4. Suggested Data and File Structures for Centralized Database

The following tables are recommended to comprise the centralized water conservation GIS database:

- Customer Billing Account
- Customer Meter
- Customer Billing Consumption
- Water Audit
- Utility
- Water Supply
- Parcel
- Census Block
- Weather
- Evapotranspiration
- Land Use
- Demographic
- Water Rates

TRWD should begin to collect and maintain data for the centralized GIS water conservation database. TRWD should use a database program such as Microsoft Access to house the centralized database.

Data sources, recommended fields, and example values for selected fields are presented below for each table. For some tables, fields are identified that provide a linkage with other tables. For some tables, there is not a one-to-one relationship with records in other tables, and relationships to other tables are best developed using GIS.

Customer Billing Account

Data should be obtained from the individual wholesale customer utilities. Recommended fields and selected example values include:

- Utility Name
- Year
- Month
- Account Number
- Customer Name
- Street Number
- Street Prefix
- Street Name
- Street Suffix
- Apartment Number
- Zip Code
- Zip+4

- Customer Sector
    - Single-Family Residential
    - Multi-Family Residential
    - Commercial
    - Industrial
    - Irrigation
    - Municipal
    - Utility
- Customer Type
    - Apartment - Individual Metered
    - Apartment/Condo - Master Metered
    - Automobile Dealer
    - Bar
    - Cemetery/Agri Business
    - Church
    - Duplex - Individual Metered
    - Duplex - Master Metered
    - Factory/Manufacturer
    - Fire Station
    - Food And Kindred Processing
    - Hospital
    - Hotel/Motel
    - Laundry
    - Median Strip
    - Mobile Home - Individual Metered
    - Mobile Home - Master Metered
    - Multi-Family/Townhome - Master Metered
    - Office Building
    - Other Business
    - Park/Golf Course
    - Parking Lot
    - Portable Meter
    - Restaurant
    - Retail
    - Sandwich Shop
    - School
    - Service Station
    - Shopping Center/Mall
    - Single Family Residential
    - Unknown
    - Vacant Lot or Raw Land
    - Vehicle Servicing/Washing
    - Warehouse
    - Wholesale

- Asset Type
    - Business
    - Cooling
    - Domestic
    - Fireline
    - Lawn Irrigation/Swimming Pool
- Rate Class
- Meter Number

Customer Meter

Data should be obtained from the individual wholesale customer utilities. Recommended fields include:

- Utility Name
- Year
- Month
- Account Number
- Meter Number
- Meter Type
- Meter Size
- Meter Calibration Date
- Parcel ID Number (from Parcel Table)

Customer Billing Consumption

Data should be obtained from the individual wholesale customer utilities. Recommended fields include:

- Utility Name
- Year
- Month
- Account Number
- Meter Number
- Meter Read Date
- Consumption

Water Audit

Data should be obtained from the individual wholesale customer utilities. Recommended fields and selected example values include:

- Utility Name
- Year
- Month

- Use Category
  - System Input Volume
  - Billed Authorized Consumption
  - Unbilled Authorized Consumption
  - Apparent Loss
  - Real Loss
- Use Type
  - Billed Metered Consumption (should equal the sum of the reported customer billing data in the Customer Billing Consumption Table)
  - Billed Unmetered Consumption
  - Unbilled Metered Consumption
  - Unbilled Unmetered Consumption
  - Unauthorized Consumption
  - Customer Metering Inaccuracies
  - Systematic Data Handling Errors
  - Leakage
- Data Type
  - Measured
  - Estimated
  - Calculated
- Data Methodology
- Consumption

Utility

Data should be obtained from the individual wholesale customer utilities. Recommended fields include:

- Utility Name
- Year
- Month
- Number of Active Connections (should be consistent with the number of active connections in the Customer Billing Consumption Table)
- Number of Inactive Connections
- Miles of Distribution Main
- Average System Pressure

Water Supply

Data should be obtained from the individual wholesale customer utilities. Recommended fields and selected example values include:

- Utility Name
- Year
- Month

- Water Supply Source
    - TRWD
    - Trinity Aquifer
    - Dallas Water Utilities
    - Reuse
- Volume Supplied (volume supplied by TRWD should be consistent with data in the Other Water Use and Customer Billing Consumption Tables)

Parcel

Data should be obtained from county appraisal districts. Recommended fields include:

- Parcel ID Number
- Site Address
- Garage Capacity
- Bathrooms
- Year Built
- Living Area
- Swimming Pool
- Land Area
- Agricultural Area
- Block Group (from the Census Block Table)

Census Block

Data should be obtained from the U.S. Census Bureau. Recommended fields include:

- Census Date
- Block Group
- Total Population
- Median Family Income
- Households
- Block Group Area

Weather

Data should be obtained from NOAA weather stations. Recommended fields include:

- CoopID/WBAN
- Station Name
- Year
- Month
- Day
- Maximum Temperature
- Minimum Temperature

- Precipitation
- Wind Speed

Evapotranspiration

Data should be obtained from Texas ET Network stations. Recommended fields include:

- Station Name
- Month
- Year
- Month
- Day
- Potential Evapotranspiration of a Grass Reference Crop
- Maximum Temperature
- Minimum Temperature
- Minimum Relative Humidity

Land Use

Data should be obtained from the North Central Texas Council of Governments. Recommended fields and selected example values include:

- Land Use Date
- Land Use Code
- Sector
    - Airports
    - Commercial
    - Dedicated
    - Government/Education
    - Industrial
    - Infrastructure
    - Residential
    - Undeveloped
    - Water
- Land Use
    - Airports
    - Expanded Parking
    - Flood Control
    - Group Quarters
    - Hotel/Motel
    - Industrial
    - Institutional
    - Landfill
    - Large Stadium
    - Mixed Use
    - Mobile Homes

  - Multi-family
  - Office
  - Parking (CBD)
  - Parking Garage
  - Parks
  - Retail
  - Roadway
  - Runway
  - Single Family
  - Transportation
  - Under Construction
  - Utilities
  - Vacant
  - Water
- Land Use Area

Demographic

Data should be obtained from the North Central Texas Council of Governments, U.S. Census Bureau, and other sources. Recommended fields include:

- Utility Name
- Year
- Population Estimate
- Single-Family Housing Units Estimate
- Multi-Family Housing Units Estimate
- Other Housing Units Estimate
- Housing Units Constructed in 1994 or Earlier
- Employment
- Office and Industrial Space
- Real Area Gross Product

Water Rates

Data should be obtained from the individual wholesale customer utilities. Recommended fields and selected example values include:

- Utility Name
- Fiscal Year
- Type
  - Water
  - Wastewater
- Sector
  - Residential
  - Irrigation
  - Commercial

    - Industrial
    - Super User
    - Gas Well Use
    - Construction
- Location
    - Inside
    - Outside
- Tier
    - 1
    - 2
    - 3
    - 4
    - 5
- Volume Rate