REGION C WATER CONSERVATION AND REUSE STUDY

APRIL 2009

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Region C Water Planning Group
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1. Executive Summary

The Texas Water Code §11.002(8) [(1)] 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 or alternative uses." By this definition, it is clear that reuse of treated wastewater effluent is a water conservation measure. Reuse, which is also referred to as "recycled water" or "reclaimed water", is defined in Title 30, Chapter 210 of the Texas Administrative Code[(2)] as "domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use".

Conservation and reuse are major recommended strategies in the *2006 Region C Water Plan*[(3)]. Figure 1.1 is a map of the Region C Water Planning Area. Conservation and reuse represent approximately 1.3 million acre-feet per year of water supply to the region by 2060. This is a significant amount of water, and it is important that the projected water savings can reasonably be achieved within the timeframe specified in the Region C plan. This Conservation and Reuse Study was conducted as a special study for Region C to provide additional information on the performance of water conservation and reuse in the region and consider recommendations for the 2011 regional water plan.

The major components of the study included a survey of all water user groups and wholesale water providers, telephone interviews with selected providers, case studies of conservation practices for different size municipalities, and detailed updates of selected reuse projects. The study also examined the potential impacts of increased conservation and reuse on return flows, which may impact instream flows, and the potential impacts of future development patterns on conservation.

Approximately half of the water users surveyed provided information on their water conservation practices. Based on these data, it is clear that conservation and reuse continue to be a major focus for water providers in Region C. As with data collected for the *2006 Region*

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(1) Superscripted numbers in parenthesis match references in Appendix A.

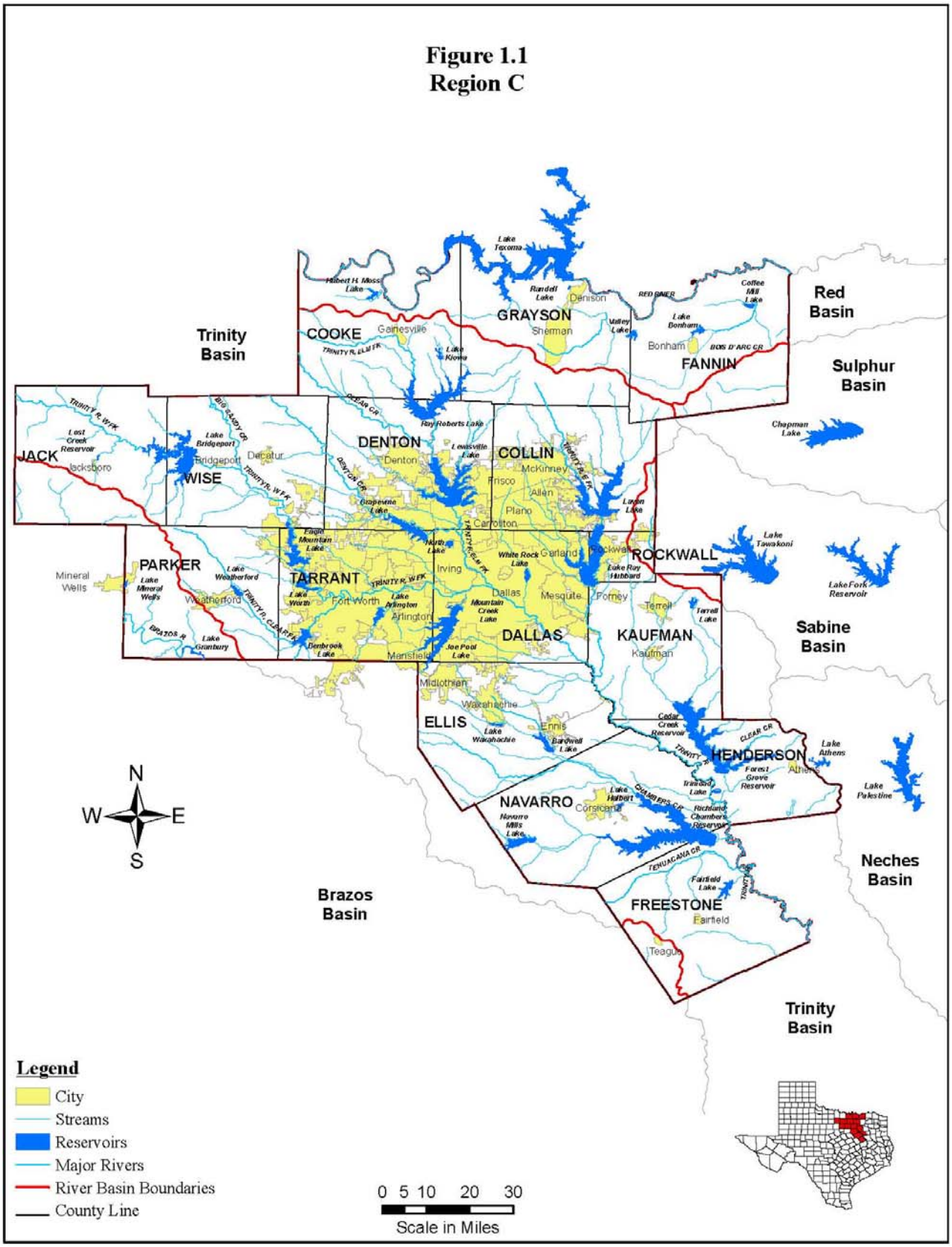


Figure 1.1
Region C
Trinity Basin
Red Basin
Sulphur Basin
Sabine Basin
Neches Basin
Brazos Basin
Trinity Basin
COOKE
GRAYSON
FANNIN
DENTON
COLLIN
ROCKWALL
JACK
WISE
PARKER
TARRANT
DALLAS
KAUFMAN
ELLIS
HENDERSON
NAVARRO
FREESTONE
Gainesville
Sherman
Denison
Bonham
Denton
McKinney
Frisco
Allen
Plano
Carrollton
Garland
Rockwell
Irving
Dallas
Mesquite
Forney
Terrell
Kaufman
Fort Worth
Arlington
Mansfield
Midlothian
Waxahachie
Ennis
Corsicana
Athens
Teague
Fairfield
Decatur
Bridgeport
Weatherford
Mineral Wells
Jacksboro
Lake Texoma
Ray Roberts Lake
Lewisville Lake
Grapevine Lake
Lake Lavon
Lake Tawakoni
Lake Fork Reservoir
Chapman Lake
Cedar Creek Reservoir
Richland Chambers Reservoir
Navarro Mills Lake
Lake Palestine
Forest Grove Reservoir
Fairfield Lake
Legend
City
Streams
Reservoirs
Major Rivers
River Basin Boundaries
County Line
0 5 10 20 30
Scale in Miles
N
W
E
S

C Water Plan, the conservation practices with the highest implementation rates included practices that are directly implemented by the provider and address system-wide savings, such as education programs, water pricing, water audits and enacting ordinances. These strategies were also consistently rated as the more effective conservation measures.

Compared to the recommendation in the *2006 Region C Water Plan*, the water providers in Region C are on-target or ahead of schedule for implementing the recommended conservation strategies. Public and school education programs, water waste prohibitions and residential audits each show increasing adoption rates among the survey sampling groups.

Strategies that are currently not being implemented (or not implemented by multiple providers) are rebate programs. Specifically, no provider reported implementing a rebate program for coin-operated clothes washers (commercial laundries), which is a recommended strategy for some providers in the 2006 Region C plan. Programs targeting industrial, commercial and institutional (ICI) water users generally have low implementation rates across the region. This may be in part because the providers do not perceive these strategies as being highly effective or because there are institutional challenges of administering these programs. There are a few providers that have begun to address Industrial/Commercial/Institutional (ICI) water conservation since the 2004 survey, and this is expected to continue to increase as ICI water use increases.

The data provided through the surveys and other sources were used to assess quantities of water saved. While the data did not allow calculations of water saved by Best Management Practices, the analysis did indicate that water conservation programs are reducing the water use that would have occurred without such measures. Seasonal outdoor water use continues to be a factor in water use in Region C and it is often targeted for conservation savings. Of ten selected cities that were not under drought restrictions, estimated outdoor water use decreased 3 percent between 2000 and 2006 while population growth increased by 26 percent. This indicates that the implemented water conservation practices are reducing outdoor water use. Longer historical records and additional data are needed to confirm these trends and provide reliable estimates of water savings.

Water providers in Region C are committing significant budget dollars for water conservation programs. Millions of dollars each year are used to promote water conservation through public and school education programs. Some entities are considering joining together

to promote water conservation with discussions of sharing implementation costs. Water audits and leak detection programs are also major budget expenditures for several providers. Comparison of costs estimated for the Region C plan indicates that the overall costs are fairly comparable. However, in some cases the costs for education programs are being expended by regional water providers (such as North Texas Municipal Water District and Tarrant Regional Water District) rather than the individual water user groups.

When evaluated at the individual city level, the selection and implementation of conservation practices appear to vary by size and location of the city. This is partly due to different budget levels and customer types. For small towns, budgets are limited and the Best Management Practices implemented are those that coincide with standard water system operation and maintenance (price increases, conservation pricing and leak detection and repair). These strategies have been shown to be effective for small towns. As the size of the city increases, the larger budgets and staff may allow increased focus on implementing additional conservation measures. Both the mid-size and large cities evaluated as part of the case studies employ (or plan to employ) education programs, water waste prohibition, residential customer audits, ICI audits and/or specific ICI conservation programs. These measures are in addition to those conservation measures implemented as part of standard operations. The large cities also targets outdoor water use through time of day watering restrictions and requiring rain/freeze sensors.

Reuse continues to be a major component of the region's water conservation plan. The *2006 Region C Water Plan* reported existing reuse of almost 100,000 acre-feet per year, with future reuse strategies totaling 771,000 acre-feet per year by 2060. Since the publication of the 2006 plan, one new reuse project has been implemented, and seven new projects (not included in the 2006 plan) have been identified. Considering the current and planned future projects, Region C has the largest reuse program in the state.

While the water providers in Region C are committed to implementing reuse projects, implementation issues continue to be a concern. Funding of the necessary infrastructure for recycled water projects and establishing policies and procedures for operation are two of the greatest challenges to implementing direct reuse projects. Indirect reuse projects pose different challenges. Often these projects require obtaining a State water rights permit, which

can be a time-consuming process. Water quality and accounting plans are frequently considerations in developing indirect reuse projects.

The region as a whole has embraced water conservation and reuse, and regional water providers are beginning to work together to further their conservation efforts and resulting benefits. The review of the conservation measures within the Dallas–Fort Worth area indicates there are opportunities to enhance the effectiveness of public education by increasing coordination of specific messages that are common across the region. Additionally, there are opportunities for entities to jointly participate in workshops or other venues to covey science and technologies and share successes of specific programs.

Evaluation of conservation programs is necessary to ensure continued use and success. Monitoring the implementation of water conservation strategies both from a qualitative and quantitative perspective is extremely important, and the monitoring approach needs to be on a consistent basis, not only across Region C, but across the state as well. In this regard, it is recommended that the region, in cooperation with the Texas Water Development Board and the Texas Commission on Environmental Quality, develop a voluntary data collection and management program to gather data and information about water savings and costs associated with individual water conservation strategies.

New technologies related to water conservation strategies continue to be developed, resulting in changes in how strategies are being implemented and in the development of new strategies. Region C water providers are encouraged to monitor these developments, and the implementation of the recommended strategies should include substitutions and/or adding new strategies to achieve targeted savings in an economical manner. Subsequent updates of the Region C Water Supply Plan should consider including newly developed strategies, as appropriate.

2. Introduction

2.1 Description of the Study

The State Regional Water Planning process requires that adopted Regional Water Plans be updated at least every five years. An update of the Region C Water Plan is currently underway and began with five special studies. One of these special studies is an evaluation of the effectiveness of water conservation and reuse strategies in Region C. Water conservation and reuse were major water management strategies in the *2006 Region C Water Plan*[3]. This study examines the initial performance of the water conservation and reuse strategies implemented within Region C.

2.2 Authorization and Objectives

In July 2007, the Region C Water Planning Group authorized Freese and Nichols, Inc. (FNI) and its sub-consultants to perform this study. The consultant team for this study consisted of FNI, Alan Plummer Associates Inc., and CP&Y, Inc. The objectives of this study are:

- Evaluate the initial performance of water conservation and reuse strategies within Region C.
- Encourage a consistent approach to water conservation across the Region.
- Update the recommendations for implementation of water conservation and reuse strategies.

2.3 Organization of the Report

This report follows the general format outlined below:

- Section 3 of this report gives background information on water conservation and reuse with regards to the last Region C Plan.
- Section 4 describes the process that was used to determine what current water conservation and reuse strategies are being practiced within Region C. It compares the current water conservation and reuse practices to what was recommended in the *2006 Region C Water Plan*.
- Section 5 is a discussion of the effectiveness of the current water conservation practices. The practices were evaluated based on the quantity of water saved, cost, public perception, ease of implementation (case studies), and the probability of achieving set goals.
- Section 6 is an expanded discussion of reuse within Region C.

- Section 7 summarizes the findings of this study.
- Section 8 presents other considerations that affect water conservation planning in Region C including future development patterns and how increased water conservation and reuse may affect downstream users and instream flows.
- Appendix A is a list of references that have been cited in the text through superscripted numbers in parentheses. The remaining Appendices present detailed information that is referred to throughout the text of the report.

3. Background

3.1 Water Conservation Strategies in 2006 Region C Water Plan

Water conservation has been a major component of the Region C Water Plans, including the first plan published in 2001 and the current 2006 plan. The Region C Water Planning Group continues to place strong emphasis on water conservation and reuse as a means of meeting projected water needs in the region.

As part of the development of the recommended water conservation strategies for the *2006 Region C Water Plan*, the region conducted a survey of conservation practices. That survey identified numerous strategies that were currently being used, with the most widely implemented strategies being water system audits, leak detection and repair, education programs and water conservation pricing.

In addition to the survey, Region C conducted an analysis of each of the Best Management Practices (BMPs) identified by the Water Conservation Task Force[(4)], considering cost, potential water savings and opportunities for implementation. Based on the findings from the conservation survey and the analysis of the conservation practices, the region developed two water conservation packages: Basic Water Conservation Package and Expanded Water Conservation Package.

The Basic Package reflects practices that were most likely to be implemented in the region and were cost effective for small and large water user groups. This package (in whole or in part) was recommended to be implemented by each municipal water user group in the region.

The Basic Water Conservation Package includes:

- Low-flow plumbing fixture rules
- Public and school education
- Water use reduction due to increasing water prices
- Water system audit, leak detection and repair, and pressure control
- New efficient residential clothes washer standards

Two of the water conservation practices included in the basic package are federally mandated initiatives that will reduce water use over time simply through the natural replacement of high water use fixtures. These initiatives are discussed below.

The Water Saving Performance Standards for Plumbing Act, implemented by Texas in

1992, prohibits the sale, distribution, or importation of plumbing fixtures that do not meet certain low-flow performance standards. The "low flow plumbing fixture rule" strategy assumes that all new construction will be built with water saving plumbing fixtures, and existing plumbing fixtures will be replaced over time with low flow fixtures. The water savings from this strategy were accounted for in the water demands developed by the Texas Water Development Board for Region C, and the total projected 2060 regional water demand is about 5 percent less than it would be without the Water Saving Performance Standards for Plumbing Act.

The second federal initiative requires residential clothes washers manufactured on or after January 1, 2004, to be 22 percent more energy-efficient than pre-2004 models and clothes washers manufactured on or after January 1, 2007, to be 35 percent more energy-efficient than pre-2004 models. The new energy standards are also projected to produce significant water conservation savings. The water savings associated with the replacement of clothes washers were assumed to occur over time with little to no action by the water user group.

The expanded water conservation package includes strategies that were slightly more costly to implement and demonstrated greater applicability to larger water user groups. The expanded package includes strategies for industrial, commercial and institutional facilities as well as wastewater reuse. All or part of the expanded conservation package is recommended in the *2006 Region C Water Plan* for 129 out of 271 municipal water user groups.

The Expanded Water Conservation Package consists of the Basic Water Conservation package, plus:

- Water conservation pricing structure
- Water waste prohibition
- Coin-operated clothes washer rebate
- Residential customer water audit
- Industrial, commercial, and institutional (ICI) general rebate
- Industrial, commercial, and institutional (ICI) water audit, water waste reduction, and site-specific conservation program
- Reuse of treated wastewater effluent (if applicable)

All of the recommended water conservation strategies were evaluated at the individual water user group (WUG) level. This includes water savings and costs. Water savings for wholesale water providers were estimated from the associated savings determined for their

customers. All costs for water conservation in the *2006 Region C Water Plan* were applied at the WUG level. In reality, some of the water conservation strategies, such as public and school education programs, are being implemented and financed both at the WUG level and by the wholesale water provider.

The development of the 2006 Region C water conservation strategies also included several assumptions on adoption rates and realization of full benefits over time. These assumptions varied by WUG, depending on current per capita water use (some BMPs were not recommended for entities with per capita water use at or below 140 gpcd), whether the strategy had already been adopted, and the applicability of the recommended strategy to the WUG. Generally, the strategies in the basic package were recommended for all WUGs with water use above 140 gpcd with full benefits being realized by 2020. The strategies in the expanded package were applied individually at the WUG level and were assumed to be implemented by 2020.

Detailed descriptions of each 2006 Region C recommended water conservation strategy are included in Appendix B.

3.2 Definitions

Gallons Per Capita per Day

"Gallons per capita per day" (gpcd) is a measurement of water use, and it is often used as a tool to assess changes in water use. However, depending on how gpcd is defined, its usefulness as a measuring tool can be limited.

There are several different approaches proposed to define "gpcd". The Texas Water Development Board has historically calculated a municipal gpcd indicator by this formula:

$$\text{GPCD} = \frac{\text{(water diverted and/or purchased)} - \text{(wholesale sales + industrial sales + power sales)}}{\text{Population of service area}}$$

This provides an estimate of municipal per capita water use that includes commercial, residential, some light industrial, institutional and in some cases, municipal golf course irrigation. This definition provides a historical context for water use for a single water provider and may be a reasonable tool to assess water conservation trends. It is not a good tool for comparing water usage between providers because of the potential different

percentages of non-residential water use. Even for a single provider, if there are significant shifts in development patterns or in the percentages of commercial/institutional water use to residential use, this measurement may not accurately reflect changes in water use due to conservation practices.

In 2004 the Water Conservation Implementation Task Force defined gpcd as:

$$\text{GPCD} = \frac{\text{(total water diverted and/or purchased)} - \text{(wholesale sales + indirect reuse)}}{\text{Population of service area}}$$

This definition takes into account reuse as a conservation strategy. However, this definition is not an effective tool to assess potential water reductions associated with conservation management strategies other than reuse. In particular, this approach includes industrial use in per capita figures, which renders the numbers all but meaningless, since industrial use is not at all related to population.

The current Water Conservation Advisory Council has also undertaken the challenge of identifying a measurement that can be used to accurately reflect water use by an entity. In its draft report to the Texas Legislature, the Council recommends identifying per capita usage by use type, such as residential, industrial, etc. This provides a tool that is more easily compared across different water providers. However, there is little historical data to date at this level of detail.

This conservation and reuse study used several different measurements of water use to assess historical water conservation savings in Region C. To clarify how gpcd was used in the assessment analyses the appropriate definition of gpcd is noted in the respective sections that use this tool. In some sections, projected estimates of per capita use were developed for comparison to the Region C water plan. These estimates were calculated by deducting the expected conservation savings from the projected water demand without conservation.

Best Management Practices (BMPs)

Best Management Practice (BMP) is a term used to describe individual water conservation strategies. As part of the work of the Water Conservation Task Force, 22 best management practices were identified and described in a report to the Texas Legislature[4].

In the *2006 Region C Water Plan* the recommended water conservation strategies

included twelve of the Task Force's BMPs, divided into two conservation packages: Basic and Expanded. BMPs are the individual strategies that comprise each package. In this study report, the term "BMP" and "water conservation strategy" are used interchangeably.

4. Identification of Current Water Conservation Practices

4.1 Data Collection

Data presented in this report comes primarily from surveys of water suppliers, telephone interviews with selected water suppliers, and other sources including Water Conservation and Drought Contingency Plans from water suppliers, TWDB historical water use records, and TCEQ water right database and historical wastewater return records.

Survey

The first task of this study was to determine what water conservation and reuse strategies are currently being practiced in Region C. This was accomplished through a survey. The survey asked for information regarding recent history of population and water use, current and future water conservation and reuse strategies, the effectiveness of the strategies (water savings realized, public perception, etc), what customer class was targeted with each strategy (residential, industrial, or commercial), and the cost of the strategies. Additional questions were asked regarding public outreach programs, water loss, updates to water conservation and drought contingency plans, and recent water rights permits. A copy of the survey is provided in Appendix C. On August 31, 2007, this survey was sent to the 35 wholesale water providers (WWPs) and the 235 water user groups (WUGs) in Region C. To help participants complete the survey, a list of the water conservation strategies (BMPs) from the *2006 Region C Water Plan*, with detailed descriptions of each BMP, were provided with the survey. The detailed descriptions of the BMPs are included in Appendix B.

Survey responses were received from 25 WWPs and 96 WUGs. An additional 17 WUGs returned the survey, but indicated that they were not involved in water supply activities and could not provide any data. Overall, the survey had a 51 percent response rate, with 71 percent of the WWPs and 48 percent of the WUGs (including the 17 WUGs who are not involved with water supply) responding. By comparison, previous surveys during preparation of the *2006 Region C Water Plan* received approximately a 60 to 70 percent response rate. To encourage the water providers to respond to this survey, entities who had not responded by the requested due date were contacted up to two times by phone to offer the consultant team's assistance.

Other Data Collection

Along with the returned surveys, many WWPs and WUGs included their current Water Conservation and Drought Contingency Plans. Information in these plans was used to supplement the survey responses. Historical water use data was also collected from the Texas Water Development Board (TWDB) for some entities. Water rights information and wastewater return flow information was collected from the Texas Commission on Environmental Quality (TCEQ).

Telephone Interviews

From among the 121 entities that returned completed surveys, 24 were selected to further query for more comprehensive cost and public education information related to the implementation of the water conservation BMPs. This query was accomplished through telephone interviews. In addition to the cost and public education questions, the respondents were also asked open-ended questions to identify which BMPs required the least amount of implementation effort or cost but proved the most effective. Lessons learned from the implementation of these water conservation measures were also requested. Table 4.1 includes a matrix summarizing the water providers contacted for this study, the number of customers they serve, and the BMPs they have implemented. Appendix D details the questions asked and the responses received from each provider. Appendix E lists some additional comments given by the water providers during the telephone interviews.

Table 4.1
Telephone Interview Matrix

	TYPE OF BEST MANAGEMENT PRACTICE	WATER USER GROUPS											WHOLESALE WATER PROVIDERS												
		CITY OF ALLEN	CITY OF ARLINGTON	CITY OF AUBREY	CITY OF AZLE	CITY OF CARROLLTON	CITY OF CHICO	CITY OF FRISCO	CITY OF LEWISVILLE	CITY OF MCKINNEY	CITY OF PLANO	CITY OF WYLIE	CITY OF DALLAS	CITY OF DENTON	CITY OF FORT WORTH	CITY OF MANSFIELD	CITY OF NORTH RICHLAND HILLS	CITY OF TERRELL	CITY OF WAXAHACHIE	CITY OF WEATHERFORD	ROCKETT SPECIAL UTILITY DISTRICT	NORTH TEXAS MUNICIPAL WATER DISTRICT	TARRANT REGIONAL WATER DISTRICT	TRINITY RIVER AUTHORITY OF TEXAS	UPPER TRINITY REGIONAL WATER DISTRICT
Basic Water Conservation Package	• Low-flow plumbing fixtures rules	x		x	x	x		x		x			x	x	x			x	x	x			x		
	• Public and school education	x	x			x	x	x	x	x	x		x	x	x	x	x	x		x		x	x		x
	• Water use reduction due to increasing water prices	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x	x					
	• Water system audit, leak detection and repair, and pressure control	x	x			x	x	x	x			x	x	x	x	x		x	x	x					
	• New efficient residential clothes washer standards	x												x	x				x				x		
Expanded Water Conservation Package	• Water conservation pricing structure	x	x			x	x						x	x	x	x		x		x	x				
	• Water waste prohibition	x				x		x	x	x	x		x	x	x	x									
	• Coin-operated clothes washer rebate																								
	• Residential customer water audit		x			x		x				x	x	x	x										
	• Industrial, commercial, and institutional (ICI) general rebate											x													
	• ICI water audit, water waste reduction, and site-specific conservation program				x								x												
	• Reuse of treated wastewater effluent				x			x	x				x	x	x							x	x		x
Other BMPs	• Rebate program for water efficient washing machines	x																							
	• Rain and freeze sensors		x							x		x													
	• ET irrigation controller rebates							x		x															
	2007 POPULATION PROJECTION	78,286	366,217	2,500	13,818	120,154	1,300	38,000	31,550	122,000	255,000	33,441	1,280,500	113,800	686,850	58,069	64,050	6,698	28,702	25,000	37,500	NOT REPORTED	NOT REPORTED	NOT REPORTED	NOT REPORTED

4.2 Best Management Practices in Region C

Survey Results

The data collected from the water conservation and reuse surveys is summarized in this section. Appendix F contains the full list of entities that responded to the survey and the BMPs implemented by each entity. Further analysis of the BMPs is included in Section 5 of this report. The majority of the questions in the survey were answered by most or all of the responders. However, a few questions went largely unanswered by the participants, resulting in little or no useful data in that area. Typically, participants were thorough in completing data on the retail population, system connections, and retail and industrial water usage. Almost every participant identified which water conservation BMPs were implemented or not implemented, and several additional BMPs not included in the Basic or Expanded packages were added as either implemented or under consideration by a few of the participants. However, very few of the participants were able to address the amount of water saved or the costs associated with each BMP because typically the water providers have not tracked this data or there is not an established method to quantify the water savings. Only about half of the participants who had implemented BMPs provided an assessment of the public's reaction to implementation.

Table 4.2 summarizes the data collected from the surveys regarding the implementation of the 2006 Region C recommended BMPs for Water Retailers. Water Retailers include WUGs and WWPs that sell retail water. This distinction was made because some BMPs are only appropriate for retail water providers. Of those who responded to the survey, 91 percent of the Water Retailers (102 out of 112) had implemented at least one of the BMPs recommended in the *2006 Region C Water Plan*. It was found that most BMPs are implemented at the Water Retailer level rather than by Regional Water Providers. In fact, only two BMPs have been implemented by Regional Water Providers - Public and School Education and Reuse. It should be noted, however, that the two Regional Water Providers who have these programs (Tarrant Regional Water District and North Texas Municipal Water District), operate two of the most expansive Public and School Education programs and Reuse programs in Region C. As shown in Figure 4.1, the most used BMPs are those involving price increases, audits and leak detection programs, public education efforts, and water

conservation pricing structure.

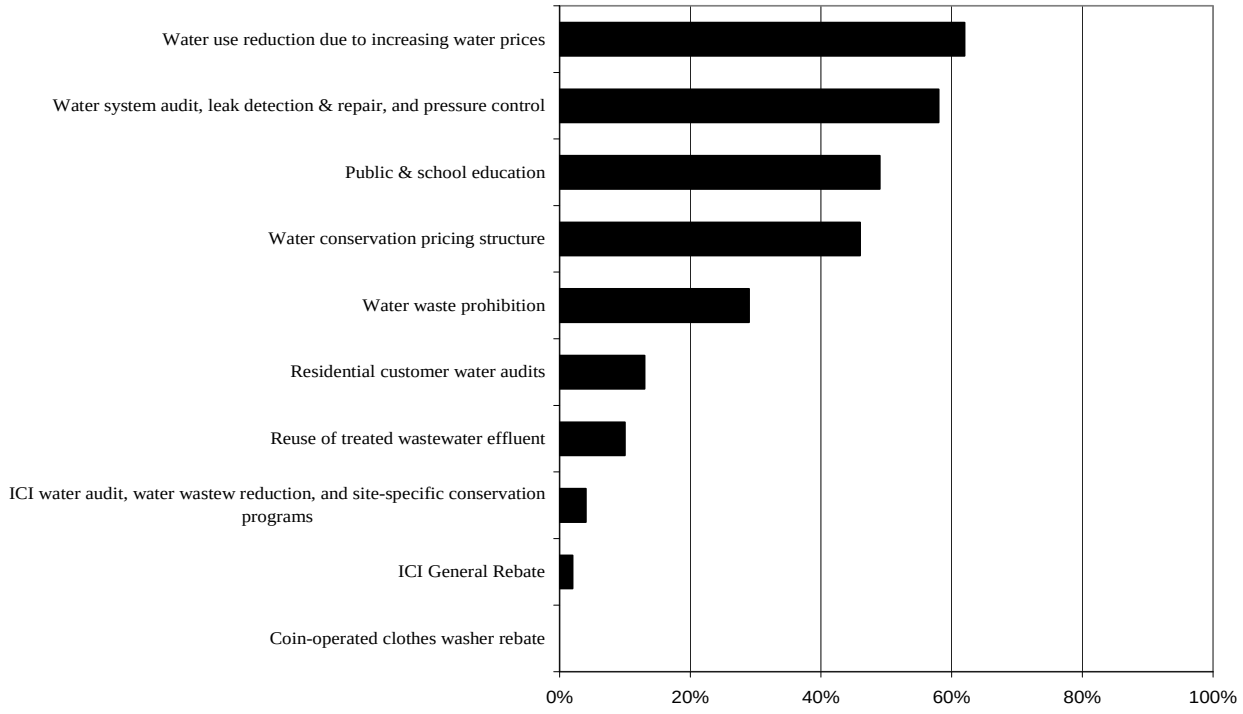
Table 4.2

BMP Response Data from Water Retailers

	Basic Package					Expanded Package						
	!Unexpected End of Formula Low-flow plumbing fixture rules	Public and school education	Water use reduction due to Increasing water prices	Water system audit, leak detection and repair, and pressure control	New efficient residential clothes washer standards	Water conservation pricing structure	Water waste prohibition	Coin-operated clothes washer rebate	Residential customer water audit	ICI general rebate	ICI water audit, water waste reduction, and site-specific conservation program	Reuse of treated wastewater effluent
BMP Implementation												
Implemented		49%	62%	58%		46%	29%	0%	13%	2%	4%	10%
Target Res.[(a)]		78%	84%	68%		71%	73%	0%	47%	0%	0%	18%
Target Ind.[(b)]		13%	43%	34%		37%	52%	0%	0%	0%	40%	27%
Target Comm.[(c)]		29%	61%	48%		49%	64%	0%	0%	0%	40%	45%
Target Inst.[(d)]		31%	48%	38%		43%	61%	0%	0%	0%	60%	27%
Level of BMP Effectiveness												
Very Effective	20%	9%	25%	31%	10%	33%	27%	0%	20%	0%	0%	45%
Somewhat Effective	61%	64%	45%	46%	60%	25%	45%	0%	60%	0%	20%	36%
Not Effective	2%	9%	13%	3%	20%	10%	9%	0%	7%	50%	0%	0%
No Response	16%	18%	16%	20%	10%	31%	18%	0%	13%	50%	80%	18%
Plans to Maintain Implemented BMP												
Yes		87%	86%	80%		71%	94%	0%	67%	50%	80%	73%
No		2%	0%	0%		0%	0%	0%	0%	0%	0%	0%
No Response		11%	14%	20%		29%	6%	0%	33%	50%	20%	27%
Would Consider Implementing BMP												
Yes		28%	30%	30%		33%	18%	17%	23%	18%	25%	20%
No		11%	9%	9%		7%	15%	23%	15%	22%	14%	20%
No Response		61%	60%	62%		61%	67%	60%	62%	60%	61%	60%
Public Reaction												
Favorable	7%	53%	7%	28%	0%	14%	33%	0%	47%	0%	20%	55%
Unfavorable	2%	0%	28%	0%	0%	18%	15%	0%	0%	0%	0%	0%
No Reaction	36%	13%	19%	23%	50%	16%	6%	0%	0%	50%	0%	0%
No Response	52%	33%	43%	48%	50%	49%	39%	0%	53%	50%	80%	45%

(a) Respondents indicated that the BMP was targeted to residential customers.
(b) Respondents indicated that the BMP was targeted to industrial customers.
(c) Respondents indicated that the BMP was targeted to commercial customers.
(d) Respondents indicated that the BMP was targeted to institutional customers.

Figure 4.1
BMP Implementation Rates by Water Retailers



Note: Implementation rates are based on the survey results. Actual implementation rates may differ.

It should be noted that even though the BMPs for "low-flow plumbing fixture rules" and for "new efficient residential clothes washer standards" were included in the survey, these BMPs are in effect already implemented for all entities because they are mandated by law. Therefore, these BMPs have not been included in portions of the analyses in this report. Only data collected on the perceived effectiveness of the strategy and public reaction was included in the survey results.

Survey responses also identified nine additional BMP strategies beyond the basic and expanded packages suggested for consideration. Six of these additional BMPs were implemented by at least one entity and three were listed as under consideration. Table 4.3 summarizes the survey responses for those additional BMP entries.

Table 4.3

Suggested BMPs

	No. of Entities Who Implemented	Effectiveness	Plan to maintain	Public Reaction
Evapotranspiration (ET) Irrigation Controllers	1	No Response	Yes	Favorable
Rain and Freeze Sensors	5	Somewhat Effective	3 of 5	3 Favorable, 1 Unfavorable, 1 No Response
Twice Per Week Irrigation	1	Very Effective	Yes	Unfavorable
Time of day water restrictions	1	Somewhat Effective	Yes	Favorable
Meter replacement program	1	Very Effective	Yes	Favorable
Even/Odd Watering Each Summer	1	Very Effective	Yes	No Response
Low-water landscape code and conversion incentives	See Note (a)			
High efficiency irrigation required and conversion incentives	See Note (a)			
Site Specific Conservation Program	See Note (a)			

(a) BMP was noted as being considered by a particular water provider, but has not been implemented.

Effectiveness Ratings of Implemented BMPs

Table 4.4 lists the types of implemented BMPs and the corresponding effectiveness ratings as determined by the surveyed entities. Based on Table 4.2, the most commonly implemented BMPs (those implemented by at least 45% of the respondents) are the five Basic Package BMPs and "Water conservation pricing structure". ("Low-flow plumbing fixure rules" and "New efficient residential clothes water standards" are assumed to be in effect for all entities.) Of those six BMPs, five of them received effectiveness ratings of 70% or above. They are as follows:

- Low-Flow Plumbing Fixture Rules
  - ✓ 82.2% rated this BMP as very effective or somewhat effective
- Water System Audit, Leak Detection and Repair, and Pressure Control

- ✓ 77.0% rated this BMP as very effective or somewhat effective

- Public and School Education
  - ✓ 73.7% rated this BMP as very effective or somewhat effective
- New Efficient Residential Clothes Washer Standards
  - ✓ 72.7% rated this BMP as very effective or somewhat effective
- Water Use Reduction due to Increasing Water Prices
  - ✓ 70.6% rated this BMP as very effective or somewhat effective

Table 4.4
BMP Effectiveness Ratings

Implemented BMPs	Very Effective (# of Entities/ % of Total)	Somewhat Effective (# of Entities/ % of Total)	Not Effective (# of Entities/ % of Total)	No Response (# of Entities/ % of Total)
Water Use Reduction due to Increasing Water Prices	17 (25%)	31 (46%)	9 (13%)	11 (16%)
Water System Audit, Leak Detection and Repair, and Pressure Control	20 (31%)	30 (46%)	2 (3%)	13 (20%)
Public and School Education	6 (11%)	36 (63%)	5 (9%)	10 (18%)
Water Conservation Pricing Structure	17 (33%)	13 (25%)	5 (10%)	16 (31%)
Low-Flow Plumbing Fixture Rules	10 (22%)	27 (60%)	1 (2%)	7 (16%)
Water Waste Prohibition	9 (27%)	15 (45%)	3 (9%)	6 (18%)
Residential Customer Water Audit	3 (20%)	9 (60%)	1 (7%)	2 (13%)
Reuse of Treated Wastewater Effluent	6 (46%)	4 (31%)	0 (0%)	3 (23%)
New Efficient Residential Clothes Washer Standards	2 (18%)	6 (55%)	2 (18%)	1 (9%)
ICI Water Audit, Water Waste Reduction, and Site-Specific Conservation Programs	0 (0%)	1 (20%)	0 (0%)	4 (80%)
Rain and Freeze Sensors	0 (0%)	5 (100%)	0 (0%)	0 (0%)
Time of Day Watering	0 (0%)	1 (100%)	0 (0%)	0 (0%)
ET Irrigation Controllers	0 (0%)	1 (50%)	0 (0%)	1 (50%)
Industrial, Commercial, and Institutional General Rebate	0 (0%)	0 (0%)	1 (50%)	1 (50%)
Meter Replacement Program	1 (100%)	0 (0%)	0 (0%)	0 (0%)
Even/Odd Watering Each Summer	1 (100%)	0 (0%)	0 (0%)	0 (0%)

Table 4.4 cont'd

Implemented BMPs	Very Effective (# of Entities/ % of Total)	Somewhat Effective (# of Entities/ % of Total)	Not Effective (# of Entities/ % of Total)	No Response (# of Entities/ % of Total)
Rebate Program for Residential Water Efficient Washing Machines*	1 (100%)	0 (0%)	0 (0%)	0 (0%)
Twice Per Week Irrigation	1 (100%)	0 (0%)	0 (0%)	0 (0%)

*Note: "Rebate Program for Residential Water Efficient Washing Machines" is a separate BMP from "Coin-operated clothes washer rebate". The entities implementing "Coin-operated clothes washer rebate" did not provide a rating for the effectiveness of that BMP.

Other Information

Information was also gathered from the 59 Water Conservation Plans that were submitted along with the surveys. Two additional entities submitted their conservation plan without returning a survey. These plans listed specific BMPs for each entity, some of which were not indicated on the entities' surveys. Information regarding the implementation of BMPs for this subset of water providers is shown in Table 4.5. Because most water conservation planning is carried out at the retail level, for the purpose of this comparison, any WWP who is also a retail provider (example, City of Dallas) was listed under the WUG section.

Table 4.5

Implemented Water Conservation Measures Based on Water Conservation Plans from 56 WUGs/ WWPs & 3 Regional Wholesale Water Providers

BMP	# of WUGs Implement-ing BMP	% Imple-mented	# of Regional Providers Implement-ing BMP	% Imple-mented
Public and school education	38	68%	3	100%
Water reduction due to increasing water prices	28	50%	1	33%
Water system audit, leak detection and repair, and pressure control	31	55%	1	33%
Water conservation pricing structure	25	45%	1	33%
Water waste prohibition	25	45%	0	0%
Coin-operated clothes washer rebate	0	0%	0	0%
Residential customer water audit	7	13%	0	0%
Industrial, commercial, and institutional (ICI) general rebate	1	2%	0	0%

Table 4.5 cont'd **BMP**	**# of WUGs Implement-ing BMP**	**% Imple-mented**	**# of Regional Providers Implement-ing BMP**	**% Imple-mented**
ICI water audit, water waste reduction, and site-specific conservation program	3	5%	0	0%
Reuse of treated wastewater effluent	9	16%	2	67%
ET Irrigation Controllers	1	2%	0	0%
Rain and freeze sensors	5	9%	0	0%
Time of day watering	1	2%	0	0%
Meter replacement program	1	2%	0	0%
Time of day water restrictions	2	4%	0	0%
Rebate program for water efficient washing machines	1	2%	0	0%

Water Right information was collected to determine what changes have been made since the *2006 Region C Water Plan*. The changes in water rights are summarized in Table 4.6. Many of these changes are related to reuse. A number of entities have applied for the right to use their own return flows. It should be noted that not all of the new water rights being sought are for 100% reliable supply.

Summary

The *2006 Region C Water Plan* recommended that all of the Water User Groups implement the Basic Water Conservation package by 2010. Based on the survey conducted for this study (see Table 4.2), currently 49% have adopted the Public and School Education BMP, 62% have adopted the Increasing Water Prices BMP, and 58% have adopted the BMP for Water system audit, leak detection and repair, and pressure control. However, when those not already implementing these BMP were asked if would consider implementing them, only about 10% indicated that they would not. (About 30% said they would consider it and about 60% did not respond to that question.) When those percentages are applied, that only leaves about 5% of those surveyed who would not consider implementing the Public and School Education program, 3% for Increasing Water Prices BMP, and 4% for Water system audit, leak detection and repair, and pressure control.

The *2006 Region C Water Plan* recommended that 48% of the Water User Groups implement the Expanded Water Conservation package (all or in part) by 2020. Based on the survey conducted for this study (see Table 4.2), currently 46% have adopted the Water Conservation Pricing Structure BMP and 29% have adopted the Water Waste Prohibition BMP. The other BMPs in the expanded package have only been implemented by less than 15% of the Water Retailers.

Based on these implementation rates, Region C appears to be on-target or ahead of the schedule laid out in the *2006 Region C Water Plan* for implementing conservation measures.

Table 4.6

Changes in Water Right Permits since the *2006 Region C Water Plan*

Entity	Type of Change	Body of Water	Amount (ac-ft/yr)	In 2006 Plan?	Details
City of Athens	Amendment	Lake Athens	2,677	Yes	Allows for transfer of 2,677 ac-ft/yr of treated wastewater from Trinity River Basin to Lake Athens in Neches River Basin for reuse.
City of Dallas	Amendment	Ray Roberts Lake; Lewisville Lake		No	Expands use type from municipal use to all uses.
	Amendment	Lewisville Lake	97,200	Only 67,253 af/y	Authorizes use of Dallas' own return flow
	Amendment	Lake Ray Hubbard	150,000	Only 67,253 af/y	Authorizes use of Dallas' own return flow
	Amendment	Elm Fork Run-of-the-river		No	Changes diversion location to upstream of Carrollton Lake
	Application to amend	Lake Ray Hubbard	119,600	No	Increase diversion from 89,700 ac-ft/yr to 209,300 ac-ft/yr
	Application to amend	Lake Ray Hubbard		No	Temporary overdraft during maintenance of WTP during drought
City of Denton	Intent to apply for amendment		13,446	No	Have plans to implement 12 MGD of Indirect Reuse
Tarrant Regional Water District	Purchase of existing Water Right (in process)	West Fork Trinity River	1,121	No	Acquiring existing water right from TXU; impoundment of 673 ac-ft; diversion of 11,210 ac-ft/yr; consumptive use of 1,121 ac-ft/yr for industrial use.

Table 4.6 cont'd

Entity	Type of Change	Body of Water	Amount (ac-ft/yr)	In 2006 Plan?	Details
	Application	Three Oklahoma river basins	460,000	Only 50,000 af/y in 2060	Seeking a water right permit to purchase water from Oklahoma
North Texas Municipal Water District	Amendment	Lavon Lake – East Fork Reuse Project	157,393	Only 102,000 af/y	Authorizes use of return flow. Diversions are limited to actual discharge from wastewater treatment plant.
	Amendment	Lavon Lake – Wilson Creek WWTP	35,941	Yes	Authorizes use of return flow. Diversions are limited to actual discharge from wastewater treatment plant.
	Application to Amend	Lavon Lake	14,670	Yes	Application is pending due to protests; additional yield per Water Availability Model.
North Texas Municipal Water District (Continued)	Issued Water Right	Lake Texoma	113,000	Yes	Permit issued in Nov 2006. Dependent on Contract from Corps of Engineers
	Pending Application	Lower Bois d'Arc Creek Reservoir	175,000	123,000 af/y	Application for new reservoir includes overdraft operation. Actual yield is 126,200 af/y. Application is in technical review stage.
	Issued new permit	Bed & banks		Yes	Authorized to use bed and banks to transport water purchased from Sabine River Auth. On an interim basis.

4.3 Reuse in Region C

Appendix G contains the reuse projects that were active at the time of the *2006 Region C Water Plan* as well as the Recommended Reuse Strategies from the Plan. Existing reuse projects as of the *2006 Region C Water Plan* accounted for almost 100,000 acre-feet per year of supply. If all of the Recommended Reuse Strategies are implemented, by 2060 there will be about 770,000 acre-feet per year of additional supply due to reuse projects.

Existing Direct Reuse Projects

The TCEQ regulates direct water reuse in Texas under Title 30, Part 1, Chapter 210 of the Texas Administrative Code. As part of this study, a telephone survey was conducted of all providers with Chapter 210 reuse authorizations in Region C. Information resulting from this survey is presented in Table 4.7. Note that only entities with existing Chapter 210 reuse

authorizations (as provided by the TCEQ) were contacted as part of the survey. Several of the projects listed in the 2006 Region C Plan could not be matched with an existing Chapter 210 authorization and therefore are not listed in Table 4.7. More detailed information on the Chapter 210 reuse provider responding to the survey is presented in Appendix H.

Table 4.8 is a summary of total reuse quantities by purpose for 2005 through 2007 for the providers listed in Table 4.7. The majority of the direct reuse water provided in Region C is used for steam electric power generation. Three reuse providers, the Cities of Denton, Garland, and Ennis collectively supplied over 9,000 ac-ft/yr to steam electric power generation in 2007.

Figure 4.2 shows a monthly distribution of direct reuse water for 2005 through 2007. The quantity of reuse water used during the summer months is over two times greater than the amount used in the winter months. From 2005 to 2007, more than 25,000 ac-ft/yr of reuse water were used between May and October. During those same years, only 10,000 ac-ft/yr of reuse water were used between November and April. This is primarily due to the increased amount of water required for irrigation during the summer months. The regional drought of 2006 also had a significant impact on reuse water demands in Region C. Reuse water usage during the summer of July 2006 was the highest experienced over the study period due to a heightened level of irrigation and power consumption.

Impacts of Direct Reuse Projects

While direct reuse water provides a constant source of supply, its application is highly seasonal, as evidenced in Figure 4.2. Direct reuse systems provide an effective and substantial means of conserving water supplies. Direct reuse systems that replace potable water result in immediate reductions in per capita potable water usage. The higher levels of reuse water usage experienced during drought periods also further aid in offsetting water supply requirements during these critical periods. The *2006 Region C Water Plan* estimated the projects included in this analysis would collectively provide 36,045 ac-ft/yr of water by the year 2010 (Table 4.8). Over the course of the period evaluated here (2005 through 2007), these projects collectively provided anywhere from 10,000 to 14,000 ac-ft/yr. While it is unlikely that these projects will reach their 2010 goals, significant opportunity for growth still exists.

Table 4.7
Reuse Quantities by Provider

Sponsor	Project	Use	2010 Estimate (2006 Plan) (ac-ft/yr)	2005 (ac-ft/yr)	2006 (ac-ft/yr)	2007 (ac-ft/yr)
NTMWD	Stewart Creek	Plant Irrigation	N/A	6.73	5.04	1.95
NTMWD	Rowlett Creek	Golf Course Irrigation (3)	1,540	383.65	422.59	140.06
NTMWD	Buffalo Creek	Golf Course Irrigation	672	187.69	244.99	145.77
NTMWD	Royce City	Golf Course Irrigation	112	112.26	129.00	0.00
***NTMWD Subtotal*[1]**			***2,324***	***690.33***	***801.62***	***287.78***
TRA	Las Colinas	Irrigation	8,000	1,684.41	2,192.30	227.16
TRA	Ten Mile Creek	Irrigation	N/A	41.93	46.06	13.42
TRA Subtotal			***8,000***	***1,726.34***	***2,238.36***	***240.58***
Garland	Forney	Steam Electric Power	8,979	6,522.64	8,015.82	7,997.97
Garland Subtotal			***8,979***	***6,522.64***	***8,015.82***	***7,997.97***
Fort Worth	Waterchase Golf	Golf Course Irrigation	897	438.12	594.36	304.78
Fort Worth Subtotal			***897***	***438.12***	***594.36***	***304.78***
Dallas	Cedar Crest	Golf Course Irrigation	561	250.61	232.28	166.04
***Dallas Subtotal*[2]**			***561***	***250.61***	***232.28***	***166.04***
Ennis	Tractabel	Steam Electric Power	3,363	707.59	706.13	861.27
Ennis Subtotal			***3,363***	***707.59***	***706.13***	***861.27***
Gainesville	Keneteso Park	Irrigation	9	11.05	11.05	11.05
Gainesville Subtotal			***9***	***11.05***	***11.05***	***11.05***
The Colony	Stonebriar Country Club	Golf Course Irrigation	380	114.96	326.28	180.23
The Colony Subtotal			***380***	***114.96***	***326.28***	***180.23***
Frisco	The Trails of Frisco	Golf Course Irrigation	307	320.04	356.92	257.96
Frisco Subtotal			***307***	***320.04***	***356.92***	***257.96***
Lewisville	Castlehills Golf Course	Golf Course Irrigation	897	383.05	379.03	210.46
Lewisville Subtotal			***897***	***383.05***	***379.03***	***210.46***
Denton	City of Garland	Steam Electric Power	3,363	388.15	644.24	172.78
Denton	Oakmont Country Club	Golf Course Irrigation	800	309.54	232.61	118.56
Denton	Various	Irrigation	6,165	64.49	106.98	82.08
Denton Subtotal			***10,328***	***762.18***	***983.83***	***373.41***
TOTAL[3]			**36,045**	**11,927**	**14,646**	**10,892**

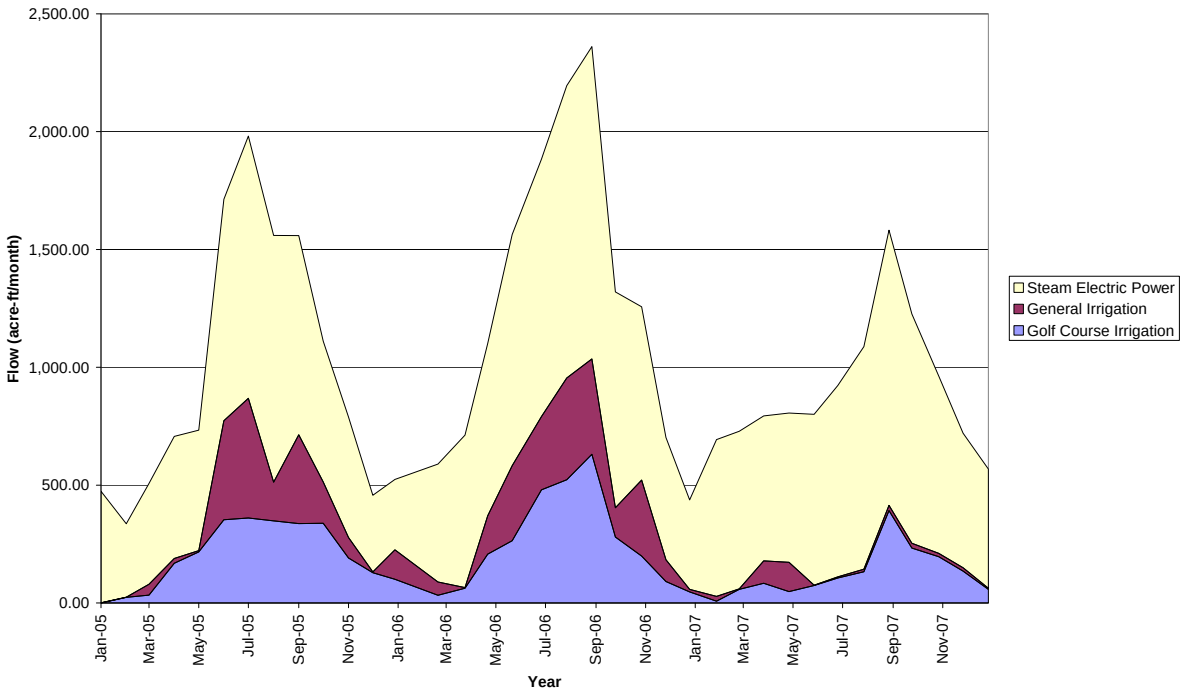
[1] Flow quantities for the Trails of Frisco are listed under Frisco. NTMWD provides the reuse water from its Stewart Creek WWTP.
[2] Flow quantities were not available from January –March 2005 for Dallas.
[3] Flow quantities were not available for Millsap ISD and Crandall during the study period.

The primary obstacles hindering the growth of direct reuse systems in Region C are the initial capital costs required to build the necessary infrastructure and securing new customers. In order to continue advancing direct reuse systems with the region, continued emphasis will need to be placed on identifying means for financing these systems and continuing to educate potential users and the public about the benefits of water reuse.

Table 4.8
Reuse Quantities by Purpose of Use

Use	2010 Estimate (2006 Plan) (ac-ft/yr)	2005 (ac-ft/yr)	2006 (ac-ft/yr)	2007 (ac-ft/yr)
Golf Course Irrigation	6,161	2,500	2,918	1,524
General Irrigation	14,163	1,809	2,361	336
Steam Electric Power	15,692	7,618	9,366	9,032
TOTAL	**36,045**	**11,927**	**14,646**	**10,892**

Figure 4.2
Reuse Quantities by Purpose of Use by Month



New Projects and Future Projects

As part of the conservation survey for this project, respondents were asked to provide information regarding new reuse projects and future reuse strategies being pursued. Based on the survey responses, the only reuse project that has been placed in operation since the 2006 Plan is the Upper Trinity Regional Water District's Lake Chapman/Lake Lewisville indirect return flow project. UTRWD has a permit to indirectly reuse return flows to Lake Lewisville that originated from Lake Chapman. The permit amount is 9,664 af/y and reuse began in May 2006. Further details can be found in Section 6.3 of this report.

Information was also gathered from the surveys regarding any potential future reuse projects. Future plans for reuse in Region C include:

Reuse strategies that are recommended in the 2006 Region C Water Plan

- City of Dallas - Extension of existing Cedar Crest Project (1,961 af/y) and development of White Rock Lake (18,495 af/y). Further details are in Section 6.2 of this report.
- City of Fort Worth – Considering four separate projects based on their *Reclaimed Water Priority and Implementation Plan.* Further details are in Section 6.2.
- Tarrant Regional Water District - Expansion of the George Shannon Wetland Water Reuse Project at Richland-Chambers Reservoir and development of a wetland reuse project at Cedar Creek Reservoir. Further details are in Section 6.3.
- City of Denton – Expansion of current reclamation facility. Further details are in Section 6.2.
- City of Frisco – Expansion of current Stewart Creek WWTP reuse and development of Panther Creek WWTP project. Further details are in Section 6.2.
- Trinity River Authority – Expansion of current Las Colinas project, development of irrigation reuse from Denton Creek WWTP, and development of irrigation reuse from Ten Mile Creek WWTP. Further details are in Section 6.2. Other future projects include supplies for steam electric power to Ellis, Dallas, Kaufman and Freestone Counties. Additional indirect supplies include municipal supplies for Johnson County SUD, Tarrant County, and City of Irving. Further details are in Section 6.3.

- City of Athens - Reuse of 2,677 af/y of return flows into Lake Athens plus additional augmentation from area wastewater treatment plants. Further details are in Section 6.3 of this report.
- North Texas Municipal Water District – Lavon Lake East Fork Reuse project. Further details are in Section 6.3.

New reuse strategies that were NOT recommended in the 2006 Region C Water Plan

- City of Midlothian - Mountain Creek Regional Wastewater System reuse project.
- City of Weatherford - Pumping decant water from lagoon back into Lake Weatherford and providing reclaimed water for natural gas exploration.
- Sabine River Authority - Lake Tawakoni Reuse project (140,125 af/y).
- City of Arlington - Reuse of 3,027 af/y (2.7 MGD) for parks, landfill, and private developer
- Culleoka WSC - Recycle water at concrete plant (336 af/y)
- Town of Flower Mound - reuse of 1,680 af/y (1.5 MGD) for Baker's Field Ballpark, Gerault Park, and Lake Side Business District.

Reuse has been and will continue to be an important strategy for meeting future water needs in Region C. Based on the survey responses it is evident that reuse projects are being pursued and have become widely accepted in Region C.

5. Assessment of Performance of BMPs

5.1 Quantity

Very little data was collected from the surveys regarding the quantity of water saved from the individual BMPs. Much of the difficulty in quantifying water savings from conservation efforts stems from the fact that there are no established means of measuring these water savings or for attributing water savings to any one particular conservation practice. Since data was not available to determine the effects of individual BMPs, an effort was made to analyze potential savings associated with conservation programs as a whole. This was done through a comparison of gpcd of selected groups of WWPs and WUGs.

Historical water use data for years 2002 through 2006 from both TWDB and the surveys were analyzed for six different WUGs. These WUGs were selected based on available data, BMPs implemented, and lack of drought restrictions during that time frame. Historical use in the surveys was broken down into retail and industrial. These data were then compared to the recommended gpcd amounts from the *2006 Region C Water Plan* (which were interpolated using historical 2000 and recommended 2010 quantities). Annual rainfall was also factored into this comparison.

Based on this analysis, a number of trends were evident.

- Rainfall had a much more distinct influence on the water use than any other factor.
- There were no significant trends in long term reduction of gpcd associated with water conservation. However, this six year period may not be a long enough data set to determine long term trends.
- Entities experiencing high population growth had increases in retail gpcd, most likely due to changing water use patterns (moving from rural to suburban water use patterns).
- In most cases, the water use reported in the surveys was significantly lower than the TWDB water use data, most likely due to the way the data was reported. The survey data only included retail and industrial sales, which does not include water losses. The TWDB data includes total water pumped from the source of supply.
- Generally, the historical TWDB gpcd values were close to or below the recommended Region C gpcd values, and the survey water use data was lower than

the recommended Region C gpcd values. This is to be expected, since the recommended Region C gpcd values represent expected use in an extremely dry year, which would tend to be higher than typical.

The significant influence of rainfall on water use found in this analysis indicates that seasonal outdoor water use still remains a dominant factor in water use in Region C. For this reason, a seasonal assessment was performed.

Seasonal Assessment

Seasonal analyses of water use were conducted in an effort to determine the impacts of water conservation measures implemented in Region C. In order to conduct these analyses, a study group of five WWPs and five WUGs was selected. The entities in the study group consisted of nine municipalities in or near the Dallas-Fort Worth Metroplex and one regional water district. In order to differentiate water saved through conservation rather than drought restrictions, none of these entities were under drought restrictions for the period of time covered by this analysis.

The total monthly water data for the entities included in the study group were obtained for the years 2000 and 2006. These years were selected because they both were dry years and had similar weather patterns. Winter water use, defined as the period January through March, was compared with summer water use, defined as the period May through September, to estimate the indoor water use and outdoor water use (i.e., water use attributable to outdoor irrigation) for each year.

For the entities in the study group, total water usage increased by 19.7% between 2000 and 2006. Water usage in the winter months increased by 25.6% between 2000 and 2006, and water usage in the summer months increased by 16.0% between 2000 and 2006. The overall increase in water usage is most likely due to population growth during this seven-year period, which increased 26% for the study group. The Region C Water Planning Area includes some of the fastest growing counties in Texas. For the entities in the study group, the total populations for 2000, the estimated total populations for 2006, and the percent changes for each entity from 2000 to 2006 are listed in Table 5.1. The population estimates are from the

Texas State Data Center[5].

In order to assess the portion of water usage attributable to outdoor irrigation, the winter months of January through March were used as a baseline, and an assumption was made that the increase in the summer period of May through September over the baseline was attributable to outdoor irrigation. Therefore, it was assumed that there was no outdoor water use in the winter months. Using these assumptions, the portion of water usage attributable to outdoor irrigation has declined from 39.2% in 2000 to 36.6% in 2006 for the entities in the study group.

Table 5.1
Population Growth for Entities in Seasonal Analysis

Study Group Entity	Total Population 2000	Estimated Total Population 2006	% Change 2000-2006
City of Fort Worth	534,694	650,344	22%
City of Mansfield	28,031	40,819	46%
City of North Richland Hills	55,635	61,784	11%
City of Weatherford	19,000	23,118	22%
Upper Trinity RWD	N/A	N/A	N/A
City of Allen	43,554	68,001	56%
City of Azle	9,600	10,606	11%
City of Frisco	33,714	76,168	126%
City of Lewisville	77,737	97,771	26%
City of Plano	222,030	262,722	18%

To assess the impact of climate on the decline in outdoor water usage in August and September of 2006, the historical average temperatures and rainfall data from 1971 to 2000 were compared with actual monthly temperatures and rainfall data for 2006. As obtained from the Dallas-Fort Worth International Airport climate station, the average historical temperatures for the months of August and September are 84.4°F and 77.5°F, respectively (NOAA, 2000)[6]. In 2006, the average temperatures for August and September were 89.8°F and 77.6°F, respectively (NOAA, 2006)[7]. In August 2000, the average daily high temperature was 101.9°F, and in September 2000, the average daily high temperature was 92.4°F (NOAA, 2000)[6]. In August 2006, the average daily high temperature was 100.6°F, and in September 2006, the average daily high temperature was 88.6°F (NOAA, 2006)[7]. The

average daily high temperatures in August and September of 2006 were only slightly lower than the average daily high temperatures in August and September of 2000. Thus, it does not appear that the decline in outdoor water usage can be attributed to cooler temperatures in 2006. In addition, the average historical rainfall in the months of August and September is 2.03 inches (in) and 2.42 in, respectively (NOAA, 2000)[(6)]. In 2006, the rainfall in August and September was 0.52 in and 2.60 in (NOAA, 2006)[(7)]. Thus, it does not appear that the decline in outdoor water usage can be attributed to higher than normal rainfall in 2006.

The decrease in outdoor water usage in August and September of 2006 likely relates to the implementation of water conservation best management practices (BMPs) by the entities in the study group. As will be discussed in a later section, different entities elected to implement different BMPs. Although there are some overlapping patterns, no absolute list was replicated for every entity represented in the seasonal analysis.

Reported Water Savings Associated with Specific BMPs

A few entities in the survey and telephone interview responded with specific water savings for selected BMPs. That water savings data is presented below.

One BMP where savings can more easily be measured is Water System Audit, Leak Detection and Repair, and Pressure Control. Water savings were reported by three entities for this BMP: NTMWD and the Cities of Dallas and Terrell. NTMWD reported discovering six two-gallon per minute leaks that resulted in a loss (savings) of 500,000 gallons. The City of Dallas reported a savings of 220 million gallons since implementing their program in 2004 at a water saving cost of approximately $54 per thousand gallons saved. The City of Terrell reported a water savings of 5 million gallons since implementing their program in October 2006 at a water saving cost of approximately $6 per thousand gallons saved.

North Texas Municipal Water District reported that during the recent drought (2006-07) with Water IQ and mandatory water restrictions in place, an estimated annualized 12 to 15% reduction was achieved. During the peak summer months, this resulted in an estimated reduction of 200 million gallons per day. Part of this savings can be attributed to their public education program which includes the Water IQ program, but much of it is attributed to the mandatory water restrictions.

The City of Terrell reported that increasing their water prices had proven to be a very effective BMP and saved 12 million gallons of water annually. The City of Terrell also reported an annual savings of 12 million gallons for the BMP of Conservation Pricing Structure. The City of Frisco reported saving of over 24.5 million gallons through their water waste prohibition BMP.

The City of Allen is the only entity participating in this study that has implemented Single-Family Rebate Program for Water Efficient Clothes Washers. The City of Allen implemented this BMP in 2006 and provided 483 rebates through 2006 and 2007. Data obtained from the City of Allen web site[8] can be used to estimate the water savings and unit cost of this measure. Assuming that inefficient washers use 40 gallons per load of laundry and 400 loads are done in a year, then 483 inefficient washers would use approximately 7.73 million gallons per year. If the 483 washers were post-2007 highly efficient machines at 18 to 25 gallons per normal load, then the approximate water used would be 3.48 to 4.83 million gallons per year, and a water savings of 2.90 to 4.25 million gallons per year would be achieved over the life of the washer (approximately 13 years).

The majority of water providers have implemented their BMPs fairly recently, which makes the overall effectiveness of the BMPs difficult to quantify in terms of water savings of BMP implementation. Procedures and protocols to quantify BMP effectiveness in terms of savings on a per capita basis should be developed and utilized. As utilities gain more experience with these water conservation programs, their quantification methods will become more evident.

5.2 Cost

Information regarding actual costs of implementing BMPs was obtained from the 24 telephone interviews conducted as part of this project. In many cases, the water providers were not able to provide costs for individual BMPs since they only budget for their conservation programs as a whole and do not divide costs into separate BMPs. Where available, the costs for individual BMPs were compared to the projected costs in the *2006 Region C Water Plan* (which were generally based on the costs in the Water Conservation Implementation Task Force Committee Report). In order to do this comparison, costs from the *2006 Region C Water Plan* were converted from unit costs (per acre-foot) to total annual

costs. This was done by multiplying the unit costs by the projected annual savings (in acre-feet) from the Plan.

Basic Water Conservation Package

Public and School Education

Seventeen of the twenty-four water providers have implemented public and school education programs. Table 5.2 shows the costs reported by the responding entities. It was found that larger water providers typically have budgets that range from $35,000 to $1.6 million dollars to fund public and school education programs. Further, the majority of the smallest water providers typically have not implemented public and school education programs. Depending on the media used, public education messages can reach outside of a water provider's customer base and reach outside of the normal service area. The majority of responding entities reported that they coordinate with other entities in disseminating a common water conservation message. Further, many of the entities were open to the idea of contributing monetarily to a region wide education initiative. Some entities suggested that the North Central Texas Council of Governments would be a valuable resource in coordinating a region wide conservation message.

Table 5.2
Reported Costs of Public and School Education BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
City of Dallas	Not Reported	$1,200,000
City of Denton	Not Reported	Not Reported
City of Fort Worth	Not Reported	$200,000
City of Mansfield	$2,300	$2,300
City of North Richland Hills	$15,499	$15,499
City of Terrell	$500	$200
City of Weatherford	$6,000	Not Reported
North Texas Municipal Water District	$2,000,000	$1,600,000
City of Arlington	$0	$35,000
City of Carrollton	$2,000	$6,000
City of Lewisville	$1,000	$800
Tarrant Regional Water District	Not reported	$250,000

Table 5.3 shows the cost comparison for this BMP to the costs projected in the 2006 Water Plan. In general, these cities are not spending as much as estimated in the 2006 Region C Plan. However these cities benefit greatly from the extensive public education programs of their major regional providers, North Texas Municipal Water District (NTMWD), Tarrant Regional Water District (TRWD), and City of Dallas. In the 2006 Region C Plan, costs were only developed for WUGs, so costs for NTMWD and TRWD were not quantified. A better comparison of cost would be to total the actual costs for NTMWD (or TRWD) and its customers, and then compare it to the 2006 Plan's projected costs for its customers. Surveys were not returned for all customers of these major providers, so this comparison could not be made. However, it is interesting to note that the sum of costs for NTMWD customers in the 2006 Plan was $1,622,804 in 2010. NTMWD alone spent $1.6 million in 2008. When adding the 2008 costs incurred by NTMWD's customers, actual spending for education programs far exceed the projected costs from the 2006 Plan.

Table 5.3
BMP Cost Comparison – Public and School Education

ENTITY	2008 Annual Cost (from surveys)	Annual Projected Cost from 2006 Region C Plan (for Year 2010)
City of Dallas	$1,200,000	$1,312,324
City of Fort Worth	$200,000	$632,940
City of Mansfield	$2,300	$101,086
City of North Richland Hills	$15,499	$114,861
City of Terrell	$200	$39,624
North Texas Municipal Water District	$1,600,000	Not Estimated in Region C Plan
City of Arlington	$35,000	$408,333
City of Carrollton	$6,000	$171,000
City of Lewisville	$800	$155,690
Tarrant Regional Water District	$250,000	Not Estimated in Region C Plan

Increasing Water Prices

Water consumption generally decreases with increasing water rates. Therefore, increases in real water prices over time should conserve water. Seventeen of the twenty-four entities participating in this study have increased their water prices. Table 5.4 below shows

the costs reported by the responding entities. The majority of the entities viewed this BMP as one of the most effective BMPs due to its low implementation cost. Implementation cost was found to vary with the size of the entity. Larger entities incurred greater costs in implementing price increases due to mailing of bill fliers announcing the increase and conducting public meetings concerning the price increases. The majority of surveyed entities did not provide specific dollar amounts for implementation of this BMP.

Table 5.4
Reported Cost of Increasing Water Prices BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
City of Fort Worth	Not Reported	$15,000
City of Mansfield	$0	$0
City of Terrell	$500	$200
City of Allen	$0	$0
City of Arlington	$0	$0
City of Carrollton	$0	$0
City of Lewisville	$0	$0

Reported costs for the implementation and maintenance of this BMP ranged from no cost to $15,000. Differences in cost could be attributable to the amount of public interaction in implementing a price increase. The City of Fort Worth reported that they hold meetings prior to implementing a price increase and include bill fliers announcing the proposed price increase prior to implementation. These administrative costs can add to the cost of the BMPs implementation. In some cases, the cost of a rate study may be attributed to this BMP. In the 2006 Region C Plan it was assumed that no cost would be incurred by cities to implement this practice.

Water System Audit, Leak Detection and Repair, and Pressure Control

Fifteen of the twenty-four entities participating in this study have implemented pro-active leak detection and repair programs, and all of the entities have been required to perform a water system audit to identify system water losses. Table 5.5 shows the costs reported by the responding entities. The effectiveness and cost of this BMP are difficult to determine based on a region wide view due to the difference in size of participating entities, and uncertainty whether leak detection and repair is a conservation measure or part of regular operation and maintenance procedures.

Table 5.5
Reported Costs of Water System Audit, Leak Detection and Repair, and Pressure Control BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
North Texas Municipal Water District	Not Reported	$550,000
City of Dallas	$400,000	$3,800,000
City of Fort Worth	Not Reported	$600,000
City of Mansfield	Part of CIP	$100,000
City of Terrell	$30,000	Not Reported
City of Allen	$0	$125,000
City of Arlington	$0	$388,000
City of Carrollton	$9,000	$25,000
City of Frisco	Not Reported	$250,000
City of Lewisville	$150,000	$150,000

Reported costs of implementing this BMP ranged from $9,000 to $400,000 for startup costs and $25,000 to $3,800,000 for annual costs. Larger entities are more likely to have implemented pro-active leak detection and repair programs that have necessitated the acquisition of additional equipment and personnel. Two entities reported that additional personnel were acquired for leak detection and repair (Fort Worth and Carrollton). However, the City of Carrollton's additional personnel were not acquired specifically for pro-active leak detection and repair. Several of the smaller entities reported that they do not have the budget to add equipment and personnel for a pro-active program.

This particular BMP is difficult to compare between the cities' reported costs and the 2006 Region C plan costs. The Water Audit BMP includes a combination of the tabletop accounting of water use and water loss, leak detection and repair, and pressure plane analysis. The projected costs from the Region C Plan reflect the assumption that all elements of the BMP are implemented. This may or may not be the case in the cities surveyed. Some cities have implemented only selected elements of this BMP. Also, these costs can vary greatly by city based on the age and condition of the city's infrastructure. The cost comparison is shown in Table 5.6. Of note is the City of Dallas which has a significantly higher annual cost than the Region C projections. This is largely due to Dallas' aggressive leak detection and repair program, which includes pipe replacement.

Table 5.6
BMP Cost Comparison – Water System Audit, Leak Detection And Repair, and Pressure Control Programs

ENTITY	2008 Annual Cost (from surveys)	Annual Projected Cost from 2006 Region C Plan (for Year 2010)
City of Dallas	$3,800,000	$2,001,071
City of Fort Worth	$600,000	$1,043,923
City of Mansfield	$100,000	$120,298
City of Allen	$125,000	$190,371
City of Frisco	$250,000	$277,682
North Texas Municipal Water District	$550,000	Not Estimated in Region C Plan
City of Arlington	$388,000	$684,441
City of Carrollton	$25,000	$249,663
City of Lewisville	$150,000	$223,043

Expanded Water Conservation Package

Water Conservation Pricing Structure

Of the twenty-four entities surveyed, eleven have implemented some form of water conservation pricing structure. Table 5.7 shows the costs and estimated savings reported by the responding entities. The entities surveyed viewed this as one of the most successful BMPs in terms of ease and cost of implementation. However, no specific cost figure was provided by these entities for implementing this BMP.

In the *2006 Region C Water Plan*, costs were developed for this practice which included passing a water rate ordinance. These costs ranged from $5,000 to $10,000. The cost for a rate study to support the passage of this ordinance was estimated between $10,000 and $100,000 based on the size of the city.

Table 5.7
Reported Costs of Water Conservation
Pricing Structure BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
City of Fort Worth	$10,000	$15,000
City of Mansfield	$0	$0
City of Terrell	$0	$0
City of Allen	$0	$0
City of Arlington	$0	$0

Water Waste Prohibition

Ten of twenty-four entities surveyed indicated that they have implemented some form of water waste prohibition ordinance. Enforcement of that ordinance is the only quantifiable element in terms of cost for this BMP. Table 5.8 shows the costs and estimated savings reported by the responding entities. Of the surveyed entities, the City of Dallas, the City of Fort Worth, and the City of Allen have funded programs to enforce water waste ordinances. The City of Dallas and the City of Fort Worth within their respective departments, employ multiple personnel to police water waste. For example, the City of Fort Worth reported that they have added two enforcement personnel to enforce water waste ordinances. The City of Allen water department funds half of one of the four city code enforcement officers ($45,500 annually – salary and benefits). All four code enforcement officers are required to police water waste within the city.

The primary cost from the *2006 Region C Water Plan* was for the adoption of an ordinance and the enforcement of the ordinance. The assumed cost in the 2006 Region C plan was $0.25 per capita per year. Although several cities responded that they have implemented water waste prohibition, only the City of Allen provided an annual cost, which was $22,750. The 2006 Region C Plan assumed that Allen would not begin this program until 2020. Based on the $0.25 per capita cost, the 2020 cost estimated in the Region C Plan for Allen was $26,171. Based on Allen's annual cost, Region C's assumption of $0.25 per capita is a good estimate of cost.

Table 5.8
Reported Costs of Water Waste Prohibition BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
City of Mansfield	$0	$0
City of Allen	$0	$22,750
City of Frisco	Not Report	Not Reported
City of Lewisville	$0	$0

Residential Customer Water Audit

Currently seven of the entities participating in this survey have implemented residential customer water audit programs. These include City of Dallas, City of Fort Worth, City of Arlington, City of Denton, City of Carrollton, City of Frisco and City of Wylie. Table 5.9 shows the costs and estimated savings reported by the responding entities.

Table 5.9
Reported Costs of Residential Customer Water Audit BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
City of Dallas	$55,000	$50,000
City of Fort Worth	Not Reported	$50,000
City of Carrollton	$55,000	$55,000

Audits are effective means to distribute low-flow plumbing fixtures and other water saving features. An advantage to providing fixtures during water audits is that they are installed during the visit by the auditor. In contrast to a give away program, an audit ensures the proper installation of fixtures and other water saving devices. Audits are also useful in stopping water loss. Often audits involve leak detection and minor repairs at the customer's home.

The reach of water audits on a community level is fairly restricted. The City of Carrollton reported that of the 6,000 offers for water audits given in a year; only 400 customers accepted the offer. The City of Carrollton and several other entities extend offers

for water audits to customers whose water use exceeds a set amount. These entities also offer water audits to customers who volunteer for the audits.

In the *2006 Region C Water Plan* the approximate cost for a single audit was $102. In the plan, the annual cost for each entity for this BMP was calculated as the cost per audit ($102) multiplied by an assumed number of audits conducted (based on a percentage of residential customers). Only three cities surveyed reported costs for this BMP. Table 5.10 compares the actual costs to the projected costs from the 2006 Plan. Based on these actual costs, a similar level funding is being dedicated to this BMP, and it is not contingent on the size of the city.

Table 5.10
BMP Cost Comparison – Residential Customer Water Audit

ENTITY	2008 Annual Cost (from surveys)	Annual Projected Cost from 2006 Region C Plan (for Year 2010)
City of Dallas	$50,000	$129,402
City of Fort Worth	$50,000	$60,536
City of Carrollton	$55,000	$10,848

Industrial, Commercial, and Institutional General Rebate

Costs associated with this BMP are highly variable due to the complexities and intricacies of ICI practices and processes. These practices and processes range from commercial dish washing units to water cooling towers to highly advanced processing units. The resulting costs associated with this BMP are highly individualized and would presumably vary from year to year. Of the entities surveyed, two of the twenty-four providers reported the implementation of this BMP. However, neither of those entities provided costs associated with the implementation of this BMP.

Industrial, Commercial, and Institutional Water Audit, Water Waste Reduction and Site-Specific Conservation Program

The City of Dallas is the only one of the twenty-four entities surveyed that has implemented an ICI water audit. The City of Dallas reported an initial startup cost of $25,000 and a yearly program cost of $50,000. In the *2006 Region C Water Plan* the estimated cost for this practice was $575 for each audit. The estimated annual cost was calculated as the estimated unit cost multiplied by the projected water savings. The Region C Plan assumed

that Dallas did not begin this program until 2020. The cost calculated from the Plan for Dallas for 2020 was $30,356.

Additional BMPs Implemented by Select Water Providers

Single-Family Rebate Program for Water Efficient Clothes Washers

The City of Allen is the only entity participating in this study that has implemented this BMP. In this instance, the City of Allen has spent $60,000 on rebates for 483 washing machines and now realizes a water savings of approximately 2.90 to 4.25 million gallons per year over the life of the washer (approximately 13 years). As the washers continue to conserve water over their useful life, the projected cost of the BMP would be approximately $1.09 to $1.59 per thousand gallons saved, assuming that these washers would not have been replaced with efficient washers due to the federal residential clothes washer energy standards that took effect in 2007.

The estimated cost from the *2006 Region C Water Plan* was $150 per machine which includes the cost of the rebate amount, marketing and program administration. The estimated annual cost was calculated as the estimated unit cost multiplied by the projected water savings. Although this was not a recommended strategy for Allen, the 2006 Region C Plan had estimated Allen's annual cost at $33,615. This is compared to the actual cost of $60,000 over a two year period.

Time of Day Water Restrictions and Twice Per Week Irrigation

Of the twenty-four entities surveyed, City of Dallas, City of McKinney, City of Fort Worth, and the City of Arlington reported to have instituted a year round time of day watering restriction. The City of McKinney reported to have implemented a recurring twice per week irrigation ordinance. Costs for implementing these BMPs may include public education and enforcement. Enforcement costs reported by various entities are discussed under the water waste prohibition section.

Rain and Freeze Sensors

Five of the entities participating in this study (City of Dallas, City of Fort Worth, City of Arlington, City of Allen, and City of Carrollton) have implemented rain and freeze sensor

ordinances, giveaways, or rebate programs. The City of Allen and the City of Carrollton provided information concerning program costs, and the City of Carrollton provided information related to the number of sensors given to customers. Table 5.11 shows the costs and estimated savings reported by the responding entities. The estimated cost in the *2006 Region C Water Plan* was $0.25 per capita per year for enforcement and between $5,000 and $10,000 to implement the ordinance.

Table 5.11
Reported Costs of Rain and Freeze Sensor BMP Programs

ENTITY	ESTIMATED STARTUP COST	ESTIMATED ANNUAL COST
City of Allen	$0	$2,000
City of Carrollton	$20,000	$0

Evapotranspiration Irrigation Controllers

Of the entities surveyed, the Cities of McKinney and Frisco have implemented ET irrigation controller programs. Neither of the cities who have implemented this BMP reported any cost nor water savings associated with the BMP.

5.3 Case Studies

Case studies were performed for three cities to analyze the procedures and processes a city undertakes to implement a BMP or a set of BMPs. These case studies were performed to get a general sense of the ease or difficulty certain sizes of cities face when implementing various BMPs. This information is intended to inform other cities that desire to implement BMPs in the future. These studies were performed for three categories: small town, mid-sized city, and large city. The criteria for selecting the cities were as follows.

Small Town:

- Does not get water from a Wholesale Water Provider (WWP) and therefore is not subject to the conservation plans of that WWP.
- Located well away from Dallas/Fort Worth metroplex area.
- Population less than 5,000.
- Is representative of other towns in the category.
- Implementing some, but not all BMPs that are typical of small towns.

Mid-sized City:

- Does not get water from a Wholesale Water Provider (WWP) and therefore is not subject to the conservation plans of that WWP.
- Not bordering Dallas or Fort Worth, but possibly within the surrounding counties.
- Population between 20,000 and 70,000.

Large City:

- City within Dallas/Fort Worth Metroplex area.
- Population greater than 100,000.

Based on these criteria, the cities of Muenster, Corsicana, and Arlington were selected for the case studies.

Small Town - Muenster

Based on the returned water conservation survey, Muenster's current BMPs include:

- Increasing water prices
- Water system audit, leak detection and repair, and pressure control
- Water conservation pricing structure

The year 2000 population for Muenster was 1,156. As with most small towns, there is no dedicated budget for water conservation. Muenster's current Water Conservation and Drought Contingency Plan was developed by city staff in November 1999 using the template and guidelines provided by the state.

The BMPs employed by Muenster are fairly typical for small towns. The Increasing Water Prices BMP is really a function of collecting adequate funds for maintaining and operating the water system with a side benefit of conservation. The Water Conservation Pricing Structure BMP is a response to the state's requirement to eliminate decreasing block water pricing. Both of these BMPs associated with water pricing are effective in bringing about conservation results and are fairly inexpensive to implement. For a small town, the steps involved in implementing these BMPs are: city staff calculation of needed rates, presenting the new rates to the City Council at regularly scheduled meetings, notifying

customers of proposed change via inserts in water bills and public notices in the newspaper, City Council passing the new rate structure ordinance, and adjusting the billing calculations to include the new rate structure. Much of this can be done as part of normal city staff operations and does not require additional funds to accomplish.

As with most small towns, the BMP related to water system audit and leak detection and repair in Muenster is covered by the city's water maintenance staff and is not considered explicitly for water conservation purposes. It is generally more for system maintenance purposes, was implemented when the system was created, and is conducted on a continuous basis. Currently the city replaces 10% of its water meters per year.

Mid-Sized City - Corsicana

Based on the returned water conservation survey, Corsicana's current BMPs include:

- Low-flow plumbing fixture rules
- Public and school education
- Water system audit, leak detection and repair, and pressure control
- New efficient residential clothes washer standards
- Water conservation pricing structure
- Water waste prohibition
- Residential customer water audit
- Industrial, commercial, and institutional (ICI) water audit, water waste reduction, and site-specific conservation program

The year 2000 population for Corsicana was 26,442. Corsicana's annual budget for water conservation is approximately $10,000.

Corsicana's original Water Conservation and Drought Contingency Plan was prepared by a consulting engineering firm in 1997 and was adopted by the city on March 18, 1997. The Plan has been updated numerous times since 1997. When the Plan was originally adopted, a number of BMPs were implemented including:

1) Public and school education,
2) Water system audit, leak detection and repair, and pressure control,

3) Residential customer water audit, and

4) Industrial, commercial, and institutional (ICI) water audit, water waste reduction, and site-specific conservation program.

The Water Conservation Plan and these BMPs were written into the city's Code of Ordinances under the Utilities and Solid Waste Planning Chapter. All elements of the conservation plan are maintained on file in the City Secretary's office and are available to the public. The Water Conservation and Drought Contingency Plan was updated and amended again in October 2008 to include specific conservation goals (per capita use) and associated timeframes.

Corsicana currently sells water to 21 wholesale water customers. Any contracts with these wholesale customers include the requirement that the customers develop and implement a water conservation plan.

The basis of the city's public and school education program is pre-printed brochures from TWDB. These brochures are available on the TWDB website (www.twdb.state.tx.us/assistance/conservation/pubs.asp). Cities may receive up to 500 pieces of literature per year at no charge from TWDB and additional pieces may be purchased. The first year of the program, brochures were distributed semi-annually via water bills in conjunction with newspaper articles. In following years, various brochures have been distributed annually in May or June (corresponding to peak summer periods) along with news releases to the local newspaper. The news releases are used to provide information on water conserving practices, encourage water conservation and report progress on achieving the city's water conservation goal. Also, new customers are given information on the city's conservation program at the time that they apply for service. The school education program involves presentations at schools as well as tours of the water plant at the request of the school. These requests are made to the City's Environmental Services Department and tours are conducted by the plant superintendent. Water conservation is emphasized as part of these presentations and tours.

The city's water system audit and leak detection and repair program also began in 1997. An annual water audit is performed to identify unaccounted for water. The city's goal is to meter all water used, including water used for city services. All customer meters were

replaced in 2002 and 2003. The current average meter replacement is 8 to 10% per year. The city has a goal that meters will be maintained within 1% accuracy. The city staff manually audits monthly meter readings of large water customers (2" meters and larger) against the previous two or three months to determine if there is a significant change in water use or if there is an indication of an improperly operating meter. The city has a schedule of meter testing where larger meters are tested annually and smaller (residential) meters are tested every 7 years. Meter age is associated with each billing account. In addition to the audits and meter replacement, city employees conduct daily leak inspections as they travel within the city. Citizens are also asked to report leaks when observed. When leaks are found or reported, a work order is issued for repair as soon as possible. Residential customers may request individual audits if leaks in their system are suspected.

In August 2006, the city eliminated its decreasing block rate structure. With the new structure, no discounted rate is given for higher volumes of use. In addition, the new rates represent a 20% increase over the previous rates, which will encourage water conservation. Steps involved in this process were having a consultant perform a water rate study, proposing the new rate structure to the City Council, notifying customers of proposed change in rates and rate structure via inserts in water bills and public notices in the newspaper, holding public meetings to discuss the new rate structure, City Council passing the new rate structure ordinance, incorporating this change into the City ordinances, and adjusting the billing software to include the new rate structure. The city has a rate study performed about every three years and intends to move towards an increasing block rate structure.

The City also lists "low-flow plumbing fixture rules" and "new efficient residential clothes washer standards" as part of their BMPs. Customers and/or owners of buildings that do not have water conserving plumbing devices are encouraged by the City to retrofit their old fixtures. The City's educational and advertising program helps inform customers of the advantages of installing water saving devices as well as the availability of these items.

Large City – Arlington

Based on the returned water conservation survey, Arlington's current BMPs include:

- Public and school education
- Increasing water prices
- Water system audit, leak detection and repair, and pressure control

- Water conservation pricing structure
- 10am-6pm water restrictions; rain-freeze sensors required

Other BMPs planned or proposed for 2008 are:

- Low-flow plumbing fixture rules
- Water waste prohibition
- Residential customer water audit
- Industrial, commercial, and institutional (ICI) water audit, water waste reduction, and site-specific conservation program
- Low-water landscape code and conversion incentives
- Irrigation ET controllers required
- High efficiency irrigation required and conversion incentives

Arlington's fiscal year 2007 budget for conservation was approximately $44,000. The budget increased to $184,000 for fiscal year 2008. The year 2000 population of Arlington was 332,969.

As with most cities, water rates for the City of Arlington have been steadily increasing through the years in order to maintain adequate revenue for their water system as well as to promote conservation. In 2003, the city introduced a water conservation pricing structure. The city now has an increasing block rate structure, in which the cost of water increases as water use increases. Steps involved in increasing rates and implementing the new rate structure are: performing an internal water rate study, proposing the new rate structure to the City Council, notifying customers of proposed change in rates and rate structure via inserts in water bills and public notices in the newspaper, holding public meetings to discuss the new rate structure, City Council passing the new rate structure ordinance, incorporating this change into the City ordinances, and adjusting the billing software to include the new rate structure.

In 2005, Arlington's Water Utilities Department prepared a Water Conservation Plan in accordance with TCEQ regulations. This plan was updated in 2008. The Plan identified conservation goals and explained conservation practices the city would implement.

Arlington's public and school education program includes regularly utilizing public service announcements on Arlington's public cable television channel, using bill inserts (at least twice per year), maintaining a conservation website (www.savearlingtonwater.com),

placing conservation advertising in local newspapers, and making presentations to school and community groups. Another part of Arlington's public education is its partnership with a number of agencies to promote a regional water conservation message to the public. The city's partnership with Tarrant Regional Water District involves the WaterWise Program for 5th graders, the Major Rivers Program (produced by TWDB) for 4th graders, and the Star-Telegram Newspapers in Education (NIE) program. Arlington advertises the Texas Smartscape CD and Website developed by the North Central Texas Council of Governments. Arlington also partners with the Arlington Conservation Council and the Lone Star Irrigation Association to disseminate conservation information. The city distributes and makes available materials developed by city staff as well as material obtained from the TWDB, TCEQ, and other sources.

As part of its conservation efforts, the city's goal for unaccounted water is less than 8%. This is well below the typical goal for a city, which is around 10 to 12 percent. The city maintains efforts to manage unaccounted water uses. These efforts include metering of all customers as well as all public and government users, following AWWA standards for meter testing and repair/replacement, and maintaining accurate metering of raw water supplies from Lake Arlington. In addition, leak detection and repair are part of the routine operations of the city staff including meter readers, field operations and meter services personnel. The city does not have an aggressive pipe replacement system because of the relatively young age of the distribution system.

A primary water conservation goal of Arlington is to decrease waste in landscape irrigation through implementation and enforcement of a landscape water management ordinance. In December of 2006, this ordinance was strengthened by making the 10am to 6pm water restrictions year round. In addition, beginning in January 2007, all irrigation systems (commercial and residential) installed must be equipped with rain and freeze sensors. The city has provided customers with a list of approved rain and freeze sensor equipment. The city is imposing a $500 fine on all violators of this ordinance.

Arlington currently sells water directly to some customers within the City of Grand Prairie and is considering wholesale water sales to Grand Prairie. Any future wholesale water contract would include the requirement that the customers develop and implement a water conservation plan.

5.4 Analysis of Selected BMPs

5.4.1 Public Education

The purpose of this analysis is to summarize information gathered from 24 WUGs and WWPs relative to the implementation of Water Conservation Public Education and Information activities. The information was primarily gathered through telephone interviews of 24 entities and supplemented with data previously included in responses to a Region C survey conducted in 2007.

Public Education and Information is one of the primary Best Management Practices (BMPs) recommended for water conservation initiatives in the 2006 Region C Water Supply Plan. Public and school education programs inform water customers on water conservation approaches and reinforce this message with periodic reminders. The goal of these programs is to promote public awareness of the importance of water conservation in managing and sustaining existing water supplies. Tools to meet this goal include print, radio, and television advertising; direct distribution of literature; special events and seminars; and websites. School education programs provide water conservation curriculum material at appropriate grade levels.

Survey of Public Education and Outreach Programs

Based on the results from the 2007 Comprehensive Survey, the Public and School Education BMP have been adopted by 44 percent of the WUGs and 60 percent of the WWPs. Seventy percent of the respondents indicated that the Public and School Education BMP was a somewhat effective or a very effective practice. Tables 5.12 and 5.13 summarize responses from the 2007 survey, which requested information about public outreach programs.

Regional Cooperation and Programs

Based on the 2007 surveys and the interviews, the water conservation messages from each regional program are mostly similar with a few differences. The City of Dallas, City of Fort Worth, Tarrant Regional Water District (TRWD), the Upper Trinity Regional Water District, the North Texas Municipal Water District (NTMWD), and others contribute to water conservation programs that messages reach outside their service areas and have a positive regional impact.

a. Water *IQ: Know Your Water Program*. Water IQ is the water conservation program for the State of Texas, which is maintained by the Texas Water Development Board (TWDB). The Water IQ program is a public education program designed to inform the public about their water supply sources in terms of location, quantity, and current status. The TWDB acknowledges that some conservation programs were developed before Water IQ. The TWDB would like to see these programs partner with Water IQ so that Water IQ would provide an overall statewide conservation program that works with existing local programs.

Table 5.12

2007 WWP Survey Reported Public Education and Outreach Programs

Wholesale Water Provider	Public Outreach Programs	Annual Budget/Costs[(a)]
City of Dallas	Public awareness campaign, school programs, brochures, speaking engagements, special events and promotions, web site, water bill inserts	$1,200,000
City of Fort Worth	Training for students, Customer Advisory Committee, bill inserts, promotions, Speaker's Bureau, gardening seminars, web site	$200,000
City of Denton	Bill stuffers, television advertising, radio advertising	Not Reported
City of North Richland Hills	WaterWise, flyers	$15,499
City of Mansfield	Smartscape classes and creek cleanups	$2,300
Rockett SUD	Coloring books, stickers, brochure	Not Reported
City of Waxahachie	Pamplets, reports, CDs, newspaper	Not Reported
City of Weatherford	Recycle/reuse education day, mail outs, inserts in bills	Not Reported
North Texas Municipal Water District	School programs, state education program, Water IQ	$1,600,000
Tarrant Regional Water District	WaterWise, Major Rivers, Newspapers in Education, Wetland Water Reuse Module, SAVE WATER	Not Reported
Trinity River Authority	Public forums, meet with city staffs	Not Reported
Upper Trinity RWD	Brochures, website, book covers, tree planting program	Not Reported

[(a)]Annual budgets/costs do not include salaries, benefits, etc., related to personnel's time committed to these programs.

Table 5.13

2007 WUG Survey Reported Public Education and Outreach Programs

Water User Group	Public Outreach Programs	Annual Budget/Costs [(a)]
City of Arlington	Public service announcements, bill inserts, web site, newspaper, community groups	$35,000
City of Plano	Indoor plumbing retrofit giveaways, school programs, seminars, display boards, banners, mailing inserts, web site	Not Reported
City of Carrollton	Residential irrigation inspections	$6,000
City of McKinney	Web site, local television, mailers, billboards, and theatres	Not Reported
City of Lewisville	City website, television, kiosks, mail outs, book covers for schools, public education events	$800
City of Frisco	Evapotranspiration (ET) program, elementary school programs, public events, web site, bill inserts, meetings	Not Reported
City of Allen	Water Conservation Rebate Program, school clubs, Adopt-A-Waterway Program, flyers, newspapers, cable television, AISD, presentation for Scouts and civic organizations	Not Reported
City of Wylie	Website, annual water report	Not Reported
City of Azle	Water plant tours, schools visits	Not Reported
City of Chico	Major Rivers program taught at 5th grade level at Chico Elementary School	Not Reported

[(a)]Annual budget/costs do not include salaries, benefits, etc., related to personnel's time committed to these programs.

Currently, the Lower Colorado River Authority, the City of Austin, the City of Lubbock, the City of San Angelo, the City of Tyler, the High Plains Underground Water Conservation District No. 1, and the NTMWD subscribe to the Water IQ program. Each subscriber to the program develops specific educational materials to inform their customer base about current and past issues, efforts, and developments within their water supply system. These educational materials range from brochures to television advertisements. Each subscriber has developed a user friendly website to promote educational efforts.

Specific to Region C, the NTMWD unveiled its Water IQ program in 2006 responding to the need to educate the public on their source of water and the need to use water wisely and efficiently. Currently, the NTMWD promotes its messages through various media outlets including a user friendly website (www.WaterIQ.org), television advertisements, radio reads, print media, brochures, and an extension community outreach program. All of the educational messages are geared towards driving the consumer to the Water IQ website to learn more about conservation tips and information and knowing the current location and status of the District's water supplies. Information on the Water IQ website includes the District's conservation efforts, current water planning developments within the District, recent and current advertisement campaigns, a "Water IQ quiz," an interactive "Water IQ home," various other related water conservation links. In addition to the Water IQ program, NTMWD provides numerous speaking engagements to civic community, and school organizations.

b. *Save Water Nothing Can Replace It Program.* In 2002, the City of Dallas through the Dallas Water Utilities developed its own regional public education campaign to promote conservation efforts within the city and its customer cities. The Save Water program promotes conservation efforts through the use of various forms of media including television, billboards, print advertisements, a user friendly website, classroom materials, and public speaking engagements. This program promotes water conservation by educating the public on ways that citizens can conserve water.

The City of Fort Worth and the TRWD also participate in the Save Water program, and encourage their customers to participate in the program. Tarrant Regional Water District also promotes several other elementary school water conservation education initiatives directed towards grade school children. These initiatives include the Major Rivers program, the Newspapers in Education program, and the Water Wise program. These initiatives require the coordination and support of the City of Fort Worth and other cities for them to be taught in the schools. The Newspapers in Education program is a program that partners with the Fort

Worth Star-Telegram to bring water conservation issues to the classroom with the newspaper. More information on these programs can be obtained from the following website: http://www.trwd.com/Prod/Conservation.asp

c. The Upper Trinity Regional Water District has embarked on a customer city/user web based educational program (http://www.utrwd.com/WaterConservation.htm).

Conclusions

a. Public Outreach programs are in effect and are being actively pursued by most of the water providers within Region C. The major water providers have extended their programs to media outlets (radio, television, print, and signage) that reach the entire Region C area. The smaller and mid-size water providers generally utilize pamphlets, bill inserts, school programs, websites, etc. to convey their water conservation messages.

b. At present, there is not a common, regional public outreach program. 'Water IQ' and 'Save Water Nothing Can Replace It' are programs that educate a great majority of water customers in the region. Most water suppliers agree that there is value in joining together to present a uniform water conservation message. Although an amount of money was not specified, there was some agreement regarding financial contributions.

Efforts are underway by the major water providers to further coordinate conservation public education and information activities and water conservation strategies implementation to achieve a common regional approach.

Many of the mid-sized and small water providers are attempting to further coordinate a regional approach for water conservation public education and information activities and the implementation of water conservation strategies.

Some entities suggested that programs administered by the North Central Texas Council of Governments (NCTCOG) could be a possible vehicle to provide a common

regional water conservation educational and information message. (Note: A component of the current Region C Planning effort includes interface with the NCTCOG's program known as Vision North Texas.)

5.4.2 Water Loss, Leakage and Leak Detection

The purpose of this analysis is to summarize information gathered from 24 WUGs and WWPs relative to the implementation of strategies to identify leaks and to reduce water loss. The information was primarily gathered through telephone interviews of 24 entities and supplemented with data previously included in responses to a Region C survey conducted in 2007.

The detection of leaks and actions to reduce water loss represents one of the primary Best Management Practices (BMPs) in the *2006 Region C Water Plan* This BMP consists of three components – Water System Audits, Leak Detection and Repair, and Pressure Control.

The Water System Audits, Leak Detection and Repair, and Pressure Control BMPs were reported being utilized by 55 percent of the responding WUGs and 48 percent of the responding WWPs from the 2007 Region C survey. These percentages were second only to the Public Awareness and School Education BMP. Seventy five percent of the respondents using this BMP rated this practice to be "somewhat or very effective." The respondents provided very little quantitative data or specific cost information on water savings.

Considerations

The BMP strategy to identify and reduce the quantities of water lost from systems consists of four components: 1.) *Water System Audits,* 2.*) Leak Detection and Repair,* 3.*) Pressure Control*, and 4.) *Water Meter Replacement and Upgrades.*

Water System Audits

Since 2003, water system utility audits are mandated by HB 3338 (78th Texas Legislature 2003) for retail public water utilities in Texas that provide potable water. The Texas Water Development Board (TWDB) is the implementing state agency responsible for

collecting and processing the water audit information. The bill required retail public utilities that provide potable water to "perform and file with the TWDB a water audit computing the utility's most recent annual system water loss" every five years. Under this authority, the TWDB instituted new water audit reporting requirements that require retail public utilities to carefully audit their system water use at least once every five years; to estimate system water use in standard, well-defined categories; and to report their first set of water loss data to the TWDB by March 31, 2006. Appendix I includes a listing of retail public water utilities within the Region C area that submitted a water loss audit to the TWDB for 2005.

The new water audit reporting requirements follow a methodology that is recommended by the International Water Association (IWA) and the American Water Works Association (AWWA) Water Loss Control Committee. This methodology relies on strictly defined water use categories and water loss performance indicators and is becoming the international water loss accounting standard.

In 2006, an assessment of the first set of audit submissions was conducted jointly by Alan Plummer Associates, Inc. and Water Prospecting and Resource Consulting, LLC and documented in the report, *Analysis of Water Loss as Reported by Public Water Suppliers in Texas*, dated January 2007[(9)].

Significant conclusions in the report:

- *Approximately half of retail public utilities in Texas (representing 84 percent of the State's population) reported their water loss data.*
- *A substantial amount of water was attributed to a "balancing adjustment" (entries made to reconcile difference in water supplied with water delivered or lost from the system, and is therefore not attributed to any water use category), causing significant uncertainty in estimates of water loss.*
- *Because of the large balancing adjustment entries, some of the utilities may have underestimated their real water loss (water that was physically lost from the system, such as main breaks and leaks, customer service line breaks and leaks, storage overflows, and others).*
- *Reporting utilities experienced an average total water loss of 5.6 to 12.3 percent of all water entering the reporting systems (the range is due to uncertainty regarding*

the balancing adjustment). Total water loss includes real loss (as defined parenthetically above) and apparent loss (water that was not accurately measured and billed to a customer, such as unauthorized consumption, customer meter under-registering, and billing adjustment and waivers).

- *The State of Texas's median reported real loss on a mile of main per day basis is 233 gallons/mile/day. The State of Texas's median reported real loss on a per service connection per day basis is 18.8 gallons/connection/day. Notwithstanding other uncertainties, the results of the statewide audit submittals indicated the median statewide real loss is only 23 percent of the lowest identified real loss for selected utilities in North America. Although this could indicate excellent or superior performance regarding system maintenance and operation, it appears more likely to be an indication of imprecise data and results.*

In any event, system audits are now required of water utilities, which if prepared in strict accord with the reporting protocols should provide quantifiable data of water savings related to water system audits.

Leak Detection and Repair

Leak Detection and Repair is an important component of system operation and maintenance. Conducting a proactive approach instead of a reactive approach to leak detection and repair represents an action that is an effective BMP. Employing electronic equipment for detecting line leaks can also be a beneficial BMP. It is noted that utilities that have practiced proactive leak detection and repair and have used electronic leak detecting equipment already benefit from this BMP. Therefore, identifying this as a new BMP will not result in as much water savings as that which would be achieved by entities that are implementing this BMP for the first time.

The size of the utility will have a bearing on the leak detection program. For small utilities, there may be no increase in their maintenance staff to successfully implement a BMP. Utility systems in small cities or utility districts may enjoy a high level of leak detection and repair since the maintenance staff is usually intimately familiar with the system and its customer base.

Large utilities have a revenue stream that allows for the procurement of specialized equipment (e.g. water leak detection devices, etc.). They can also more easily undertake capital programs for utility line replacements. Most large utilities serve a customer base with core areas that are greater than 50 years old. Because of the age of the infrastructure, maintenance and system upgrades require aggressive leak detection and repair programs to prevent increased or continued water loss from aging infrastructure.

Challenges to mid-sized utilities vary. Some have similar age problems like the larger utilities. Others have growth patterns that are more recent, and their utility systems are more modern resulting in potentially less water loss through the system.

Pressure Control

Pressure control envisions modulating pressure in the system to reduce line pressures when the demand is not present. The direct effect is to minimize the volume of water lost to line leaks at the times when the pressure is reduced. Constraints to the concept of system pressure modulation are (1) the need to supply adequate water for fire fighting at all times, (2) the need to refill water storage tanks during off-peak hours, and (3) the need for SCADA systems and advanced technology valving to efficiently implement a pressure control program.

Water Meter Replacement and Upgrades

A viable water meter management program is a mandatory component of the Water System Audits, Leak Detection and Repair, and Pressure Control BMP. Water meters have predetermined timeframes where the device performs with high accuracy. Therefore to maintain accuracy over time, meters must be replaced regularly. The level of sophistication among types of meters and meter reading systems is growing. Automated Meter Reading (AMR) technology is becoming employed more frequently in water utility systems. However, the most important facet of water meters is the use of the information once the meter has been read. The comparative information can indicate the potential of a water leak. The type of water meter, the method of reading it, and the recoding system are economic

choices. The use of the information and the accuracy of the meter system are the most important components of the BMP.

Survey Results

In general there is much activity and use of this BMP. Many of the respondents noted the importance of this BMP's contributions in improving water conservation. However, procedures and protocols to quantify the effectiveness of water system audits, leak detection and repair, and pressure control were not evident from many of the WUGs and WWPs based on their responses.

Water System Audits

Accurate water system audits are critical for identifying water losses and the potential for conservation. If audits are performed on the cycle required by HB 3338, then the next comprehensive audits performed by water suppliers will be due in 2011. The report, *Analysis of Water Loss as Reported by Public Water Suppliers in Texas*, recommended increasing the frequency of the audits. Because of uncertainties in the information provided in the audits, it would be of value to conduct comprehensive audits annually in order to gain more experience in the audit system and to focus on better categorization of whether the water is used or lost to the system.

Leak Detection and Repair

In general, survey respondents were not able to quantify water savings from this BMP. The level of leak detection varied from water supplier to water supplier. The larger the population served, the more budget and manpower was dedicated to the program. The following are three examples of the program identified with the water supplier.

North Texas Municipal Water District (Wholesale Water Provider)

The North Texas Municipal Water District (NTMWD) monitors the losses of their 72 retail customers. The NTMWD estimates overall water losses at five percent.

In October 2000, the NTMWD established a preventative maintenance crew to check air valves, blow-offs, and isolation valves. During these inspections, the crew checks the system for leaks. If leaks are identified, those systems are scheduled. For Fiscal Year (FY) 2008-2009, the NTMWD intends two add two additional employees to this team. In addition to the preventative maintenance crew, the NTMWD administers an eddy current testing program to assess pipeline integrity.

The NTMWD budgets $50,000 for valve testing and $500,000 for the pipeline integrity program.

City of Dallas (Population > 1,200,000)

Beginning in Fiscal Year (FY) 2004, the Dallas Water Utilities (DWU) expanded its water main replacement programs to attain a 75-year replacement cycle. In FY 2007, an additional leak detection crew was budgeted in order to advance the leak detection program. An additional leak detection crew is scheduled to be added to the program beginning in FY 2009.

Dallas Water Utilities employs an innovative leak detection program, which utilizes a variety of technologies to detect, locate, and repair leaks in both its water distribution and transmission systems. During FY 2006, this program located over 200 leaks in Dallas' water distribution system, for an annual savings estimated at 100 million gallons of water. Beginning in FY 2005, Dallas expanded its leak detection program to include the use of remote sensing acoustical technology (Sahara® leak location system) on its large diameter transmission mains.

The City of Dallas budgets $405,000 per year for leak detection and an additional $3,500,000 per year for line repairs.

City of Allen (Population <80,000)

The City of Allen has an aggressive water conservation program. The water department contributes financially to the salary of one code enforcement officer (pays

½ of the salary and benefits (*$45,500*) of one code enforcement officer) to address water conservation issues. The city is typical of rapidly growing cities in north central Texas. It reports that 75 percent of its infrastructure is less than 15 years old. Accordingly, it has no short-range plans to increase its maintenance budget to add additional leak detection crews. The City has purchased electronic leak detection equipment to assist its crews in leak detection. Anecdotally, the City reported that it discovered a leak, which was discharging to a storm sewer. This leak detection and subsequent repair resulted in a one-time savings of several million gallons.

Tables 5.14 and 5.15 provide representative information regarding responses from WWPs and WUGs. The respondents were grouped in terms of large, medium, and small water suppliers.

The absence of quantifiable benefits makes the assessment of a leak detection program challenging. Leak detection and repair activities require additional employees and new equipment. The correlation between the costs associated with leak detection and water conservation has not been fully documented in most cases. This is a relatively new program in most utilities and will take time to establish reporting and documentation of the savings.

Table 5.14
Survey Results for WWP Leak Detection and Repair

ENTITY SIZE	BMP Implementation	Description	Annual Budget	
			Leak Detection	Repairs
Large City	Yes	Distribution Leak Detection Program	$405,000	$3,500,000
Large City	Yes	Leak detection loggers, dedicated field staff and contracts for water loss pilot programs, meter replacement program	$2,000,000	
Medium City	No	Not Reported	$438,000	
Medium City	No	Not Reported	$125,000	
Medium City	Yes	Vigilance in locating and repairing	Not Reported	
SUD Small	No	Leaks repaired as soon as possible	Not Reported	
Medium City	No	Currently developing a program	Not Reported	
Water District Large	Yes	ARV Maintenance crew - checks lines and appurtenances	$300,000	
Water District Large	Yes	Routine inspections (aerial and ground); Remote field eddy current transformer coupling (non-destructive) pipeline testing; Pressure Pipe Inspection Company's Sahara Leak Detection Technology	$50,000 for air valves; $500,000 for pipeline integrity program	

Table 5.15
Survey Results for WUG Leak Detection and Repair

Entity Size	BMP Implementation	Description	Annual Budget
Large City	No	N/A	$340,550
Large City	Yes	Automated Meter Readers	Not Reported
Large City	Yes	Replacement of leaking water mains; SCADA system monitoring; Contractors use portable meters and water loss formula.	$175,000
Medium City	Yes	Use leak detection equipment to find hidden leaks on a regular basis	$25,000
Medium City	Yes	Closely monitor unaccounted for water loss; city departments must account for usage; all city facilities are metered	Not separated
Medium City	Yes	Monitor water production and billed consumption daily for comparison. Has a crew that looks for suspicious use of water.	$250,000
Medium City	Yes	Water conservation crew utilized; electronic equipment to assist in leak detection.	$125,000
Small City	Yes	Not a formal program, but use leak detection equipment and keep track to identify losses.	Not Reported
Small City	No	Employees drive system to locate leaks	Not Reported
Small City	No	Not Reported	Not Reported
Small City	Yes	Compare daily water pumped against daily average	$15,000

Pressure Control

Responses were varied among the contacted WWPs and WUGs. Based on the survey results, pressure control has not been implemented on a widespread basis. The need to refill tanks and storage overnight was cited as one barrier to implementing such a program. There have been initiatives cited by some of the respondents. North Richland Hills regulates pressure throughout its system through SCADA operations. The City of Allen reported lowering water towers ten feet during summer months in order to decrease water usage.

Water Meter Replacement and Upgrades

Table 5.16 below depicts the responses related to meter programs. The meter replacement program schedule should be prior to the expiration of a meter's life expectancy. This would ensure accurate metering. Of the entities surveyed, all but one entity reported to have an annual meter replacement program.

Changing over to automated meter readers (AMR) has not been done on a widespread basis. Based on the interviews, some utilities concluded that for their operation, changing meters to an AMR system is not cost effective. However, for other utilities, AMR have been determined to be beneficial. The utilities certainly understand the importance of a thorough meter management program.

Table 5.16
Meter Replacement Program

Entity Size	Entity Type	% Meters Replaced Annually	Meter Testing and Replacement Budget	Estimated Average Line Pressure
Large CITY	WWP	10%	Not Reported	60 psi
Large CITY	WWP	15%	Not Reported	70 psi
Medium City	WWP	7.6%	Not Reported	60 psi
Medium City	WWP	10%	Not Reported	65 psi
Medium City	WWP	Not Reported	Not Reported	60-100 psi
SUD Small	WWP	100% in progress	Not Reported	65 psi
Medium City	WWP	4.50%	Not Reported	50-85 psi
Medium City	WWP	4%	Not Reported	70 psi
Water District Large	WWP	8%	Not Reported	40-50 psi
Water District Large	WWP	No set %	Not Reported	NA
Large City	WUG	6%	$47,500	70 psi
Large City	WUG	10%	Not Reported	60 psi
Large City	WUG	5%	Not Reported	68 psi
Medium City	WUG	5%	Not Reported	60 psi
Medium City	WUG	3%	Not Reported	47 psi
Medium City	WUG	10%	Not Reported	80 psi
Medium City	WUG	10%	Not Reported	75 psi
Small City	WUG	No set %	Not Reported	65 psi
Small City	WUG	11%	Not Reported	65 psi
Small City	WUG	10%	Not Reported	52 psi
Small City	WUG	7%	Not Reported	55 psi

Conclusions

In general there is much activity and use of this BMP. Many of the respondents noted the importance of this BMP's contributions in improving water conservation. However, procedures and protocols to quantify the effectiveness of water system audits, leak detection and repair, and pressure control were not evident from many of the WUGs and WWPs based on their responses. The ability to quantify the practice's effectiveness will facilitate obtaining resources and support of this BMP.

Water System Audits

System audits were a first step towards accurately defining water use within water supply systems. The audits need to be repeated on a more frequent basis than the five-year program mandated by HB 3338. Without current water audit data, the Region C Water Planning Group will have to rely on the 2005 water audit data for the forthcoming regional water plan due in 2011. If water providers in Region C are currently performing water system audits, those entities should be solicited to provide audit data. This data would further define current water use within water systems to facilitate an accurate reporting for the regional water plan due in 2011.

Leak Detection and Repair

Costs for leak detection and repair activities for purposes of BMP identification were difficult to quantify as they are already part of the entities' operations and maintenance service.

The line between regular maintenance and conservation is vague. Whereas the monetary cost of leak detection and repair may be difficult to quantify, the water savings could be collected relatively simply. In order to quantify the amount of water lost in each leak detected and repaired, a protocol based on line pressure, size of aperture, and assumed duration of leak should be developed. If the major water supply providers adopted such a protocol and the results were made available to the Region C Water Planning Group, there could be an increase in the quantification of the results of the program throughout the Region. This information is not being tracked routinely by most entities.

It is apparent from survey responses that leak detection and repair is a priority among the utilities. Quantifiable results of the water savings from these individual programs will greatly help utilities to adopt and resource those activities that have the most benefits.

Pressure Control

Pressure control is not practiced for the sake of water conservation by most water supply providers, including the five major providers. No recommendations are made regarding this specific component of the BMP. However, at such time that leak information is

better quantified in the Leak Detection and Repair Component, it is recommended that the consideration of use of pressure control protocols be encouraged in Region C.

Meter Replacement and Upgrade

The meter management program is reported by most respondents to be effectively managed. There does not appear to be a trend to upgrade the meter systems to AMR systems. Based on interviews, the issue is one of economics. The benefits compared to the cost of implementation have not been demonstrated to the utility managers to compel them to invest in AMR systems.

5.4.3 Landscape Ordinance Implementation Information

As shown in Table 4.2, 29% of Water Retailer responded that they have implemented the Water Waste Prohibition best management practice (BMP). In most cases, this BMP has been implemented by the adoption of landscape ordinances that restrict water use in order to achieve water conservation. Detailed information regarding these landscape ordinances was gathered for ten municipalities in the Region C Water Planning Area. Although the specific restrictions vary, several similarities can be drawn among these landscape ordinances.

The majority of these municipalities restrict water use from June 1st through September 30th. However, some cities have chosen to restrict water use for longer periods or year-round. In addition, most municipalities restrict water use from 10:00 a.m. to 6:00 p.m., but a few additionally restrict water use from 5:00 a.m. to 8:00 a.m. Most of the landscape ordinances specifically state that irrigation systems on well water, reuse, or reclaimed water may be exempt from these day and time watering restrictions. Likewise, most cities state that watering with handheld hoses, soaker hoses, or dispensers is allowed at any time.

Most of the landscape ordinances for these municipalities have very similar restrictions. The majority of the ordinances prohibit:

- Irrigation of impervious surfaces or other non-irrigated areas,
- Irrigating lawn or landscape during any form of precipitation,
- Operating an irrigation system with misdirected or broken sprinkler heads,

- Operating an irrigation system in a manner that causes runoff or wastes water, and
- Operating an irrigation system without rain sensors and freeze gauges (recently installed and existing systems).

In addition, some municipalities also state that it is a violation to irrigate lawns or landscapes when the temperature reaches 40°F or below.

Some of the landscape ordinances contain enforcement actions for violations such as discontinuance of water service and the installation of a locking device on the double-check valve to the irrigation system; however, the majority include only fines for violators of the water conservation restrictions. Most of the ordinances do not specify how the restrictions will be monitored. Therefore, it is not clear which department has the responsibility of identifying violations (e.g., water departments, police departments, etc.).

During the 2007 legislative session, the Texas Legislature adopted House Bill 1656 which provides that a city over 20,000 in population must require that an installer of an irrigation system be licensed under the Occupations Code and that the installer obtain a permit from the city before installing an irrigation system in the city or its extraterritorial jurisdiction. It also requires a city to regulate the design, installation, and operation of irrigation systems in accordance with Section 1903.053 of the Occupations Code and any rules adopted by the Texas Commission on Environmental Quality (TCEQ). The TCEQ adopted rules under H.B. 1656 in June 2008.

The Texas Municipal League and TCEQ staff members have developed a model ordinance for cities to consider using when creating irrigation system ordinances and permitting systems. The North Central Texas Council of Government (NCTCOG) formed a subcommittee to refine this model ordinance for use in the North Texas area. This subcommittee recommended some additional requirements for this model ordinance as well as some minor revision of text. NCTCOG's model ordinance is included in Appendix J of this report.

5.5 Probability of Achieving Goals

The *2006 Region C Water Plan* projected that 28% of the available water supply to the region in 2060 would be from conservation and reuse. Based on the current implementation

of BMPs and currently planned reuse projects, the probability of achieving that level of conservation and reuse by 2060 has been assessed.

The 2006 Region C Plan recommended 242,000 acre-feet per year of conservation by 2060. This amount is a total of assumed water savings from WWPs and WUGs that were assigned basic and in some cases expanded water conservation packages (BMPs). Currently, conservation efforts in Region C have been given increased attention and resources. Much of the conservation efforts have been very successful. It appears that Region C is on track or ahead of schedule for implementation of the Basic Conservation Package, which was recommended for 2010 in the Plan. The 2006 Region C Plan does not even recommend the Expanded Conservation Package until 2020, and many water user groups in Region C are already implementing these measures. Based on the discussion above about the conservation implemented in Region C, it is likely that these conservation goals will be met.

The *2006 Region C Water Plan* included 770,998 acre-feet per year of recommended reuse projects by 2060. These projects are listed in Appendix G. As discussed in Section 4.3 of this report, many reuse projects that were recommended in the 2006 Plan are already being implemented or are being planned, and a number of projects that were not included in the *2006 Region C Water Plan* are also being planned. In addition, a number of the WWPs have already amended (or are in the process of amending) their current water rights to allow for reuse of their own wastewater that flows into their reservoirs (See Table 4.6). Given these factors, it is very likely that Region C will realize its 2060 goal for reuse.

6. Update of Reuse Projects in Region C

6.1 Existing Projects

The reuse of treated wastewater effluent is an effective water conservation measure as well as a key component of future Region C water supplies. In 2006, thirty direct and indirect existing reuse projects were currently in operation in Region C, providing nearly 100,000 acre-feet/year to the region. (A list of these projects is included in Appendix G). In addition to existing reuse projects, the *2006 Region C Water Plan* recommended an additional 34 projects. The *2006 Region C Water Plan* estimates that these proposed direct and indirect reuse projects will provide 770,998 acre-feet/year of the 2060 Region C water demand. (A list of these projects is also included in Appendix G). At the time the *2006 Region C Water Plan* was published, many of these recommended reuse projects were in the planning and permitting phases. Section 4.3 of this report contains information on reuse projects that have been developed since the *2006 Region C Water Plan* as well as information from the survey regarding future plans for reuse in the Region. An update on the status of selected direct reuse projects within the Region C planning region is included in Section 6.2. Indirect reuse projects are discussed in Section 6.3.

6.2 Update of Selected Direct Reuse Projects in Region C

Direct reuse systems deliver treated effluent from wastewater treatment facilities to water users, with no intervening discharge to waters of the state. Typically, direct reuse supplies water for landscape irrigation and industrial purposes (such as cooling water for steam electric power plants).

The state of Texas requires notification to the Texas Commission on Environmental Quality (TCEQ) of any direct reuse project to ensure measures are in place to protect public health and safety. Title 30, Chapter 210 of the Texas Administrative Code includes specific regulations applicable to direct reuse, including the notification and authorization process. Two types of reclaimed water use are defined in Chapter 210 – Type 1 and Type 2. Type 1 uses include those where public contact is likely to occur and Type 2 uses include those where

public contact with the water is not likely to occur. More stringent water quality requirements apply to water used for Type 1 applications.

Most of the existing reuse projects identified in the *2006 Region C Water Plan* are direct reuse projects. A number of additional direct reuse projects are in the planning stages. The following sections provide an update and discussion of five direct reuse projects in various stages of planning and implementation within the region. These include projects for the City of Dallas (Dallas Water Utilities), the City of Fort Worth, the City of Frisco, the City of Denton, and Trinity River Authority. Direct reuse projects are projected to provide 208,958 acre-feet/year of the 2060 Region C water demand.

Dallas Water Utilities

The *2006 Region C Water Plan* included 21,017 acre-feet/year of direct reuse for Dallas Water Utilities (DWU) by the year 2060. The following sections provide an update on the status of the DWU direct reuse projects.

Summary of Current and Planned Projects

Dallas Water Utilities (DWU) developed an implementation plan to support the advancement of the DWU Recycled Water Program in August 2005. The plan was developed in conjunction with the Cedar Crest Golf Course Pilot Project, which currently uses recycled water for irrigation. In addition to identifying viable non-potable recycled water projects, the implementation plan also provided necessary infrastructure requirements and a schedule for implementation. The DWU plan includes development of policies and procedures for the design, construction, and operation of recycled water facilities and public awareness and marketing efforts.

Two direct non-potable recycled water projects were identified based on feasibility and likelihood of customer interest. The Cedar Crest Pipeline Extension Project will support a projected average supply of 1.75 million gallons per day (MGD) (1,961 acre-feet/year). This project will extend the existing pipeline, which serves the Cedar Crest Golf Course, to the Dallas Zoo and Rock-Tenn area. The Cedar Crest Pipeline Extension Project is currently being designed. Construction is anticipated to begin in 2009.

The White Rock Pipeline project will support a projected average supply of 16.50 MGD (18,495 acre-feet/year) and will serve a number of irrigation and industrial customers in the White Rock Creek corridor. The construction of a pipeline and two new pump stations will allow recycled water from Central Wastewater Treatment Plant to be pumped to customers in the White Rock Creek watershed. DWU is planning to move forward with development of customer agreements and preliminary engineering on this project in 2009.

Implementation Issues

Funding of infrastructure for the recycled water projects is one of the primary challenges for DWU. Further implementation of the program will also require establishment of policies and procedures for operation of the recycled water system and development of a marketing and public education program.

City of Fort Worth

The *2006 Region C Water Plan* included an additional 11,787 acre-feet/year of direct reuse for the City of Fort Worth by the year 2060. The following sections provide an update on the status of the City of Fort Worth direct reuse projects.

Summary of Current and Planned Projects

In May 2007 the City of Fort Worth completed its *Reclaimed Water Priority and Implementation Plan* which supports the implementation of a direct reuse program. During the course of the study, the City worked closely with wholesale customers, Tarrant Regional Water District (TRWD), Trinity River Authority (TRA), Arlington, and other surrounding cities to identify approaches to the reclaimed water program that would support regional cooperation. The study evaluated many alternatives for direct non-potable reuse and identified four potential projects based on feasibility and the likelihood of customer interest.

The first project, which would serve the central and southern portion of the City, would support an annual average demand of 2.2 MGD (2,466 acre-feet/year) and serve the Trinity River Vision Project, a number of golf courses and parks as well as an industrial area that includes Alcon Labs, Miller Brewery and Mrs. Baird's. Several alternatives were evaluated for providing water to these areas. The recommended alternative served the entire

project with reclaimed water from the Village Creek Wastewater Treatment Plant (VCWWTP). However, a second alternative which would serve the southern area with a separate satellite treatment facility was also considered. A separate special study supported by the current regional planning efforts is further evaluating the feasibility of a satellite treatment facility to serve the southern area.

The second project, which primarily would serve new developments in the western portion of the City, would support an annual average demand of 3.8 MGD (4,259 acre-feet/year). This project would include the development of a satellite treatment facility in the Mary's Creek watershed and would provide water for irrigation of a golf course, green space areas and residential developments using dual distribution systems. The City is currently proceeding with a follow-up study to select a site for the satellite facility.

The third project, which would serve an area in the northern part of the City in the Alliance corridor, would support an annual average demand of 4.2 MGD (4,707 acre-feet/year). This project would use reclaimed water from the TRA Denton Creek Regional Wastewater System to provide non-potable water primarily for irrigation and water amenities.

The fourth project, which would provide reclaimed water to the eastern service area, was initially envisioned to support an annual average demand of 2.8 MGD (3,138 acre-feet/year). This project would utilize treated effluent from Village Creek Wastewater Treatment Plant to provide non-potable water service to customers within the far eastern areas of Fort Worth, Dallas/Fort Worth airport as well as the Cities of Arlington, Euless, and Grand Prairie. The City is currently updating the potential demands for this project and proceeding with the design and development of customer commitments for this project. In particular, demands for serving the development of natural gas wells in the area are being incorporated into the project. Construction is scheduled to be completed by 2010.

Implementation Issues

Funding of infrastructure for the reclaimed water projects is a significant challenge for the City of Fort Worth. Development of a draft City ordinance defining policies and procedures for the reclaimed water program was completed as part of the *Reclaimed Water Priority and Implementation Plan*. Further implementation will require finalizing this ordinance and development of marketing and public education programs.

City of Denton

The *2006 Region C Water Plan* included an additional 4,708 acre-feet/year of direct reuse for the City of Denton by the year 2060. The following sections provide an update on the status of the City of Denton direct reuse projects.

Summary of Current and Planned Projects

The City of Denton currently provides reclaimed water for direct reuse to eight retail customers from the Pecan Creek Water Reclamation Plant. Over the past two years, the program has provided an average of 0.51 MGD (1,566 acre-feet/year) of reclaimed water for irrigation and cooling water to its customers.

The City of Denton and Robson Communities, Inc., collaborated to plan a 0.25 MGD water reclamation facility to service a residential development. Robson Communities agreed to fund the construction of the facility and yield ownership to the City in exchange for 25 years of effluent for irrigation. The facility is currently being expanded to a 0.8 MGD capacity, and future expansions are planned to increase the capacity to as much as 1.6 MGD. The reuse distribution system is currently being designed and will provide reuse wastewater to the community's golf course and other public areas.

Implementation Issues

Providing the necessary infrastructure for reclaimed water delivery in a cost effective manner is the biggest challenge for the City of Denton's reclaimed water program.

City of Frisco

The *2006 Region C Water Plan* included a total of 307 acre-feet/year of existing direct reuse for the City of Frisco. The following sections provide information on the City of Frisco direct reuse projects.

Summary of Current and Planned Projects

In 2006, the City of Frisco completed a *Reuse Water Master Plan*. The plan assessed the current state of Frisco's reuse system, potential customers, and costs to modify the existing system. At the time the report was written, only one customer, The Trails of Frisco

Golf Course, was using reuse water. Since then, the City Parks Department has begun using reuse water to irrigate a greenbelt around the wastewater treatment plant. One homeowners association has connected to the system as well. The report identified twenty-seven potential customers to be served by the reuse system.

The master plan calls for a total of three phases of modifications to the system. The City has completed the first phase of modifications. The current reuse system in Frisco consists of a pump station at the Stewart Creek Wastewater Treatment Plant (owned and operated by NTMWD) and a number of transmission lines. In the future, the Panther Creek Wastewater Treatment Plant (also a NTMWD plant) will become the primary source of reuse water and will have an average day capacity of up to 20 MGD (22,418 acre-feet/year) of wastewater flow available for the reuse system by buildout. The projected demand met through reuse is 16.2 MGD (18,158 acre-feet/year). Additional potential customers may be added as future development occurs.

Trinity River Authority

The *2006 Region C Water Plan* included an additional 180,130 acre-feet/year of indirect and direct reuse for the Trinity River Authority (TRA) by the year 2060. The following sections provide an update on the status of the TRA direct reuse projects not associated with steam electric power (SEP), which are discussed in Section 6.3.

Summary of Current and Planned Projects

TRA currently provides 8,000 acre-feet/year of direct reuse water to Las Colinas from its Central Regional Wastewater Treatment System. A planned expansion to the Las Colinas project will include an additional 7,000 acre-feet/year of direct reuse for irrigation by 2015. Discussions are ongoing with potential water users for irrigation use of 7,500 acre-feet/year of reuse water from Denton Creek WWTP for use in Denton and Tarrant counties. A direct reuse project in Dallas and Ellis counties for irrigation is also in the planning phases and is expected to provide 250 acre-feet/year from TRA's Ten Mile Creek WWTP.

Implementation Issues

As the estimated implementation dates for these projects approach, potential customers as well as their specific needs must be quantified and addressed on an individual basis.

6.3 Update of Selected Indirect Reuse Projects in Region C

Augmentation of potable water supplies with reclaimed water, or indirect reuse, involves the discharge of highly treated wastewater effluent to a stream or reservoir, blending with "natural" waters and subsequent diversion for reuse. In Region C, many water supplies consist of return flows from treated wastewater effluent as well as natural runoff. In addition to providing water for landscape irrigation and industrial purposes, indirect reuse can be used to augment water supplies for municipal use.

There are currently no specific federal regulations that address indirect recycling. However, the EPA has published guidelines for water reuse[(10)]. The EPA guidelines include recommendations for treatment levels, water quality, and monitoring for ground water recharge and surface water augmentation. With respect to surface water augmentation, the EPA guidelines suggest that the wastewater treatment process provide an appropriate form of advanced treatment which includes but is not limited to filtration and disinfection. In addition, the guidelines recommend that the reclaimed water quality meet or exceed drinking water standards (e.g. the Safe Drinking Water Act) and advocate a multiple barrier approach to potable reuse applications.

In Texas, no regulatory water quality standards pertain specifically to indirect use of reclaimed water. Instead, reclaimed water that is discharged to a stream or reservoir is subject to Texas Pollutant Discharge Elimination System (TPDES) permitting procedures and the Texas Surface Water Quality Standards (TSWQS). The TSWQS include both numerical and narrative criteria to address various constituents. In addition, all potable water supplies, including those that are comprised of reclaimed water, must meet the requirements of the Safe Drinking Water Act.

The following sections provide an update and discussion of five indirect reuse projects in various stages of planning and implementation within the region. These include projects for the Upper Trinity Regional Water District, the City of Athens, North Texas Municipal Water

District, Tarrant Regional Water District and Trinity River Authority (TRA). (The TRA projects, which focus on providing water for steam electric power, include both direct and indirect reuse. However, since they are closely related, they are all discussed in this analysis). Indirect reuse projects are projected to provide 665,459 acre-feet/year of the 2060 Region C water demand.

Upper Trinity Regional Water District

The *2006 Region C Water Plan* included a total of 30,665 acre-feet/year of indirect reuse for Upper Trinity Regional Water District (UTRWD). The following sections provide an update on the status of the UTRWD indirect reuse projects.

Summary of Current and Planned Projects

The Chapman Water Reuse System is the first project implemented by the UTRWD as part of its long term indirect reuse program. Since the completion of conveyance facilities in 2003, the UTRWD has, in collaboration with the City of Irving and NTMWD, imported water from Chapman Lake into Lewisville Lake. In addition, UTRWD also operates three regional water reclamation plants which discharge into the Lewisville Lake watershed. Recognizing the potential to augment its water supply, the UTRWD submitted a water rights application in August 2001 to the Texas Commission on Environmental Quality (TCEQ) to indirectly reuse return flows originating from Chapman Lake. In March of 2006, a permit was granted allowing UTRWD to reuse up to 9,664 ac-ft/yr of effluent discharged from the district or its customers' treatment facilities into Lewisville Lake.

In addition to providing UTRWD with an additional economical raw water supply source, this collaboration also provides positive benefits to both Dallas and Denton which hold the water rights in Lewisville Lake. The additional water supply brought to Lewisville Lake reduces UTRWD's demand upon Lewisville Lake's available raw water supply. Furthermore, Dallas and Denton will receive additional raw water supply when UTRWD's return flows exceed those permitted by the project.

Implementation Issues

As part of its agreement with the Cities of Dallas and Denton, UTRWD was required to develop a detailed accounting system that tracks Chapman Lake water on a daily basis through supply, delivery and treatment facilities, and back to Lewisville Lake. Since UTRWD also purchases Lewisville Lake water from Dallas and Denton, accounting for the Chapman Lake water involved the development of a detailed data management system to keep track of each water source and return flows within the system.

City of Athens

The *2006 Region C Water Plan* included a total of 1,596 acre-feet/year of indirect reuse for the City of Athens. The following sections provide an update on the status of the City of Athens indirect reuse projects.

Summary of Current and Planned Projects

In response to the recommendations in the *2006 Region C Water Plan*, the Athens Municipal Water Authority (AMWA) and the City of Athens (Athens) initiated planning for a raw water supply augmentation project at Lake Athens. Athens is located in both Regions C and I, and total demands are projected to increase to 9,492 acre-feet/year by 2060. A guidance document, which is being prepared as part of a separate special study associated with the Region C planning, will provide the City with further assistance in developing a plan to transport reclaimed water from area wastewater treatment plants to Lake Athens. Polishing treatment would be performed with a constructed wetland. Following polishing treatment, blending, detention, and diversion, the reclaimed water would ultimately be used for municipal, livestock, irrigation, and manufacturing purposes throughout the City.

Implementation Issues

A detailed discussion of implementation issues will be provided in the document being prepared for a separate Region C special study. Following completion of the planning level evaluation being performed as part of the separate Region C special study, additional implementation steps will include identification of funding sources, acquisition of permits, and design and construction of the conveyance and treatment facilities. Augmentation rates

ranging from 1.14 to 2.11 MGD (1,617 to 2,369 acre-feet/year) are being evaluated as part of this study based on water quality and economic considerations. Potential permitting requirements for the project include a water rights permit, USACE 404 permits, and Texas Pollutant Discharge Elimination System (TPDES) permits.

North Texas Municipal Water District

The *2006 Region C Water Plan* included a total of 173,882 acre-feet/year of indirect reuse for North Texas Municipal Water District (NTMWD) by the year 2060. The following sections provide an update on the status of the NTMWD indirect reuse projects.

Summary of Current and Planned Projects

The *2006 Region C Water Plan* noted that the NTMWD currently had a water right to reuse up to 32 MGD of discharge from the Wilson Creek WWTP and had applied for the right to reuse an additional 32 MGD. The permit has since been approved, and the NTMWD is now permitted to reuse up to 64 MGD (71,882 acre-feet/year) of discharges from the Wilson Creek WWTP.

Following its completion in 2008, the North Texas Municipal Water District (NTMWD) will utilize reclaimed water diverted from the East Fork of the Trinity River (East Fork) to augment existing supplies at Lake Lavon. The East Fork Raw Water Supply Project includes a 43 mile pipeline to transport treated water from a 1,840 acre constructed wetland near Seagoville to Lake Lavon. In 2007, NTMWD was granted a water rights permit authorizing the diversion and use of up to 157,393 acre-feet/year for the project. However, the project is currently planned to provide approximately 102,000 acre-feet/year of additional supply to Lake Lavon.

Implementation Issues

Due to its immediate need for additional supply, NTMWD expedited the implementation of the East Fork Raw Water Supply Project. There were several key actions involved in advancing the project on an expedited schedule. NTMWD worked closely with the TCEQ and several stakeholders to address issues in a manner that facilitated issuance of the water right permit. Another critical action was acquisition of a U.S. Army Corps of

Engineers (USACE) 404 permit, which was required in order to begin construction. Additionally, NTMWD proceeded on a fast-track basis to complete the design and construction of the project. This fast-track approach included establishment of a wetland nursery early on in the project to provide a supply of plants for the entire wetland area.

Tarrant Regional Water District

The *2006 Region C Water Plan* included a total of 185,368 acre-feet/year of indirect reuse for Tarrant Regional Water District (TRWD). The following sections provide an update on the status of the TRWD indirect reuse projects.

Summary of Current and Planned Projects

In order to increase the yield of the Richland-Chambers and Cedar Creek Reservoirs, the TRWD has undertaken a long term planning and implementation project to divert water from the main stem of the Trinity River, provide polishing treatment with constructed wetlands and transport the treated water to Richland-Chambers and Cedar Creek reservoirs. The TRWD was granted a water rights permit from the TCEQ in 2005 which authorizes the use of historic and future return flows of up to 195,818 acre-feet/year for both the Richland-Chambers and Cedar Creek projects. These projects have been developed using a phased approach which considers the associated financial aspects, operation and maintenance issues, treatment performance, and design criteria for the full scale wetland systems. The Richland-Chambers project is currently under development and will be completed first. The components of the phased approach include a pilot project, a field scale wetland, and Phase I and Phase II buildout of the full scale wetland. Several of these components are described below.

The pilot project commenced with the design and construction of a 2.5-acre wetland demonstration system. This system operated from 1992 to 2000. The data obtained from the pilot project was utilized to facilitate design and construction of a field scale project. In 2002, a 243-acre field scale wetland, now known as the George W. Shannon Wetlands Water Recycling Facility (GWSWWRF) at Richland-Chambers Reservoir, was constructed along with a pump station facility on the Trinity River to divert flows to the wetland system.

Following the successful operation and analysis of a pilot project and 243-acre field scale wetland, the TRWD authorized the expansion of the GWSWWRF. Expansion of the GWSWWRF will take place in two phases. Phase I included the construction of 190 acres of wetland cells and a re-lift pump station to convey the wetland polished water into Richland Chambers Reservoir. Phase I is scheduled to be operational in late 2008. Phase II will consist of the buildout of the GWSWWRF to approximately 1800 acres. The design of Phase II is currently underway and is scheduled to be completed in 2013.

Similar to the GWSWWRF at Richland-Chambers, a wetland polishing system is also planned for augmentation of supply in the Cedar Creek Reservoir. Conceptual design for the Cedar Creek Reservoir wetland system is being conducted concurrently with the design of the Phase II Expansion for the Richland-Chambers wetlands. Construction of the Cedar Creek system is anticipated to be complete by 2018.

Implementation Issues

TRWD has worked very closely with Texas Parks and Wildlife Department (TPWD) in the development of the GWSWWRF at Richland-Chambers. Through this partnership, TRWD and TPWD have demonstrated that the wetland can be managed successfully to meet both water supply and wildlife management objectives.

Notification for the USACE 404 permit at the GWSWWRF will occur in conjunction with detailed design efforts. USACE permitting at the Cedar Creek project site has not yet commenced.

Trinity River Authority

The *2006 Region C Water Plan* included a total of 180,130 acre-feet/year of indirect and direct reuse for the Trinity River Authority (TRA) by the year 2060. Many of these projects are targeted at serving steam electric power (SEP) facilities. SEP and other indirect reuse projects are summarized below.

Summary of Current and Planned Projects

TRA currently supplies nearly 5,000 acre-feet/year of indirect reuse to Waxahachie and 3,363 acre-feet/year to Ennis for steam electric power. By the year 2060, TRA is expected

to provide approximately 78,000 acre-feet/year of additional water supply for steam electric power generation in Dallas, Ellis, Freestone, and Kaufman counties. These projects will be implemented beginning in 2012 in Ellis County. TRA will transport 40,000 acre-feet/year of both direct and indirect reuse water 20 miles to steam electric power generation facilities in the Ellis County area by 2050.

By the year 2020, both the Dallas County and Kaufman County steam electric power reuse projects are projected to be in operation. TRA will supply Dallas County projects with 3,000 acre-feet/year through delivery of reuse water from TRA Central Wastewater Treatment Plant to Mountain Creek Lake. Kaufman County projects will receive 15,000 acre-feet/year of indirect reuse water from TRA and 5,000 acre-feet/year from North Texas Municipal Water District (NTMWD). TRA will treat return flows from the Trinity River and deliver the water to Kaufman County steam electric generation facilities via a 15 mile pipeline.

TRA's final steam electric power reuse project is projected to begin by the year 2030 in Freestone County. In addition to the 6,602 acre-feet/year from Richland-Chambers Reservoir and other supplies, Freestone County is projected to receive 20,000 acre-feet/year of indirect reuse water from TRA to supplement supply at area steam electric power generation facilities.

Several other indirect reuse projects via Joe Pool Lake are in various phases of planning. TRA will provide up to 20,000 acre-feet/year of indirect reuse water through Joe Pool Lake for use by the Johnson County SUD by 2060. TRA also has a separate water right to divert up to 3,500 acre-feet/year of indirect reuse at Joe Pool Lake by 2020.

Discussions are ongoing with potential water users for municipal use of 7,500 acre-feet/year of reuse water from TRA's Denton Creek Regional Wastewater System for use in Tarrant county. TRA also entered into a contract to allow Irving to reuse wastewater discharged from TRA's Central Regional Wastewater System. The 2006 Region C Plan estimated that 28,000 acre-feet/year of reuse water would be provided to Irving by 2060.

Implementation Issues

As the estimated implementation dates for these projects approach, potential customers as well as their specific needs, must be quantified and addressed on an individual

basis. Additionally, potential water quality permitting issues may need to be addressed for discharges of the concentrated blowdown water from the steam electric power plants.

7. Summary of Findings and Recommendations

7.1 Summary

The data collected as part of this study show that conservation and reuse continue to be a major focus for water providers in Region C. A survey conducted in 2004 for the *2006 Region C Water Plan* indicated that water user groups and wholesale water providers had implemented an array of conservation measures with a significant percentage implementing system/utility types of conservation practices. These include the practices that are directly implemented by the provider and address system-wide savings, such as education programs, water pricing, water audits and enacting ordinances. In this most recent survey system/utility conservation practices continue to be the most implemented strategies. Based on data received, there are indications that the implementation rates for several strategies are increasing at faster rates than projected. Public and school education programs, water waste prohibitions and residential audits each show increasing percentages of adoption among the survey sampling groups.

Strategies that are currently not being implemented (or not implemented by multiple providers) are rebate programs. Specifically, no provider reported implementing a rebate program for coin-operated clothes washers (commercial laundries). Programs targeting commercial and institutional water users generally have a low implementation rate across the region. There are a few providers that have begun to address ICI water conservation since the 2004 survey, and this is expected to continue to increase.

Several strategies that were not included in the 2006 Region C recommended conservation packages are currently being implemented by a few providers. Most of these strategies target outdoor water use and are perceived as being somewhat to very effective. Most of the providers plan to continue using these strategies.

The quantities of water saved by each BMP are difficult to confirm. There are too many variables that influence water use to accurately assess the water savings and compare these savings to the estimates developed for the Region C Water Plan. There is evidence that water conservation programs are controlling (and reducing) the water use that would have occurred without such measures. However, longer historical records and additional data are needed to confirm these trends and provide reliable estimates of water savings.

The cost data obtained from this study was limited, but it did confirm that water providers in Region C are committing significant budget dollars for water conservation programs. Public and school education programs appear to have a wide range of costs, depending on the level of effort of the program. Some entities are considering joining together to promote water conservation while sharing implementation costs.

Reuse continues to be a major component of the region's water conservation plan. Since the publication of the 2006 plan, one new reuse projects has been implemented, and seven new projects (not included in the 2006 plan) have been identified. Considering the current and planned future projects, Region C has the largest reuse program in the state.

7.2 Recommendations for 2011 Region C Plan

The information gathered by the surveys and an assessment of other potential water conservation strategies indicate that the water providers in Region C are on-target or ahead of schedule for implementing the recommended conservation practices in the *2006 Region C Water Plan*. The strategies currently being implemented reflect the recommended strategies in the 2006 water plan, and it is recommended that the strategies included in the municipal water user groups basic and expanded packages continue to serve as the primary means for achieving water conservation savings in the region.

Based on the analysis presented in this report, the following recommendations should be considered for inclusion in the 2011 Region C Water Plan:

1. Keep the same general format of Basic Conservation Package and Expanded Conservation Package, with some modifications as outlined below.
2. Move "Water Conservation Pricing" and "Water Waste Prohibition" from the Expanded Package to the Basic Package. Both of these BMPs have minimal costs and are relatively easy to implement. Sample language that could be used by entities in a Water Waste Prohibition ordinance has been included in Appendix K of this report.
3. Eliminate "ICI general rebate" from the Expanded Conservation Package due to low implementation rates and institutional challenges of administering these programs.
4. Consider adding some form of "Landscape Watering Restriction" to the Expanded Conservation Package. In particular, the time-of-day lawn water described in Section 5.4.3 of this report has become widely implemented in Region C and could be used as a model for implementation of this BMP.

5. Contact North Central Texas Council of Governments (NCTCOG) to determine their interest in and feasibility to coordinate Region-wide public education/conservation efforts for entities who are not already involved in such programs.
6. Consider other strategies currently being used in the region for possible inclusion in the Expanded Conservation Package.
7. Encourage regional coordination of public education efforts.
8. Develop, in cooperation with other regions and the TWDB, a program to gather information and data about water savings and costs, and perform a quantitative assessment of water savings and cost per implemented water conservation strategy.
9. Monitor water conservation technology developments and review new strategies for possible inclusion in subsequent updates of the Region C Water Supply Plan.
10. Monitor findings and recommendations of the Water Conservation Advisory Council established by the State Legislature as part of Senate Bill No. 3 for possible inclusion into subsequent updates of the Region C Water Supply Plan.
11. The Region should continue to pursue the reuse projects identified in the *2006 Region C Water Plan.* The Region should consider adopting the new reuse strategies identified at the end of Section 4.3 of this report.

Public education is being practiced by water providers (both WUGs and WWPs) across the region. It is critical that these efforts continue in order that water conservation strategies are implemented and practiced in accordance with the *2006 Region C Water Plan*. The overriding message about the value and need for water conservation has been conveyed to the public. There are opportunities to enhance the effectiveness of the public education strategy by increasing coordination of specific messages that are common across the region. Additionally, there are opportunities for entities to jointly participate in workshops or other venues to transfer science and technology to implementers and users of water conservation strategies. Partnerships have begun to be formed within the region and subsequent updates to the Region C Water Supply Plan should recognize these endeavors.

Monitoring the implementation of water conservation strategies both from a qualitative and quantitative perspective is extremely important. It is also important that the monitoring approach be achieved not only on a consistent basis across Region C, but across

the state between all the regions. In this regard, it is recommended that the region, in cooperation with the Texas Water Development Board and the Texas Commission on Environmental Quality, develop a voluntary data collection and management program to gather data and information about water savings and costs associated with individual water conservation strategies.

New technologies related to water conservation strategies continue to be developed, resulting in changes in how strategies are being implemented and in the development of new strategies. Region C water providers are encouraged to monitor these developments and, as appropriate, the implementation of the recommended strategies should include substitutions and/or adding new strategies to achieve targeted savings in an economical manner. Subsequent updates of the Region C Water Supply Plan should consider including newly developed strategies, as appropriate.

8. Other Considerations

8.1 Potential Impacts of Water Conservation on Return Flows

While water conservation and reuse projects provide an important source of water supply in Region C, they may also impact the amount of water returned to streams and rivers, particularly the Trinity River. However, the analysis of return flows is not a straightforward calculation. There are several factors that can impact potential return flows and instream flows, including the source of water. For many of the Region C water supply strategies, the source of water is from outside the river basin of use. Any out-of-basin water returned to the basin of use can potentially increase instream flows. On the other hand, reduced water use from conservation or direct reuse of in-basin water supplies can reduce instream flows.

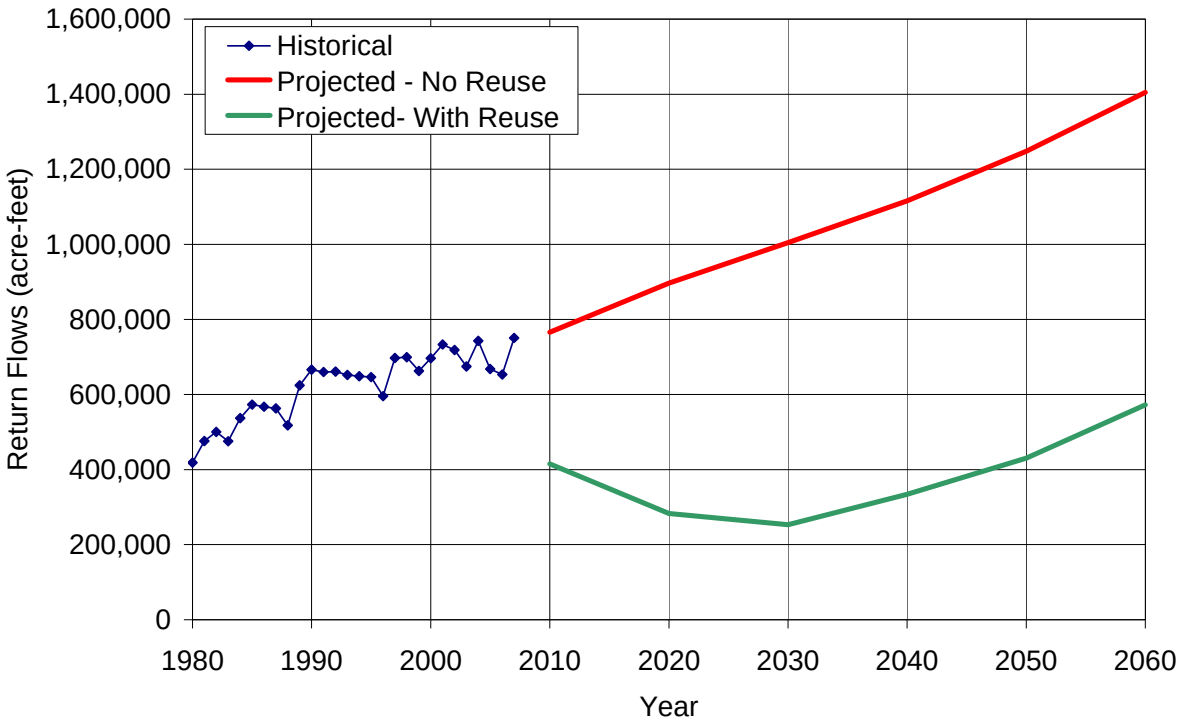
The average return flows from municipal wastewater treatment plants in Region C for the five year period 2003-2007 was approximately 698,000 acre-feet per year or 622 mgd. It is expected the total return flows will increase to approximately 1.4 million of acre-feet per year by 2060. Of this amount, 59 percent (or about 832,000 acre-feet per year) will be needed for the implementation of reuse projects. Table 8.1 and Figure 8.1 show the projected increase on return flows in the Trinity River Basin by decade considering expected water demands, population growth and conservation savings. The return flows in Table 8.1 are the total discharges of treated wastewater that are expected to be available for water right holders, reuse projects and the environment. The net return flows is the net instream flows across the Trinity Basin after accounting for the re-diversion by reuse projects.

Table 8.1
Projected Increase of Return Flows by Decade
(Values are acre-feet)

	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Demand	1,563,725	1,858,601	2,092,965	2,328,370	2,607,058	2,943,509
Conservation	51,370	106,427	148,159	188,500	230,232	277,434
Net Demands	1,512,355	1,752,174	1,944,806	2,139,870	2,376,826	2,666,075
Return Flows	765,662	896,882	1,004,341	1,115,359	1,247,968	1,404,851
Proposed Reuse	350,476	613,996	751,286	781,515	817,876	832,360
Net Return Flows	415,185	282,886	253,055	333,844	430,092	572,491
Return Flow Factor*	0.51	0.51	0.52	0.52	0.53	0.53

*Return Flow Factor is defined as the ratio of Return Flows to Net Demands.

Figure 8.1
Historical and Projected Return Flows in Region C



The net return flows in Table 8.1 and Figure 8.1 are lower than the values reported in the *2006 Region C Water Plan* because this study assumed a lower return flow factor. Table 8.1 is based on a return flow per capita for each county, which results in a return flow factor between 0.51 and 0.53. This number is consistent with historical use and discharges in the basin. The *2006 Region C Plan* assumed a return flow factor of 0.67, which was obtained from the then "current conditions" model of the Trinity WAM (Run 8).

Not all of the net increase of return flows from Region C plants will reach the lower basin because the additional flow is available for diversion by water right holders or may be impounded in reservoirs. This study evaluated the net increase to regulated flows for the decades 2020, 2040, and 2060 at the Trinity Basin near Oakwood, the lowest gage in Region C. These results can be used to evaluate potential impacts on bay and estuary flows and water availability in region H. The net increase at the Oakwood gage was evaluated using a modified version of the Trinity WAM. The most significant changes to the Trinity WAM are the addition of projected return flows across the basin, the use of modified area-capacity tables to account for sedimentation in reservoirs and the use of firm yield demand instead of

the permitting amount. Other modifications include the modeling of reservoir system operations consistent with the calculation of firm yield of the *2006 Region C Plan*.

Results for each decade were compared to natural flow and to the results from the most recent TCEQ's "current conditions" model of the Trinity Basin (Run 8), dated September 2008. (TCEQ has been updating Run 8 as water use as return flow data become available). The TCEQ Run 8 model includes return flows of 608,233 acre-feet per year in Region C.

Figure 8.2 compares the median annual flow at the Oakwood gage for each decade with natural conditions and the TCEQ's current conditions model. This figure shows that the median natural flow is 4.0 million acre-feet per year. The current net return flow is 10% of the naturalized flow. The median regulated flow will slightly increase from 2.84 million acre-feet per year under Run 8 to 2.86 million acre-feet per year by 2040. The median annual flow is projected to increase by 0.23 million acre-feet per year by 2060. This is an increase of 9% over 50 years.

Figure 8.3 compares the minimum annual flow for the same scenarios. The minimum annual flow under Run 8 and the 2020 and 2040 scenarios are lower than the minimum annual natural flow. However, the minimum annual flow by 2060 is almost equal to the minimum natural flow.

Figures 8.4 to 8.7 show the impact of the 10^{th}, 25^{th}, 50^{th} (median) and 75^{th} percentile for each month. The 10^{th} and 25^{th} percentiles of the 2060 scenario are similar to the values under current conditions. During low flow months (July to September), the 10^{th} and 25^{th} percentile by 2060 are higher than natural conditions. The monthly median has similar results to the annual flow, with regulated flows decreasing under the 2020 and 2040 scenarios but increasing under the 2060 scenario to a level similar to current conditions.

Overall, the regulated flow leaving Region C is projected to decrease until 2030 because proposed reuse projects will use more than the increase on return flows. After 2030, instream flows are expected to increase.

Figure 8.2
Comparison of the Median Annual Flow at the Trinity River near Oakwood

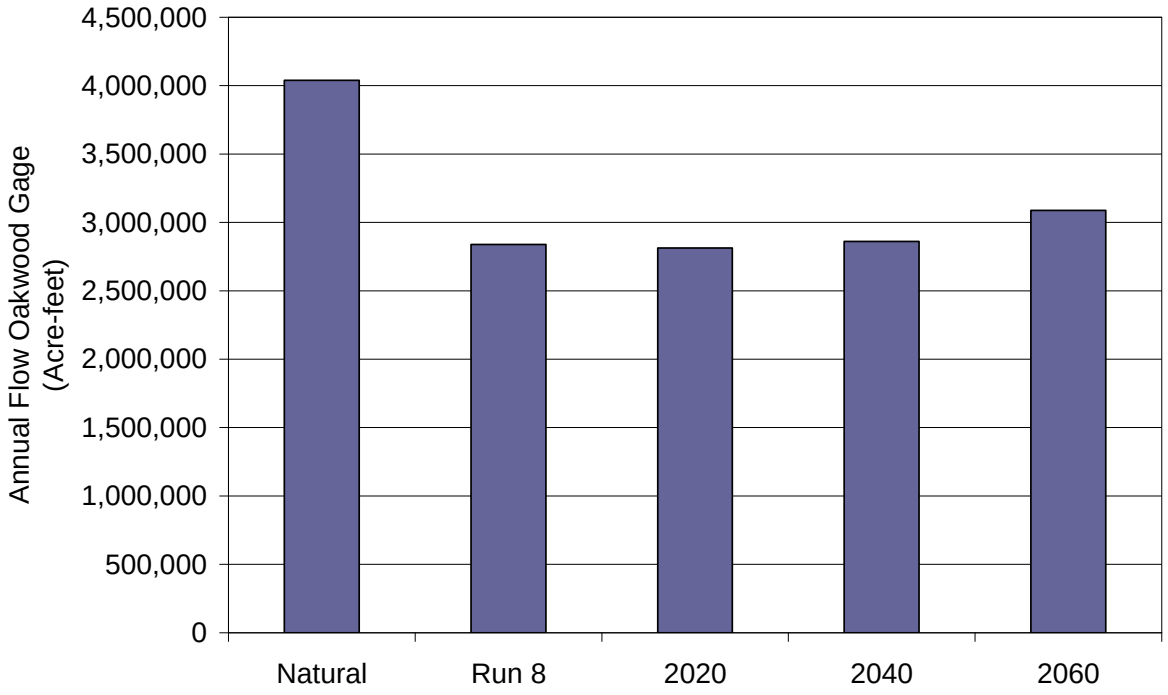


Figure 8.3
Comparison of the Minimum Annual Flow at the Trinity River near Oakwood

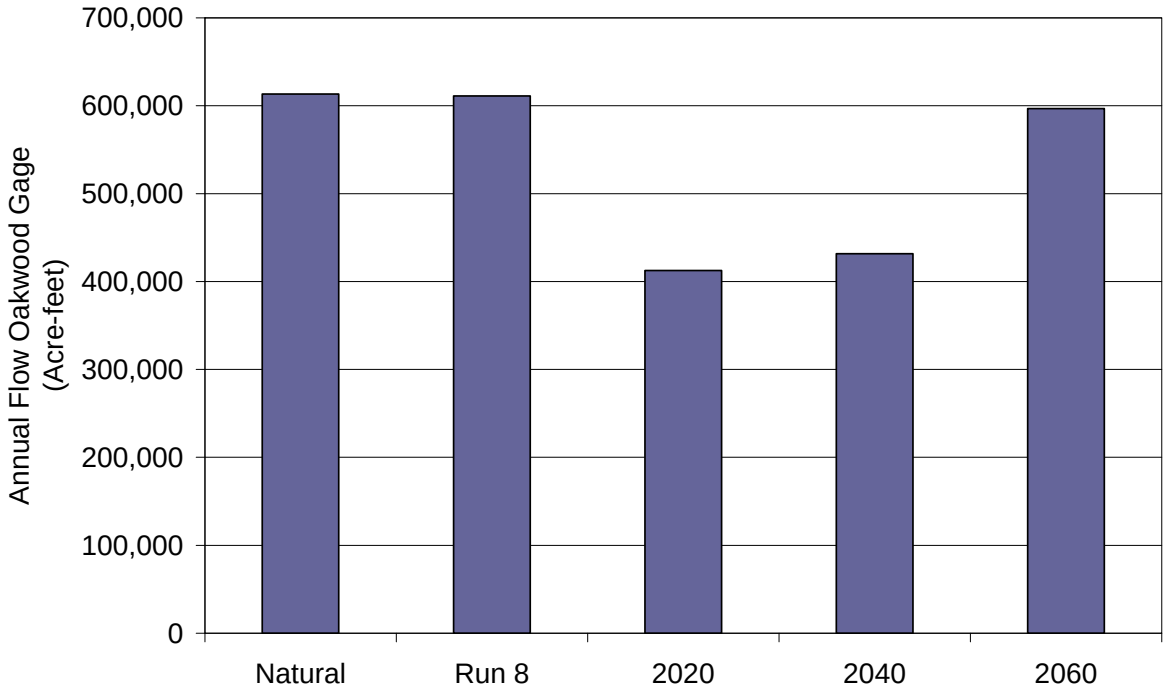


Figure 8.4
Comparison of the Monthly 10th Percentile at the Trinity River near Oakwood

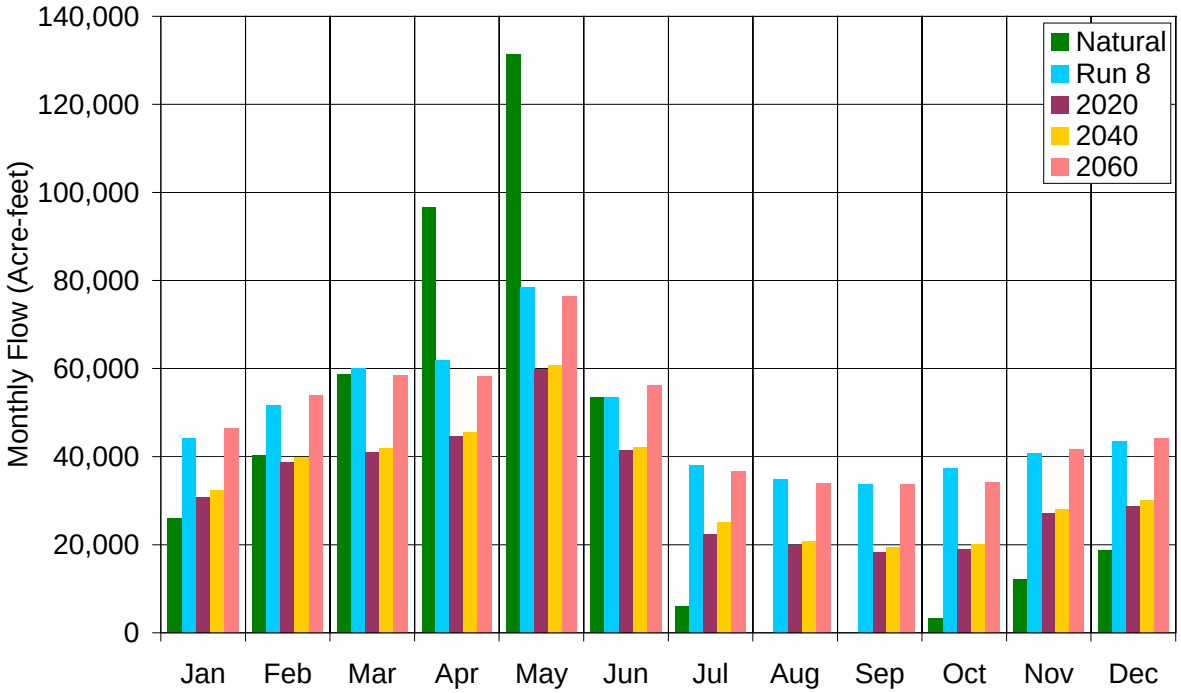


Figure 8.5
Comparison of the Monthly 25th Percentile at the Trinity River near Oakwood

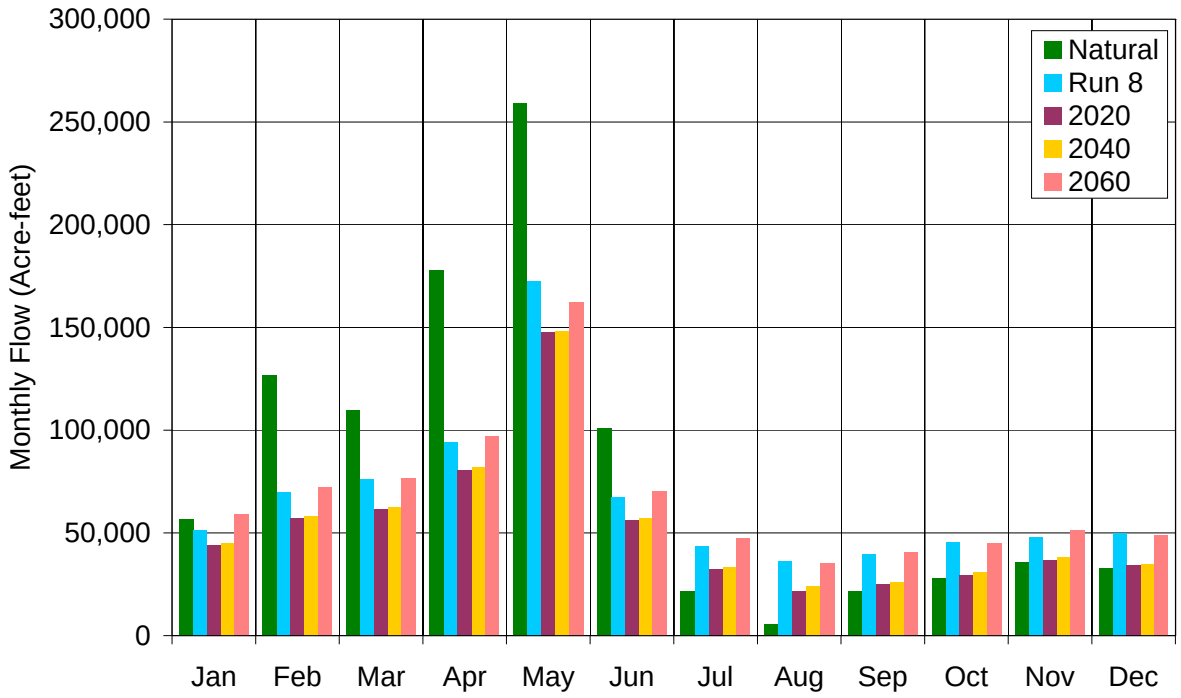


Figure 8.6
Comparison of the Monthly Median at the Trinity River near Oakwood

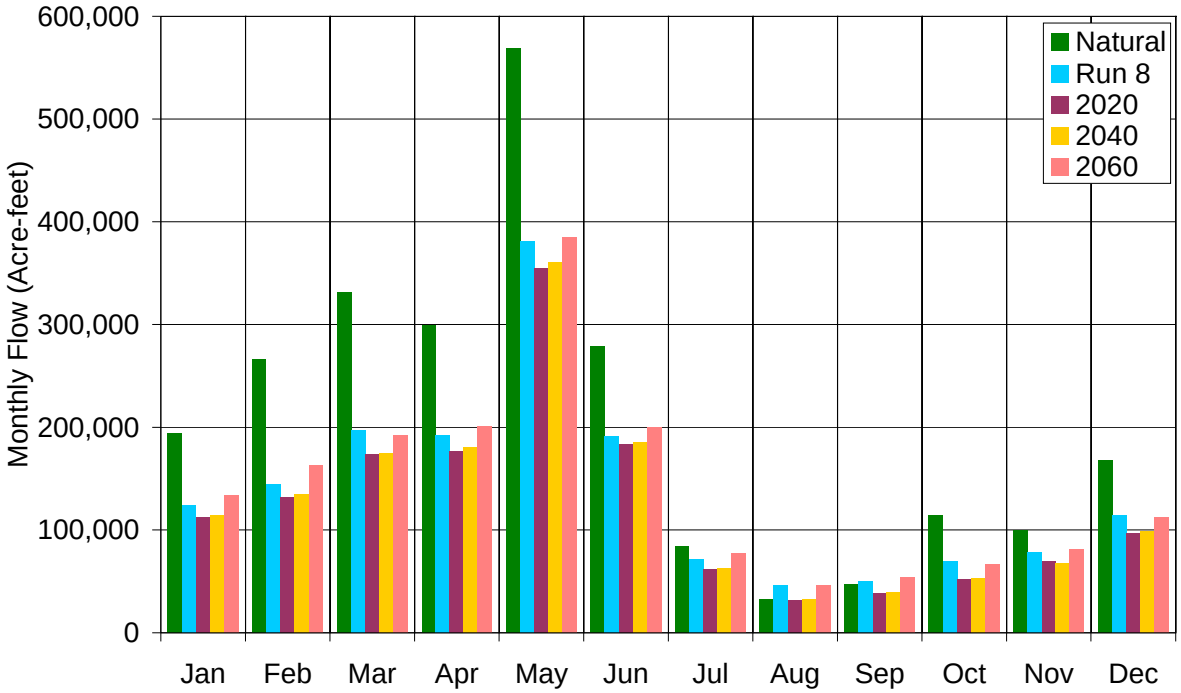
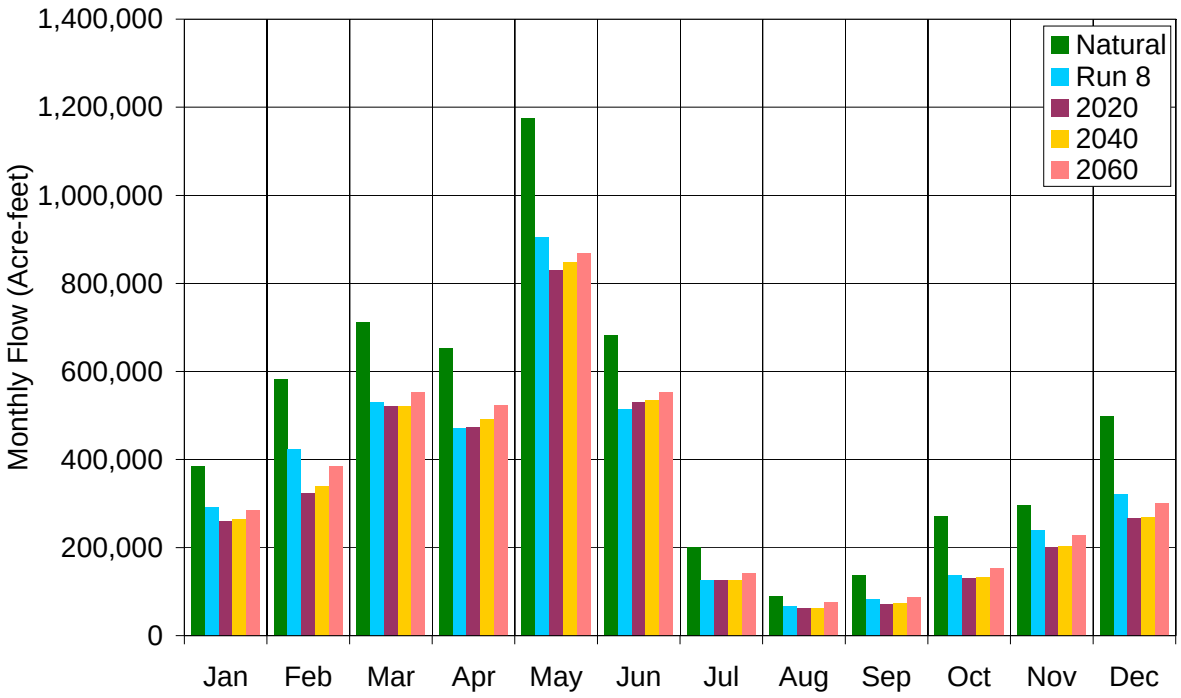


Figure 8.7
Comparison of the Monthly 75th Percentile at the Trinity River near Oakwood



8.2 Coordination with Region H Consultants on Instream Flows

The Trinity River flows out of Region C into Region H. During times of low flow, a large part of the flow in the river consists of return flows of treated wastewater from the Dallas-Fort Worth Metroplex. Flows in the Trinity River, including return flows of treated wastewater, are the primary inflow to Lake Livingston, a major water supply source in Region H. As a result, reuse projects in Region C have the potential to impact the yield of Lake Livingston in Region H. They may also impact instream and bay and estuary flows.

The Region C consultant team provided the results of the modeling of flows in the Trinity River, including the impact of reuse projects, to the Region H consultant team in December of 2008. The Region H consultant team completed a *Draft Environmental Flows Analysis* in January 2009. The two consultant teams held a meeting by conference call on October 30, 2008, and March 12, 2009. Points raised in the discussion included the following:

- The reduction in flows shown in the recent Region C modeling (compared to modeling in the previous round of planning) is caused by a reduction in the assumed percent of use discharged from wastewater treatment plants.
  - The modeling in the previous round of regional planning used the assumed return flow factors in Run 8 of the Texas Commission on Environmental Quality Water Availability Model for the Trinity Basin.
  - The more recent modeling used return flow factors based on recent experience in Region C, which are lower than the TCEQ WAM assumptions.
- The numbers in the recent Region C modeling are probably conservative, since the reduced return flows will probably change the timing of some reuse projects. Possible changes in timing were not considered in this special study but will be considered in analyses for the *2011 Region C Water Plan.*
- The Region H consultants will also be conducting additional analyses based on these flows, and would appreciate further information from Region C as it becomes available.
- The two consultant teams agreed to maintain communication on this issue.

8.3 Potential Impacts of Future Development

The Region C Water Planning Group should take into consideration how differing patterns of future population growth and development might impact water demand. The North Central Texas Council of Governments (NCTCOG), along with the Urban Land

Institute and the University of Texas at Arlington, is leading a collaborative planning process called Vision North Texas (VNT) to prepare for the coming growth and its potential impact on transportation, water supply, and other quality of life issues. As part of Vision North Texas, five primary scenarios for future population growth have been developed. Those scenarios and their impact on water demand and conservation will be discussed in this section.

The planning areas of Region C and NCTCOG overlap in ten counties, which include the Dallas-Fort Worth metroplex and surrounding counties where most of the concentrated future growth of the region will occur. Many water providers in Region C have already had some involvement with the Vision North Texas initiative as partners or sponsors and this involvement is likely to continue to increase. As part of their outreach and education efforts, Vision North Texas has made a presentation to the Region C Water Planning Group. Both Region C and VNT will greatly benefit from cooperation in their planning efforts.

Development Growth Patterns

Patterns of development will significantly affect the water demand of the area. Past development in this region is characterized by urban sprawl with associated expansion of water, sewer, roads and other infrastructure as well as increasing commute distances and roadway congestion. These patterns of development will be difficult to sustain in the long term. New development patterns may allow the region to accommodate future growth in a more sustainable way.

Vision North Texas has five primary scenarios for development. These development scenarios impact the expected water demand in different ways. The initial scenario, the **official 2030 forecast**, is in line with current population projections and is consistent with development patterns continuing as in the past. This scenario assumes urban sprawl growth patterns as population continues to expand into less developed and more rural areas. The other four scenarios are rail, infill, polycentric and green region scenarios.

The **rail scenario**, also referred to as the connected centers scenario, limits urban sprawl by concentrating growth around new rail assets with the goal of improved transportation access. The **infill scenario**, also referred to as the return on investment scenario, concentrates on increased development in already-developed areas. This scenario is

exemplified by the urban growth being observed near the large centralized downtown districts. This development uses much of the water, wastewater and transportation infrastructure already existing in these areas. The **polycentric scenario**, also referred to as the diverse, distinct community scenario, distributes growth more widely across the region but at higher intensities in central locations. This type of development will be more similar to current growth trends. Development in these areas will likely include mixed use development with structures only a few stories tall. Shared green spaces will also be prevalent in these areas. However, they will likely be smaller and more numerous than in the rail and infill scenarios. A fifth scenario, the **green region scenario**, is under development as a result of stakeholder input and a greenprinting initiative undertaken by Vision North Texas and its contractor, the Trust for Public Land. Greenprinting is a GIS-based system to integrate land conservation priorities in the planning process by combining computer mapping with community input. Green development and natural assets are the foundation for future growth. The green region scenario will likely impact development in areas near valued natural assets.

Impacts to Water Demands

Each of Vision North Texas' development scenarios has some impact on the per capita water demands for Region C. The **rail**, **infill** and **polycentric** scenarios have a common characteristic of increasing population densities at specific locations, and will improve per capita water usage as shared greenbelts, townhomes, condos and apartment complexes become more prevalent.

In the **rail scenario,** municipal per capita water demand is expected to decrease because of higher population concentration and shared the green spaces. This reduction will be predominantly due to the more efficient landscaping irrigation that can be achieved in shared green spaces and the ability to require enhanced water saving devices in these new developments.

One aspect of the **infill** development scenario is that relatively low irrigation demands may occur since the availability of green space is limited. In these areas, large green spaces will likely be located on the fringes of the development. A major issue that utilities will need to address is the aging infrastructure near some of these districts and the increased water demands that will occur as population concentrations increase. Due to the reduced amount of

irrigation and the ability to implement water saving features into new high-rise buildings, the expected municipal per capita water demand for this type of development is expected to be much lower than current trends.

Municipal per capita water demand is expected to be lower than current rates for the **polycentric** development scenario. However, they are still expected to be higher than for the rail and infill scenarios.

The fifth scenario, the **green region** scenario, is still under development. It will be difficult to assess the impacts to water demand and the opportunities for conservation until this scenario is more thoroughly defined.

Opportunities for Conservation

Three of the new development scenarios defined by Vision North Texas bring significant opportunities for additional conservation in Region C. During development of the shared green spaces in the **rail scenario**, municipalities can require landscaping designs to be more sustainable by using water wise, xeriscape, or other "green" principles. Use of shared green spaces in mixed use developments also makes the use of reclaimed water for irrigation and water features more manageable since fewer metering locations are required and the shared spaces will be managed by organizations instead of individual residences.

Opportunities to use reclaimed water in the **infill** scenario for irrigation may be limited due to age of the pipeline infrastructure in the area; however, implementation of certain LEED practices in the use of reclaimed water for toilet flushing in new commercial buildings may be practical if constructing the new infrastructure is cost effective.

The **polycentric** development scenario will allow municipalities and utilities to implement more sustainable landscaping requirements to reduce irrigation demand and to better manage a reclaimed water system.

Conclusions

A combination of the five development scenarios will likely occur throughout the region depending on the area, and the scenarios will be refined as they evolve from the additional research and analysis which remains in progress. The Region C planning process needs to consider the impact these growth scenarios have on per capita water use.

Water resource concerns have influenced the preferred development scenarios of Vision North Texas thus far. In one Vision North Texas workshop, participants ranked the measures for evaluating potential scenarios. “Protect water quality in streams and lakes” and “Conserves the region’s water supply” were among the measures receiving over 90% support as ‘essential’ or ‘important’. Collaboration and involvement in the Vision North Texas initiative by water planners and suppliers is important as the process moves forward. Region C should take an active role in the Vision North Texas workshops and other activities, and encourage the water providers in the region to participate. Region C water planning must be integrated with Vision North Texas planning. This is an opportunity to influence the vision of future development such that water resources are utilized as efficiently as possible.

APPENDIX A
REFERENCES

APPENDIX A

REFERENCES

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APPENDIX B

BMP DESCRIPTIONS

Description of Water Conservation Strategies / Best Management Practices

Low-Flow Plumbing Fixture Rules. In 1991, the 72nd Texas Legislature passed the Water Saving Performance Standards for Plumbing Act. The Act, implemented in 1992, prohibited the sale, distribution, or importation of plumbing fixtures that do not meet certain low-flow performance standards. Therefore, low-flow plumbing fixtures are used in new construction and in remodeling projects.

Public and School Education. Public and school education programs conserve water by teaching water-conserving behavior to water customers and reinforcing such behavior through periodic reminders. The goal is to make the public aware of the importance of water conservation in managing and sustaining existing water supplies and avoiding or delaying the building of new sources or facilities. Tools to effectively communicate water conservation to the public include the use of print, radio, and television advertising; direct distribution of conservation literature; special events; and informative websites. School education programs provide water conservation curriculum material at appropriate grade levels.

Water Use Reduction Due to Increasing Water Prices. Water consumption generally decreases with increasing water rates. Therefore, increases in real water prices over time can conserve water.

Water System Audit, Leak Detection and Repair, and Pressure Control. In 2003, the 78th Texas Legislature passed House Bill (HB) 3338, which requires all retail public utilities that provide potable water to perform a water system audit to identify system water losses. Apparent water losses include water that was actually used but not accounted for, such as customer meter errors or theft. Accounting for apparent losses increases a utility's revenue but does not reduce water usage. Real losses include overflows at the water treatment plant and leakage from the water distribution system. Identifying and preventing real losses decreases a utility's costs and decreases water usage. Real losses are the target of this water conservation strategy. Leak detection and repair and pressure control are two elements of a proactive water loss control program.

Federal Residential Clothes Washer Standards. Title 10 Part 430 of the Code of Federal Regulations (CFR) requires residential clothes washers manufactured on or after January 1, 2004, to be 22 percent more energy-efficient than pre-2004 models and clothes washers manufactured on or after January 1, 2007, to be 35 percent more energy-efficient than pre-2004 models.

Water Conservation Pricing Structure. As water rates increase, water consumption generally declines and vice versa. Therefore, changes in water pricing structure can conserve water. Potential conservation rate structures include increasing block rates, base and excess usage rates, and seasonal rates.

Water Waste Prohibition. To eliminate water waste, a utility may enact and enforce ordinances to prohibit wasteful activities including, but not limited to: irrigation water waste, once-through use of water in commercial equipment, non-recirculation systems in all new

conveyer and in-bay automatic car washes and commercial laundry systems, non-recycling decorative water fountains, and installation of water softeners that do not meet certain regeneration efficiency and waste discharge standards.

Coin-Operated Clothes Washer Rebate. Coin-operated clothes washers are not covered under the federal residential clothes washer rules in Title 10 CFR Part 430. Therefore, a municipal water user group could offer a rebate or other incentive for coin-operated clothes washer owners to upgrade clothes washers to water-efficient models.

Industrial, Commercial, and Institutional (ICI) General Rebate. Under this strategy, water user groups would encourage ICI customers to convert to water-saving equipment and practices by rebating a portion of the acquisition and installation cost of water-saving equipment. Examples of equipment changes or practices that might be eligible for a rebate include:

- Replacement of single-pass cooling systems with recirculating or air-cooling systems
- Reuse of high quality rinse water for landscape irrigation or for wash cycles in laundry equipment
- Improvements in cleaning processes
- Installation of water-saving equipment in a car wash.

Industrial, Commercial, and Institutional (ICI) Water Audit, Water Waste Reduction, and Site-Specific Conservation Program. The ICI water audit, water waste reduction program, and site-specific water conservation program is a regional strategy that is intended to serve as a way to identify, evaluate, and implement water conservation for individual ICI customers. With the assistance of the customer, the ICI water audit will:

- Accurately measure all water entering the facility.
- Inventory and calculate all on-site water uses.
- Identify any unused water sources or waste streams available.
- Calculate water-related costs.
- Identify potential water conservation measures within a facility.

Residential Customer Water Audit. Under this strategy, an auditor reviews a customer's bill to determine whether it is within normal seasonal parameters, reviews water use habits with the customer, and performs an on-site walk-through, if necessary, to teach the customer how to read the water meter, to evaluate the landscaping and irrigation system, to check for leaks, to review conservative water use habits, and, if the customer wishes, to install water saving devices. The auditor then provides a report and water saving suggestions.

Showerhead and Faucet Aerators Retrofit. The 1991 Water Saving Performance Standards for Plumbing Act effectively required the use of low-flow plumbing fixtures in new construction and remodeling projects. The maximum allowable flowrates are 3.0 gallons per minute (gpm) for showerheads and 2.5 gpm for faucets. Showerheads and faucet aerators have a useful life of approximately 5 to 15 years [(3)]. Some fraction of existing inefficient showerheads and aerators has already been replaced with efficient fixtures, and all inefficient fixtures will eventually be replaced without a retrofit program.

A showerhead and faucet aerator retrofit program would target single-family and multi-family homes that have not been retrofitted with water-efficient plumbing fixtures and would accelerate the natural replacement of inefficient plumbing fixtures.

Water-Efficient Toilet Rebate. The 1991 Texas Water Saving Performance Standards for Plumbing Act effectively required the use of low-flow plumbing fixtures in new construction and remodeling projects. Under this law, the maximum flowrate for toilets is 1.6 gallons per flush. Some fraction of existing inefficient toilets has already been replaced with efficient fixtures, and all inefficient toilets will eventually be replaced without a rebate program. A water-efficient toilet rebate program would offer rebates or incentives for replacement of toilets in single- and multi-family homes that have not been retrofitted with water-efficient toilets and would accelerate the natural replacement of inefficient toilets.

Single-Family Water-Efficient Clothes Washer Rebate. A single-family water-efficient clothes washer rebate program would offer rebates or incentives for replacement of clothes washers in single-family homes that have not been retrofitted with water-efficient clothes washers. As discussed above, federal residential clothes washer energy standards that take effect in 2007 are projected to result in significant water savings. All inefficient clothes washers will eventually be replaced without a rebate program. However, a single-family water-efficient clothes washer rebate program would accelerate the natural replacement of inefficient clothes washers.

Landscape Irrigation Systems Rebate. Improving the efficiency of irrigation systems can reduce outdoor water usage while maintaining a healthy landscape. Irrigation system equipment that could qualify for a rebate might include: irrigation controllers that allow programmed amounts for use with evapotranspiration-based water budgets, low-precipitation-rate sprinkler heads, drip irrigation equipment, pressure regulators, soil moisture sensors, rain sensors, and freeze sensors. A landscape irrigation systems rebate program is targeted toward residential and ICI customers that use automatic irrigation systems.

Landscape Design and Conversion Rebate. Landscape design and conversion programs, involving both plant selection and water wise landscape design principles, are intended for municipal water user groups with residential and ICI customers having high-water-use landscaping that results in substantial irrigation. Financial assistance would be provided to the customer to convert existing high-water-use landscaping to water wise landscaping. In addition, the water user group would either require or provide incentives for new construction to use water wise landscaping on all or part of the property.

Manufacturing General Rebate. This strategy is modeled after the ICI general rebate strategy for municipal water user groups. Under this strategy, municipal water user groups would encourage wholesale manufacturing customers to convert to water-saving equipment and practices by rebating a portion of the acquisition and installation cost of new water-saving equipment. Examples of equipment changes or practices that might be eligible for a rebate are as follows:

- Replacement of single-pass cooling systems with recirculating or air-cooling systems

- Reuse of high quality rinse water for landscape irrigation or for wash cycles in laundry equipment
- Improvements in cleaning processes
- Installation of water-saving equipment in a car wash.

Golf Course Conservation. Golf course conservation is a potentially feasible water conservation strategy for the irrigation water user groups. Under this strategy, golf course operators would conserve water using computer-controlled irrigation systems, soil moisture sensors, weather stations, irrigation scheduling, efficient irrigation equipment, reduced irrigation area, and other best management practices. Implementation alternatives include voluntary implementation for self-supplied golf courses, rebates for courses supplied by a municipal water user group, and ordinances if supplied by a city.

Recycling of Water in Operations. Recycling of water in operations is a potentially feasible water conservation strategy for the mining water user groups. Under this strategy, a mining water user would conserve water by cycling water through the washing/rinsing process multiple times before discharge. This strategy would be implemented by the owner/operator of the mining operations.

Reuse of Treated Wastewater Effluent. Indirect reuse is a potentially feasible municipal water conservation strategy. Direct reuse is a potentially feasible water conservation strategy for manufacturing, steam electric power, irrigation, and mining water user groups, and has limited potential for non-potable municipal use such as municipal irrigation.

APPENDIX C

SAMPLE SURVEY

Region C Water Planning Group
Water Conservation and Reuse Survey
Please Return by September 14, 2007

Name of Supplier:_____
Contact Person:_____
Telephone Number:_____FAX:_____
Email Address:_____
Mailing Address:_____

1. If you are a retail water supplier, what was the population of your retail customers over the last five years?

   2002: _____ 2005: _____

   2003: _____ 2006: _____

   2004: _____ 2007 (current): _____

2. What was your water usage for your retail customers over the last five years?

   2002: _____ acre-feet 2005: _____ acre-feet

   2003: _____ acre-feet 2006: _____ acre-feet

   2004: _____ acre-feet 2007: _____ acre-feet (thru ____)

3. What was the water usage by your industrial clients over the last five years?

   2002: _____ acre-feet 2005: _____ acre-feet

   2003: _____ acre-feet 2006: _____ acre-feet

   2004: _____ acre-feet 2007: _____ acre-feet (thru ____)

4. What was your maximum and minimum month usage over the last five years?

Year	Maximum Month Usage			Minimum Month Usage		
	Usage	Units	Month	Usage	Units	Month
2002						
2003						
2004						
2005						
2006						

5. The evaluation of many water conservation strategies requires that population/connections/housing units be split into single-family, multi-family and ICI (industrial, commercial, institutional) categories. The following questions are related to the number of connections in your system:

   A. How many single-family residential connections do you have in your system?

   B. How many multi-family residential connections do you have in your system?

   C. How many ICI connections do you have in your system?

   D. What is the total number of connections in your system?

6. If you are a wholesale water supplier, who are your wholesale water customers? How much water did your entity sell to these customers over the last five years?

   Customers: _____

   _____

   _____

   _____

   2002: _____ acre-feet

   2003: _____ acre-feet

   2004: _____ acre-feet

   2005: _____ acre-feet

   2006: _____ acre-feet

   2007: _____ acre-feet (thru ____)

7. Please report information about the conservation strategies that you have already implemented. For strategies that you have not implemented, please indicate whether you would consider pursuing the strategies.

Best Management Practices	Have You Implemented This Strategy? (please circle) Yes	No	Target Water Users * (please circle)	In your opinion, what has been the effectiveness? (please circle) Very Effective	Somewhat Effective	Not Effective	Amount of Water Saved Per Year Quantity	Units	Estimated Percent of Water Saved %
Basic Package:									
Low-flow plumbing fixture rules	Y	N	R Ind C Inst	VE	SE	NE			
Public and school education	Y	N	R Ind C Inst	VE	SE	NE			
Increasing water prices	Y	N	R Ind C Inst	VE	SE	NE			
Water system audit, leak detection and repair, and pressure control	Y	N	R Ind C Inst	VE	SE	NE			
Federal residential clothes washer standards	Y	N	R Ind C Inst	VE	SE	NE			
Expanded Package:									
Water conservation pricing structure	Y	N	R Ind C Inst	VE	SE	NE			
Water waste prohibition	Y	N	R Ind C Inst	VE	SE	NE			
Coin-operated clothes washer rebate	Y	N	R Ind C Inst	VE	SE	NE			
Residential customer water audit	Y	N	R Ind C Inst	VE	SE	NE			
Industrial, commercial and institutional general rebate	Y	N	R Ind C Inst	VE	SE	NE			
Industrial, commercial and institutional water audit, water waste reduction, and site-specific conservation program	Y	N	R Ind C Inst	VE	SE	NE			
Reuse of treated wastewater effluent	Y	N	R Ind C Inst	VE	SE	NE			
Others: (please list)									
	Y	N	R Ind C Inst	VE	SE	NE			
	Y	N	R Ind C Inst	VE	SE	NE			
	Y	N	R Ind C Inst	VE	SE	NE			

* R=Residential, Ind=Industrial, C=Commercial, Inst=Institutional

---Question #7 continued---

Best Management Practices	When Was This Strategy Implemented? (Month/Year)	Capital (Startup) Cost ($)	Annual Operating Cost ($ / year)	Will You Continue To Maintain This Strategy? (please circle) Yes No	Would You Consider Implementing This Strategy? (please circle) Yes No	What Has Been The Public Reaction To The BMPs That You Have Implemented? (favorable, unfavorable, no reaction)
Basic Package:						
Low-flow plumbing fixture rules				Y N	Y N	
Public and school education				Y N	Y N	
Increasing water prices				Y N	Y N	
Water system audit, leak detection and repair, and pressure control				Y N	Y N	
Federal residential clothes washer standards				Y N	Y N	
Expanded Package:						
Water conservation pricing structure				Y N	Y N	
Water waste prohibition				Y N	Y N	
Coin-operated clothes washer rebate				Y N	Y N	
Residential customer water audit				Y N	Y N	
ICI general rebate				Y N	Y N	
ICI water audit, water waste reduction, and site-specific conservation program				Y N	Y N	
Reuse of treated wastewater effluent				Y N	Y N	
Others: (please list)						
				Y N	Y N	
				Y N	Y N	
				Y N	Y N	

7. If you are a wholesale water supplier, do you require that your wholesale customers implement any BMPs? (If you require specific BMPs, please list which ones.)

8. Have you initiated any public outreach programs to help educate the public about water conservation? If so, please explain the type of programs that you have initiated.

9. Have you coordinated your public outreach programs with any other water providers? If so, please list which providers that you have partnered with.

10. The following questions are related to a <u>proactive</u> maintenance program that addresses water loss, leakage, and leak detection?

    A. Do you have an active leak detection program?

    B. Please describe your program.

    C. What is your annual budget for leak detection and leak repair?

    D. What percentage of customer meters do you replace each year?

    E. What is the average water pressure in your system?

11. If you have updated your water system audit since reporting water losses to the TWDB in 2006, please provide a copy of the revised water system audit.

12. If you did not report water loss data to the TWDB in 2006, please provide an estimate of your unaccounted for water in 2006.

    Percentage: _____

    Amount: _____ acre-feet (or _____ mgd)

13. Approximately how much money is budgeted for water conservation efforts on an annual basis by your entity?

14. Our records indicate that your current Water Conservation Plan was issued on _____, and that your current Drought Contingency Plan was issued on _____. Are these still your current Plans? If you have issued a new Water Conservation and/or Drought Contingency Plan, please provide a copy of the new plan with your responses to this survey.

15. During the last five years (2002 – current), have you implemented any drought management strategies that would limit water use by your customers? If so, please indicate which stages were implemented and the dates (month and year) that each stage was implemented.

16. How much reuse water was used during the last five years?

    2002: _____ acre-feet 2005: _____ acre-feet

    2003: _____ acre-feet 2006: _____ acre-feet

    2004: _____ acre-feet 2007: _____ acre-feet (thru ____)

17. Please report information about the water reuse strategies that you have already implemented.

Project Name	Permit Numuber	Type of Use*		Permit Amount		Actual Amount Used in 2006	
		Non-Potable	Augmentation**	Quantity	Units	Quantity	Units
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					
		R Ind C Inst					

* R=Residential, Ind=Industrial, C=Commercial, Inst=Institutional

** Augmentation supplementing potable supply with reuse water.

18. Please report information about any future water reuse strategies that you are pursuing.

Project Name	Type of Use*	Planned Amount	
		Quantity	Units
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		
	R Ind C Inst		

* R=Residential, Ind=Industrial, C=Commercial, Inst=Institutional

19. Please describe any other reuse strategies that are potentially feasible. (These could also include strategies that you are not pursuing or have not evaluated.)

20. Have you applied for, or received, any new water rights permits over the last five (5) years? If so, please provide amount of water requested or granted and permit number (if applicable).

21. Do you have any other input related to water conservation, reuse, or regional water planning that you would like to provide?

APPENDIX D

RESPONSES FROM TELEPHONE SURVEY

NORTH TEXAS MUNICIPAL WATER DISTRICT

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   In comparing the BMP for Public and School Education to reuse of treated wastewater effluent, the reuse of treated effluent would require the least amount of effort and cost to implement.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Both BMPs are effective in terms of cost. Reuse of effluent supplied to golf courses is a valuable reuse of wastewater effluent and enables the golf courses to use reuse supplies rather than a treated, potable water supply of water for irrigation. The public and school education (BMP) is effective as well. Education raises awareness of water issues and the importance for each individual to use water wisely and efficiently. Education, through the repetitive and constant reminder, of water awareness is how the behavior changes regarding water use will develop into fruition as saving of water resources.

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Each BMP has its own unique set of value. The reuse BMP is least expensive for NTMWD to implement in that the cost of the BMP is paid for through the end user. Reuse is also very easy to maintain or continue as long as there is an interest from the end user for the effluent.

   The public and school education has long term benefits and values that are related to behavior changes. While the BMP is quite expensive to implement it can have a tremendous amount of success with conservation efforts.

4. Please provide lessons learned from the implementation of these BMPs.
   The education and awareness while expensive to implement is a key necessity for behavior change. It is imperative that state funding be allocated to fully achieve the desired level of conservation needed through out the state in order to meet the projected water needs of the future.

CITY OF ALLEN

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Water Conservation Pricing Structure…highest rates for highest tier (>75K gallons). Rates are $8.31 per 1000 gallons over 75K. When you get into customers pocketbook, they change their patterns.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Same as above

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Same as above

4. Please provide lessons learned from the implementation of these BMPs.
   Groups of people will not conserve regardless of what happens. However 90% of the folks in his opinion do adhere to the conservation message.

CITY OF AUBREY

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Increased water price.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Increased water price.

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Increased water price.

4. Please provide lessons learned from the implementation of these BMPs.

CITY OF AZLE
Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Increasing water rates.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Increasing water rates.

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Increasing water rates and low flow fixture requirements

4. Please provide lessons learned from the implementation of these BMPs.
   People do not understand the value of water, or the cost involved in production

CITY OF CARROLLTON
Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Increasing water rates, due to the low cost implementation

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Increasing water rates, based on their low cost of implementation

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Increasing water rates, based on the low implementation cost

4. Please provide lessons learned from the implementation of these BMPs.
   Implemented rain and freeze sensor giveaway in 2006; 2000 units bought, 1200 given away as of Feb 2008.

   Started an irrigation inspection/ audit in 2007. Invitations sent to customers using more than 25,000 gallons/month. 6000 invitations sent, 400 invitations accepted. Inspections conducted by licensed irrigators, all 400 inspections found ways to increase conservation (leaking pipes, misaligned heads, etc.) Were also able to distribute and install additional rain/freeze sensors.

   City is implementing a toilet giveaway program.

CITY OF DALLAS

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   The landscape audit program
   Cooling Tower Audit Program

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Public Outreach Campaign
   Minor Plumbing Repair/Fixture Replacement Program
   Rain/Freeze Sensor Rebate Program (now discontinued)

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)

   In terms of quantifiable water conservation savings, plumbing fixture replacements have consistently proven to yield the best value compared to the initial investment.

4. Please provide lessons learned from the implementation of these BMPs.

   - Regarding rebate and incentive programs, make every effort to forecast a minimum level of customer participation
   - Obtain community buy-in prior to launching a new BMP
   - Remember to develop a tracking and monitoring mechanism to gauge program effectiveness
   - Beware of companies claiming to have invented the "ultimate" water saving device—perform due diligence

CITY OF FORT WORTH

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Initially said water price structure (price increase), but qualified it with an estimation of some of the costs to show that it is not a no cost BMP. Costs are approximate: $600 for committee meetings, $4200 for bill inserts announcing the price change, and unquantified internal labor costs associated with determining amounts for price increase and other support for the measure.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
4. Please provide lessons learned from the implementation of these BMPs.

CITY OF FRISCO

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Low-flow plumbing fixture rules

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Low-flow plumbing fixture rules. As requirement/code very little education and program maintenance are necessary.

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Low-flow plumbing fixture rules

4. Please provide lessons learned from the implementation of these BMPs.
   Low-flow plumbing fixture rules

CITY OF LEWISVILLE

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Inserts in customer water bills.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Inserts in customer water bills

   Permanent signs strategically located throughout the City requesting conservation

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Inserts in customer water bills

   Permanent signs strategically located throughout the City requesting conservation

4. Please provide lessons learned from the implementation of these BMPs.
   Regular ongoing notification – 1 or 2 per season or quarterly per year is not enough.

CITY OF MANSFIELD

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Water conservation price structure

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Water conservation price structure

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Water waste prohibition

4. Please provide lessons learned from the implementation of these BMPs.
   Provided that they are educated in water conservation, citizens want to save water.

CITY OF NORTH RICHLAND HILLS

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   We have implemented school education on water conservation to elementary 5th grade level students. Education hand outs and faucet devices were given to the kids. We are just starting our BMP Programs.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Public education on web-site.

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Public awareness and education on publications and on web-site.

4. Please provide lessons learned from the implementation of these BMPs.
   Coordination with support entities is vital to implementing programs.

CITY OF PLANO

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   The indoor retrofit items have been the easiest to implement. These items are distributed through our Customer and Utility Services Department's service counters. Customers acquire these items by pick up. There is no charge for the items so cashier activities are not necessary. Inventory is kept to a minimum and re orders are easily processed through our vendor.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   The indoor retrofit items are inexpensive yet very effective if installed.

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Same answer and questions 1 and 2.

4. Please provide lessons learned from the implementation of these BMPs.
   Showerheads and toilet flappers are the most popular items with the public. Citizens are wary about filling out forms with identifying information to receive items. They seem to be worried that their consumption will be monitored.

CITY OF WYLIE

Cost of Best Management Practices (BMPs)

1. In your opinion, which of the BMPs required the least amount of effort and cost to implement?
   Public Education, Water Audit, Leak Detection and Repair.

2. In your opinion, which of the BMPs were the most effective in terms of cost?
   Water Audit/Leak Detection and Repairs

3. In your opinion, which of the BMPs proved to be the best value? (Greatest amount of conservation, for the least amount of cost to implement and maintain)
   Public Education – The City web site provides tips on how to apply conservation measures on a daily basis.

5. Please provide lessons learned from the implementation of these BMPs.
   For water conservation strategies to be affective it will require the participation of City of Wylie employees and the citizens of Wylie. It is difficult to gauge the effectiveness and amount of water conserved in a rapidly growing community like Wylie.

APPENDIX E

ADDITIONAL COMMENTS FROM TELEPHONE INTERVIEWS

APPENDIX E

ADDITIONAL COMMENTS FROM TELEPHONE INTERVIEWS

Twenty four entities were contacted to gather more specific information on their public education approaches and their willingness to cooperate on common regional messages. The entities were asked a series of questions. These questions were designed to be as open-ended as possible to promote in-depth responses.

a. Would you be open to partnering with other entities to convey a region-wide water conservation message? If so, what would you like that message to include?

Of the entities that responded to this question, all supported the development of a regional message. One respondent noted that several water conservation managers periodically meet to discuss water conservation issues. These monthly water conservation manager meetings were also discussed and reinforced at a recent Alliance for Water Efficiency workshop hosted by the San Antonio Water System.[11]

The following are specific responses from the entities surveyed:

- *"The North Texas Municipal Water District is actively involved in promoting a region-wide water conservation message through our Water IQ program. This program includes a dedicated website (www.WaterIQ.org) as well as media advertisement (television, radio, billboards, print media, etc.) and various outreach events throughout the year. Use of Water IQ materials is available to our member cities and customers as well as others in the region who participate in the program. This program promotes the message that water is a finite resource and we can all make lifestyle changes to conserve it. It offers generic tips on how you can save water during daily activities." North Texas Municipal Water District*

- *"Yes, include educational information on long term benefits and consequences if serious implementation is not applied." City of North Richland Hills*

- *"Yes, in 2007, Dallas formed a partnership with Tarrant Regional Water District (TRWD) to expand its "Save Water" campaign beyond its service area borders. TRWD currently uses Dallas' widely recognized "Save Water. Nothing Can Replace It" brand for its campaign. It was determined that the universal "Save Water" message can be used in any public outreach initiative, therefore we would like to see that message included as part of a regional effort." City of Dallas*

- *"Yes, conservation information aimed at young people." City of Azle*

- *"As a matter of fact, we already do. Last fall a small group of water education coordinators began meeting to compare notes. The group has grown to 16 with 3 water districts and several cities represented. We are currently working on elementary blocks of information regarding landscaping and irrigation systems." City of Plano*

- *"Yes, a unified regional message should be specific to the needs of the overall region and not focused on a specific problem in one area. The message should be a basic water conservation message that is applicable for long term. The objective would be to get a consistent message to the public that will encourage a culture change to water conservation permanently not seasonal or drought driven." City of Lewisville*

- *"Yes, Tarrant Regional Water District has a great message. I think that we should all use theirs." City of Mansfield*

- *"Yes, we are currently meeting with Plano, Frisco, Rowlett, and others for producing a landscaping guide and program for all landscapes. As for regionally, there should be one consistent message." City of Allen*

- *"Yes, a regional unified message could help educate our region to understand: where their water comes from, why conservation in North Texas is an important tool for water-use reduction, why their efforts will help plan for water resources with this region's growth, and how their indoor and outdoor habits can conserve and save them water." City of Frisco*

- *"(Currently) Coordinating with Plano, Richardson, and McKinney water conservation managers. Monthly meeting on water conservation and public message." City of Carrollton*

- *"Yes, we would be open to partnering with other entities to convey a region-wide water conservation message. We already are a member city of the North Texas Municipal Water District, and they publicize water conservation via television, radio, and print media." City of Wylie*

b. Would you be inclined to contribute financially to a region-wide program?

The overall responses to this question were positive. Although, concerns were noted on contribution amounts and in ensuring this program met the needs of the respondents' agencies. Other entities noted that a regional water conservation message could be developed by the North Central Texas Council of Governments, since the majority of the respondents already contribute financially to this organization.

c. In your opinion, which method of public education or public outreach would prove the most effective for the overall cost?

The responses to this question varied. The following are some of the responses:

- *"Both public education and public outreach are aimed to increase the knowledge of water and to hopefully increase the desire to alter the social behaviors of the consumer as related to water conservation and the wise and efficient use of the water supply. Both strategies, dependent on the educational/outreach strategies implemented, are quite extensive. North Texas Municipal Water District feels that both public education and public outreach are vital to changing the consumer's knowledge and use of their water supply." North Texas Municipal Water District*
- *"Web pages and television ads." City of Plano*
- *"Building partnerships and coalitions with other water purveyors are the most effective outreach methods due to economics of scale. In other words, if several entities pool their economic, technical and grassroots resources, their efforts will yield exponential results." City of Dallas*
- *"Billboard advertisements and handouts/mailouts." City of Lewisville*
- *"Newspaper publications and web-site education." City of North Richland Hills*
- *"Education for young people that could be taken home and talked about." City of Azle*
- *"Print ads and media. Television messaging (i.e. cable outreach channels) do not reach everyone. Water bill inserts are helpful." City of Allen*
- *"Our free irrigation audit program has been one of our more successful education outreaches. Another success is home owner association meetings where we have the opportunity to speak to each neighborhood and personally educate them on the programs offered." City of Frisco*
- *"City focuses on well coordinated and planned public education events to large audiences, instead of a lot of smaller events." City of Carrollton*
- *"Interactive web-site for water conservation." City of Wylie*

d. Please provide lessons learned from your current public education/information programs.

The responses to lessons learned were quite varied from irrigation issues to the importance of educating elementary school children.

- *"Through the implementation and yearly post campaign research of the Water IQ program, it is proven that when one increases their knowledge of the water supply, they are more apt to make a conscious effort to use water wisely and efficiently. Research has also shown that consumers relate their water savings to indoor*

practices and that a progression to savings outdoor is needed through future awareness efforts. Research also has shown that with repetitive messaging and a reminder of wise water practices, consumers will retain the awareness and initiate or continue water conserving practices. An awareness campaign whether water related or for other resources is an expensive but necessary strategy that must be ongoing to achieve results now and in the future." North Texas Municipal Water District

- *"Education programs work best when the content is elementary and easy to take action as opposed to heavy text brochures that go into a lot of detail. Many people are just too busy to absorb vast amounts of information; however, resources should be provided for those interested in digging deeper. Getting most people to do something small is better than overwhelming them and having them do nothing." City of Plano*

- *"People just don't understand the depth and the scope of the issue." City of Mansfield*

- *"Always perform pre and post analysis on the effectiveness of your outreach efforts. If using outside consultants, hold them accountable for achieving results. Don't be afraid to abandon a concept that does not work." City of Dallas*

- *"It has to be continuous and ongoing." City of Lewisville*

- *"Need to create several methods to get public's attention and motivational devices are very important." City of North Richland Hills*

- *"You cannot reach everyone…and most do not read the bill inserts. North Texas should target school-aged people." City of Allen*

- *"We've found that many homeowners are not familiar with their sprinkler system timer's settings and their landscape's actual watering needs. One minute of outdoor watering wasted, or a matter of thousands of gallons wasted, contributes to a huge potential savings and reshaping of traditional thoughts on landscape management." City of Frisco*

- *"Citizens seem more willing to be more cooperative when they have an understanding of the importance of water conservation." City of Wylie*

APPENDIX F

BMPS IMPLEMENTED BY ALL ENTITIES RESPONDING TO SURVEY

APPENDIX F
BMPS IMPLEMENTED BY ALL ENTITIES
RESPONDING TO SURVEY

	Basic Package*			Expanded Package							Other Conservation Measures			
Entity	Public and school education	Water reduction due to increasing water prices	Water system audit, leak detection and repair, and pressure control	Water conservation pricing	Water waste prohibition	Coin-operated clothes washer rebate	Residential customer water audit	ICI general rebate	ICI water audit, water waste reduction, and site-specific conservation program	Reuse of treated wastewater effluent	ET Irrigation Controllers	Rain and freeze sensors	Lawn water restrictions	Rebate program for water efficient washing machines
Argyle WSC		X	X	X										
Bartonville WSC		X	X	X			X						X	
Benbrook Water Authority	X	X												
Bethel-Ash WSC		X	X	X										
Bethesda WSC	X	X	X	X										
Blackland WSC	X	X	X	X	X		X							
Brandon-Irene WSC		X												
Buena Vista - Bethel SUD		X												
Caddo Basin SUD		X	X	X			X		X					
Cash SUD	X	X	X	X	X		X							
Chatfield WSC	X	X	X											
City of Allen	X	X	X	X	X									X
City of Arlington	X	X	X	X								X		
City of Athens		X												
City of Aubrey		X												
City of Azle		X							X	X				
City of Burleson	X	X	X	X	X									
City of Carrollton	X	X	X	X	X		X	X				X		
City of Chico	X	X	X	X										
City of Colleyville												X		
City of Coppell	X		X	X	X									
City of Corsicana	X		X	X	X		X		X					
City of Dallas	X	X	X	X	X		X		X	X				
City of Dawson		X												

* Two BMPs (Low-flow plumbing fixture rules and new efficient clothes washer standards) are not shown in this analysis. These BMPs are in effect already implemented for all entities because they are mandated by law.

	Basic Package*			Expanded Package							Other Conservation Measures			
Entity	Public and school education	Water reduction due to increasing water prices	Water system audit, leak detection and repair, and pressure control	Water conservation pricing	Water waste prohibition	Coin-operated clothes washer rebate	Residential customer water audit	ICI general rebate	ICI water audit, water waste reduction, and site-specific conservation program	Reuse of treated wastewater effluent	ET Irrigation Controllers	Rain and freeze sensors	Lawn water restrictions	Rebate program for water efficient washing machines
City of Denton	X	X	X	X	X		X			X				
City of DeSoto	X	X		X										
City of Duncanville		X	X											
City of Euless	X				X									
City of Eustace		X	X											
City of Everman					X									
City of Farmers Branch	X		X											
City of Farmersville	X	X												
City of Ferris		X		X										
City of Fort Worth	X	X	X	X	X		X			X			X	
City of Frisco	X	X	X		X		X			X	X			
City of Frost		X	X	X	X		X							
City of Garland	X		X	X	X					X				
City of Grand Prairie	X	X	X	X										
City of Grapevine	X		X		X		X		X					
City of Haltom City	X		X											
City of Highland Village	X	X	X	X	X									
City of Howe		X	X											
City of Hurst	X		X		X									
City of Hutchins			X		X									
City of Kaufman	X				X									
City of Ladonia		X	X											
City of Lewisville	X	X	X		X					X				
City of Log Cabin		X	X							X				
City of Mabank	X		X	X										
City of Mansfield	X	X	X	X	X									
City of McKinney	X	X			X						X	X	X	

* Two BMPs (Low-flow plumbing fixture rules and new efficient clothes washer standards) are not shown in this analysis. These BMPs are in effect already implemented for all entities because they are mandated by law.

	Basic Package*			Expanded Package							Other Conservation Measures			
Entity	Public and school education	Water reduction due to increasing water prices	Water system audit, leak detection and repair, and pressure control	Water conservation pricing	Water waste prohibition	Coin-operated clothes washer rebate	Residential customer water audit	ICI general rebate	ICI water audit, water waste reduction, and site-specific conservation program	Reuse of treated wastewater effluent	ET Irrigation Controllers	Rain and freeze sensors	Lawn water restrictions	Rebate program for water efficient washing machines
City of Mesquite			X											
City of Midlothian	X	X	X											
City of Mineral Wells										X				
City of Muenster		X	X	X										
City of Murphy				X										
City of North Richland Hills	X													
City of Palmer		X		X										
City of Plano	X	X			X									
City of Pottsboro		X		X										
City of River Oaks	X	X	X		X		X							
City of Rockwall	X	X	X	X	X					X				
City of Rowlett	X				X									
City of Terrell	X	X	X	X										
City of Tioga	X			X										
City of Van Alstyne			X											
City of Watauga	X				X									
City of Waxahachie		X	X											
City of Weatherford	X	X	X	X										
City of Whitesboro		X	X	X				X		X				
City of Wylie			X											
Combine WSC		X	X	X										
Community Water Company		X												
Community WSC				X										
Culleoka WSC				X										
Dallas County WCID #6	X	X												
Danville WSC		X		X										

* Two BMPs (Low-flow plumbing fixture rules and new efficient clothes washer standards) are not shown in this analysis. These BMPs are in effect already implemented for all entities because they are mandated by law.

	Basic Package*			Expanded Package							Other Conservation Measures			
Entity	Public and school education	Water reduction due to increasing water prices	Water system audit, leak detection and repair, and pressure control	Water conservation pricing	Water waste prohibition	Coin-operated clothes washer rebate	Residential customer water audit	ICI general rebate	ICI water audit, water waste reduction, and site-specific conservation program	Reuse of treated wastewater effluent	ET Irrigation Controllers	Rain and freeze sensors	Lawn water restrictions	Rebate program for water efficient washing machines
East Cedar Creek FWSD	X													
East Fork SUD	X	X	X											
Gastonia-Scurry WSC	X	X	X											
Gunter Special Utility District	X	X	X	X										
Lake Cities MUA	X	X	X	X										
Luella SUD	X		X	X										
Mac Bee Special Utility District		X	X	X										
Milligan WSC				X										
Mountain Peak WSC	X	X	X	X										
Mt Zion WSC		X												
Navarro Mills WSC		X	X											
North Hunt WSC			X											
North Texas Municipal Water District	X									X				
Rockett SUD				X										
Sardis-Lone Elm WSC		X	X	X			X							
Southwest Fannin County SUD	X		X											
Tarrant Regional Water District	X									X				
Town of Flower Mound	X	X			X									
Town of Highland Park	X	X	X	X	X							X	X	
Town of Lakeside		X	X	X										
Town of Lindsay		X												
Town of Little Elm	X	X	X	X	X									
Town of Northlake				X	X									

* Two BMPs (Low-flow plumbing fixture rules and new efficient clothes washer standards) are not shown in this analysis. These BMPs are in effect already implemented for all entities because they are mandated by law.

	Basic Package*			Expanded Package						Other Conservation Measures			
Entity	Public and school education	Water reduction due to increasing water prices	Water system audit, leak detection and repair, and pressure control	Water conservation pricing	Water waste prohibition	Coin-operated clothes washer rebate	Residential customer water audit	ICI general rebate	ICI water audit, water waste reduction, and site-specific conservation program	Reuse of treated wastewater effluent	ET Irrigation Controllers	Rain and freeze sensors	Lawn water restrictions	Rebate program for water efficient washing machines
Town of Ponder	X	X	X		X		X							
Two Way SUD	X		X											
Virginia Hill WSC		X	X											
West Wise Rural SUD			X	X										

* Two BMPs (Low-flow plumbing fixture rules and new efficient clothes washer standards) are not shown in this analysis. These BMPs are in effect already implemented for all entities because they are mandated by law.

APPENDIX G

EXISTING AND RECOMMENDED REUSE PROJECTS FROM THE *2006 REGION C WATER PLAN*

2006 Region C Existing Reuse Projects

-Values in Acre-Feet per Year

Reuse Description	User	County	2010	2020	2030	2040	2050	2060
NTMWD Stewart Creek Direct Reuse	Frisco/ Golf Courses	Collin	307	307	307	307	307	307
NTMWD Rowlett Creek Direct Reuse	Golf Courses	Collin	1,540	1,540	1,540	1,540	1,540	1,540
Gainesville Direct Reuse	Park irrigation	Cooke	9	9	9	9	9	9
Alcatel Network Systems Direct Reuse	Manufacturing	Dallas	20	20	20	20	20	20
Trinity River Authority/Las Colinas Reuse	Irrigation	Dallas	8,000	8,000	8,000	8,000	8,000	8,000
Cedar Crest Golf Course (Dallas)	Dallas/ Golf Courses	Dallas	561	561	561	561	561	561
Denton (Power Plant - direct reuse)	Denton/Power	Denton	3,363	3,363	3,363	3,363	3,363	3,363
Denton County Direct Reuse	Denton/ Irrigation	Denton	6,165	5,717	4,932	4,372	3,475	2,466
Denton County Indirect Reuse	Denton/ Irrigation	Denton	1,682	2,130	2,915	3,475	4,372	5,381
UTRWD Direct Reuse	Denton Co. FWSD #1	Denton	897	897	897	897	897	897
Collin County Direct Reuse	The Colony	Collin	380	380	380	380	380	380
Denton County Direct Reuse	Trophy Club	Denton	800	896	977	1,049	1,129	1,210
Ennis Direct Reuse	Steam Electric Power	Ellis	3,363	3,363	3,363	3,363	3,363	3,363
TRA/Waxahachie Indirect Reuse	Waxahachie	Ellis	4,998	5,129	5,129	5,129	5,129	5,129
Pinnacle Club Direct Reuse	Golf Course	Henderson	32	32	32	32	32	32
Jack County Direct Reuse	Bryson/ Irrigation	Jack	27	27	26	26	25	25
Jacksboro Direct Reuse	Golf Course	Jack	385	385	385	385	385	385
Country Club WSC Direct Reuse	Golf Course	Kaufman	92	92	92	92	92	92
Crandall Direct Reuse	Crandall	Kaufman	484	666	835	1,024	1,267	1,567
Garland Direct Reuse (sales through Forney)	Steam Electric Power	Kaufman	8,979	15,600	15,600	15,600	15,600	15,600
Weatherford Direct Reuse	Golf Course	Parker	202	202	202	202	202	202
Deer Creek Waterworks Direct Reuse	Golf Course	Parker	11	11	11	11	11	11
Millsap ISD Direct Reuse	Athletic Fields	Parker	2	2	2	2	2	2
NTMWD Buffalo Creek Direct Reuse	Golf Course	Rockwall	672	672	672	672	672	672
Royce City Direct Reuse	Golf Course	Rockwall	112	112	112	112	112	112
Azle Direct Reuse	Azle	Tarrant	811	1,089	1,484	1,930	2,403	2,818
Grapevine reuse (Grapevine Lake)	Grapevine	Tarrant	3,317	3,696	3,964	4,142	4,276	4,386
Fort Worth Direct Reuse	Golf Course	Tarrant	897	897	897	897	897	897
North Texas MWD Lake Lavon Reuse	NTMWD	NA	35,941	35,941	35,941	35,941	35,941	35,941
Wise County Mining Reuse	Mining	Wise	15,930	14,074	12,152	10,643	9,236	8,061
Total			**99,979**	**105,810**	**104,800**	**104,175**	**103,697**	**103,429**

2006 Region C Recommended Reuse Projects

-Values in Acre-Feet per Year

Water Provider	Project	Receiving Water	User Group	2060 Total	Amt to Region C
Athens	Indirect Reuse	Lake Athens	MUN, MFG	2,677	1,596
Dallas	Direct Reuse		IRR	20,456	20,456
Dallas	Southside WWTP Indirect Reuse	Lake Ray Hubbard	MUN, MFG	67,253	67,253
Dallas	Central WWTP Indirect Reuse	Lewisville Lake	MUN, MFG	67,253	67,253
Dallas	Indirect Reuse of Return Flows Above Dallas Lakes	Dallas Lakes	MUN, MFG	79,605	79,605
Ennis	Indirect Reuse	Bardwell Lake	MUN, MFG	3,696	3,696
Fort Worth	Direct Reuse		SEP	2,600	2,600
Fort Worth	Direct Reuse (3 projects)		IRR	8,290	8,290
Gainesville	Indirect Reuse	Moss Lake	MUN, MFG	561	561
NTMWD	Additional Wilson Creek WWTP Indirect Reuse	Lake Lavon	MUN, MFG	35,941	35,941
NTMWD	East Fork Indirect Reuse	Trinity River	MUN, MFG	102,000	102,000
TRWD	Trinity River Indirect Reuse	Richland-Chambers Reservoir	MUN, MFG	63,000	61,866
TRWD	Trinity River Indirect Reuse	Cedar Creek Reservoir	MUN, MFG	52,500	51,555
TRWD	TRWD Additional Yield due to reuse project	Richland-Chambers Reservoir	MUN, MFG	37,465	36,791
TRWD	TRWD Additional Yield due to reuse project	Cedar Creek Reservoir	MUN, MFG	35,800	35,156
TRA	Tarrant County Indirect Reuse	Grapevine Lake	MUN, MFG	7,500	7,500
TRA/Irving	Contract with Irving	Unknown	MUN, MFG	28,000	28,000
TRA	Joe Pool Lake Indirect Reuse (Central WWTP)	Joe Pool Lake	MUN	20,000	0
TRA	Joe Pool Lake Indirect Reuse (New WWTP)	Joe Pool Lake	Unknown	3,500	3,500
TRA	Mountain Creek Direct Reuse		SEP	3,000	3,000
TRA	Ellis County Direct Reuse		SEP	40,000	40,000
TRA	Freestone County Direct Reuse Phases I – II		SEP	20,000	20,000
TRA	Kaufman County Direct Reuse Phases I – II		SEP	15,000	15,000
TRA	Las Colinas Direct Reuse		IRR	7,000	7,000
TRA	Tarrant and Denton Counties Direct Reuse		IRR	7,500	7,500

Water Provider	Project	Receiving Water	User Group	2060 Total	Amt to Region C
UTRWD	Indirect Reuse of Lake Ralph Hall Water	Lewisville Lake	MUN	17,760	17,760
UTRWD	Indirect Reuse of Chapman Lake	Lewisville Lake	MUN	7,743	7,743
Weatherford	Indirect Reuse	Lake Weatherford	SEP	5,000	5,000
Waxahachie	Additional TRA/Waxahachie Indirect Reuse	Bardwell Lake	MUN, MFG	1,846	1,846
Bridgeport	Wise County Direct Reuse		SEP	2,000	2,000
Decatur	Wise County Direct Reuse		SEP	2,000	2,000
Local	Wise County Mining Reuse		MIN	28,520	28,520
TOTAL				**795,466**	**770,988**

APPENDIX H

CHAPTER 210 REUSE PROVIDER INFORMATION

Appendix H
Chapter 210 Reuse Provider Information

As regulated by TCEQ, Chapter 210 Type I uses include applications where contact between humans and reclaimed water is likely, such as irrigation of public parks, fire protection, toilet or urinal flushing, and irrigation of food crops or pastures for milking animals. Type II uses include applications where contact between humans and reclaimed water is unlikely, such as dust control, cooling tower makeup water, and maintenance of impoundments or natural water bodies where direct human contact is not likely. Below is a list of Chapter 210 Providers in Region C. The following pages contain detailed information obtained from each provider through a survey conducted early August 2008 as part of this study.

Approved Chapter 210 Providers in Region C

Provider Name	Reuse Type	County
City of Crandall	Type II	Kaufman
City of Dallas	Type I & II	Dallas
City of Denison	Type II	Grayson
City of Denton	Type I & II	Denton
City of Ennis	Type II	Ellis
City of Fort Worth	Type I & II	Tarrant
City of Frisco		Collin
City of Gainesville	Type II	Cooke
City of Garland	Type II	Dallas
City of Garland	Type II	Kaufman
City of Grapevine	Type II	Tarrant
City of Lewisville		Denton
City of Royse City	Type II	Rockwall
City of Runaway Bay	Type II	Wise
City of Sanger	Type II	Denton
City of The Colony	Type II	Denton
City of Weatherford	Type II	Parker
City of Willow Park	Type II	Parker
Deer Creek Waterworks	Type I	Parker
Millsap ISD	Type I	Parker
North Texas MWD	Type I & II	Collin
Town of Flower Mound	Type I	Denton
Trinity River Authority	Type I & II	Dallas

City of Crandall

The City of Crandall supplies reclaimed water to the city-owned Creekview Golf Club. Creekview Golf Club is the only current user of reclaimed water from the City, and there are no plans to add additional reuse customers in the near future. The golf club pumps reuse water for irrigation as needed during the summer months. A record of reuse water usage was not available, although the 2006 plan estimated the City of Crandall would provide 484 acre-feet/year of water to the golf course by the year 2010.

City of Dallas

Dallas Water Utilities (DWU) developed an implementation plan to support the advancement of the DWU Recycled Water Program in August 2005. The plan was developed in conjunction with the Cedar Crest Golf Course Pilot Project, which currently uses recycled water for irrigation.

Dallas Water Utilities (DWU) is expected to provide 561 acre-feet/year of water to the Cedar Crest Golf Course by 2010. DWU plans to further develop its direct non-potable reuse system by 2010. The system is planned to supply an additional 20,458 acre-feet per year of direct reuse for landscaping and industrial use by 2060.

City of Denton

The City of Denton currently provides reclaimed water for direct reuse to eight retail customers from the Pecan Creek Water Reclamation Plant. Additionally, the City of Denton and Robson Communities, Inc. collaborated to plan a 280 ac-ft/yr water reclamation facility to service a residential development. Robson Communities agreed to fund the construction of the facility and yield ownership to the City in exchange for 25 years of effluent to irrigate the community's golf course. The reuse pipeline to connect to the golf course is currently being designed. A representative with the City indicated that additional expansions to the current system are hindered by high capital costs.

City of Ennis

The City of Ennis supplies reclaimed water to the Tractebel Power Company for steam electric power use. The 2006 plan estimated the City of Ennis would provide 3,363 acre-feet/year of water to Tractebel by the year 2010.

City of Fort Worth

Currently, the City of Fort Worth is providing between 300 and 600 acre-feet/year of reuse water for irrigation at Waterchase Golf Course, currently the City's only existing reclaimed water customer.

In May 2007 the City of Fort Worth completed its *Reclaimed Water Priority and Implementation Plan* which supports the development of 14,570 acre-feet/year of direct reuse to meet irrigation and industrial demands within the City and surrounding communities (including Arlington, Euless, and the Dallas Fort Worth International Airport). The study evaluated many alternatives for direct non-potable reuse and identified four potential projects based on feasibility and the likelihood of customer interest. The 2006 Region C plan projected that the City's reclaimed water system would provide approximately 897 acre-feet/year of water by the year 2010. The City is currently moving forward on the design phase of the first of the four projects identified in the *Reclaimed Water Priority and Implementation Plan*.

City of Frisco

In 2006, the City of Frisco completed a *Reuse Water Master Plan*. The plan assessed the current state of Frisco's reuse system, potential customers, and costs to modify the existing system. At the time the report was written, only one customer, The Trails of Frisco Golf Course, was using reuse water. The report identified twenty-seven potential customers to be served by the reuse system. Additional phases of the plan are intended to increase the amount of reuse applied for irrigation purposes, including medians, schools, and parks. The City parks department and a homeowner's association will also soon be connecting to the system. Reuse water is provided by NTMWD's Stewart Creek Wastewater Treatment Plant.

City of Gainesville

The City of Gainesville supplies reclaimed water to irrigate Keneteso Park. The 2006 plan estimated the City of Gainesville would provide 9 acre-feet/year of water to Keneteso Park by the year 2010.

City of Garland

The City of Garland provides treated effluent to Forney for use at Florida Power and Light Energy (FPLE). The 2006 plan estimated the City of Garland would provide 8,979 acre-feet/year of water to Forney by the year 2010.

City of Runaway Bay

The City of Runaway Bay contracted with US Water Services Corporation in April 2008 for water and wastewater services. In the past, the City's 18-hole golf course was a customer for reuse water, but that course now purchases raw water from Tarrant Regional Water District. There is no plan or schedule in place for reuse water to be provided to new users in the future.

City of The Colony

The City of The Colony provides treated effluent to Stonebriar Country Club. The 2006 plan estimated The Colony would provide 380 acre-feet/year of water to the golf course by the year 2010. The Colony does not have any immediate plans to expand their reuse program.

City of Lewisville

The City of Lewisville ultimately provides treated effluent to the Denton County Fresh Water Supply District #1A via a contract with the Upper Trinity Regional Water District (UTRWD). The 2006 plan estimated Lewisville would provide 897 acre-feet/year of water for golf course irrigation by the year 2010.

City of Weatherford

Beginning in early 2009, the City of Weatherford will provide up to 90% of the flow from its wastewater treatment plant (currently approximately 2 MGD) to Barnett Shale gas wells

throughout eastern Parker County. This project will utilize a network of water supply lines to deliver reuse water for the next 20 years to the wells.

Millsap ISD

The Millsap ISD uses reclaimed water from its treatment plant to irrigate a football field during the off-season. Since the 2006 plan, the Millsap ISD constructed a new football stadium and now uses the original field for practice. The field is used more frequently than in the past and is less available for irrigation with reclaimed water. Consequently, the use of reclaimed water has declined. A record of reuse water usage was not available, although the 2006 plan estimated the Millsap ISD would provide 2 acre-feet/year of water to the field by the year 2010.

North Texas Municipal Water District

The NTMWD supplies treated effluent from Stewart Creek, Sabine Creek, Rowlett Creek, and Buffalo Creek wastewater treatment plants to various irrigation customers (primarily golf courses) in Collin and Rockwall counties. The 2006 plan estimated that NTMWD would provide 2,631 acre-feet/year of water to direct reuse customers by the year 2010.

Trinity River Authority

Currently, treated effluent from the TRA Central Regional Wastewater System is used for golf course irrigation, landscape irrigation, and lake level maintenance in Las Colinas. The 2006 plan estimated TRA would provide 8,000 acre-feet/year of water to Las Colinas by the year 2010 and additional 7,000 acre-feet/year by 2015. Additionally, treated effluent from the Ten Mile Creek Wastewater Treatment Plant is used for irrigation at a pecan orchard. By the year 2060, TRA is expected to provide approximately 78,000 acre-feet/year of additional water supply for steam electric power generation in Dallas, Ellis, Freestone, and Kaufman counties. These projects will be implemented beginning in 2012 in Ellis County.

Others

The Cities of Runaway Bay, Flower Mound, Grapevine and Weatherford have been granted a Chapter 210 authorization but are not currently providing direct reuse water to any customers.

APPENDIX I

UTILITIES PROVIDING A 2005 WATER SYSTEM AUDIT

UTILITIES PROVIDING A 2005 WATER SYSTEM AUDIT

UTILITY NAME	COUNTY
ABLES SPRINGS WSC	KAUFMAN
AERO VALLEY WATER SERVICE	DENTON
ANGUS WSC	NAVARRO
ARGYLE WSC	DENTON
ATHENS WATER SYSTEM COOP	HENDERSON
AURORA VISTA	WISE
AVALON WATER SUPPLY & SEWER SERVICE CORPORATION	ELLIS
BARTONVILLE WSC	DENTON
BEACHWOOD ESTATES & NORTH TRINIDAD	HENDERSON
BEATON LAKE ESTATES WATER SYSTEM	NAVARRO
BECKER JIBA WSC	KAUFMAN
BENBROOK HILLS	TARRANT
BENBROOK WATER & SEWER AUTHORITY	TARRANT
BENT TRAIL HOMEOWNERS ASSOC	TARRANT
BLACKLAND WATER SUPPLY CORPORATION	ROCKWALL
BLUE MOUND	TARRANT
BLUEBONNET HILLS WSC	PARKER
BOLIVAR WSC	DENTON
BRIARWOOD HARBOR	HENDERSON
BRITTANY HILL WATER SUPPLY	DENTON
BUENA VISTA BETHEL SUD	ELLIS
C R C WSC	HENDERSON
CHAMBERS MEADOW ESTATE WATER CO	ELLIS
CHATFIELD WSC	NAVARRO
CHEROKEE SHORES WATER SUPPLY	HENDERSON
CITY OF ADDISON	DALLAS
CITY OF ALLEN	COLLIN
CITY OF ALVORD	WISE
CITY OF ARLINGTON	TARRANT
CITY OF ATHENS	HENDERSON
CITY OF BARRY	NAVARRO
CITY OF BELLS	GRAYSON
CITY OF BLOOMING GROVE	NAVARRO
CITY OF BOYD	WISE
CITY OF CALLISBURG	COOKE
CITY OF CARROLLTON	DALLAS
CITY OF CELINA	COLLIN
CITY OF CHICO EAST	WISE
CITY OF COCKRELL HILL	DALLAS
CITY OF COLLINSVILLE	GRAYSON
CITY OF COPPELL	DALLAS
CITY OF CORINTH	DENTON
CITY OF CORSICANA	NAVARRO
CITY OF CRANDALL	KAUFMAN
CITY OF DAWSON	NAVARRO
CITY OF DENTON	DENTON
CITY OF DESOTO	DALLAS

UTILITY NAME	COUNTY
CITY OF DUNCANVILLE	DALLAS
CITY OF ECTOR	FANNIN
CITY OF ENNIS	ELLIS
CITY OF EULESS	TARRANT
CITY OF EVERMAN	TARRANT
CITY OF FAIRVIEW	COLLIN
CITY OF FARMERS BRANCH	DALLAS
CITY OF FATE	ROCKWALL
CITY OF FORT WORTH	TARRANT
CITY OF FRISCO	COLLIN
CITY OF GAINESVILLE	COOKE
CITY OF GARLAND	DALLAS
CITY OF GRAND PRAIRIE	DALLAS
CITY OF GRAPEVINE	TARRANT
CITY OF GUNTER	GRAYSON
CITY OF HALTOM CITY	TARRANT
CITY OF HASLET	TARRANT
CITY OF HEATH	ROCKWALL
CITY OF HIGHLAND VILLAGE	DENTON
CITY OF HOWE	GRAYSON
CITY OF IRVING	DALLAS
CITY OF ITALY	ELLIS
CITY OF KAUFMAN	KAUFMAN
CITY OF KELLER	TARRANT
CITY OF KEMP	KAUFMAN
CITY OF KENNEDALE	TARRANT
CITY OF KRUM	DENTON
CITY OF LAKE WORTH	TARRANT
CITY OF LANCASTER	DALLAS
CITY OF LEONARD	FANNIN
CITY OF LEWISVILLE	DENTON
CITY OF LINDSAY	COOKE
CITY OF LOG CABIN	HENDERSON
CITY OF MABANK	KAUFMAN
CITY OF MALAKOFF	HENDERSON
CITY OF MANSFIELD	TARRANT
CITY OF MCKINNEY	COLLIN
CITY OF MESQUITE	DALLAS
CITY OF MIDLOTHIAN	ELLIS
CITY OF MILFORD	ELLIS
CITY OF MUENSTER	COOKE
CITY OF MURPHY	COLLIN
CITY OF NEWARK	WISE
CITY OF NORTH RICHLAND HILLS	TARRANT
CITY OF PARADISE	WISE
CITY OF PLANO	COLLIN
CITY OF POTTSBORO	GRAYSON
CITY OF RENO	PARKER
CITY OF RHOME	WISE

UTILITY NAME	COUNTY
CITY OF RICHLAND HILLS	TARRANT
CITY OF SANSOM PARK	TARRANT
CITY OF SEAGOVILLE	DALLAS
CITY OF SOUTHLAKE	TARRANT
CITY OF TEAGUE	FREESTONE
CITY OF TERRELL	KAUFMAN
CITY OF TIOGA	GRAYSON
CITY OF TOM BEAN	GRAYSON
CITY OF TRENTON	FANNIN
CITY OF UNIVERSITY PARK	DALLAS
CITY OF VAN ALSTYNE	GRAYSON
CITY OF WATAUGA	TARRANT
CITY OF WAXAHACHIE	ELLIS
CITY OF WESTWORTH VILLAGE	TARRANT
CITY OF WHITEWRIGHT	GRAYSON
CITY OF WILMER	DALLAS
CITY OF WORTHAM	FREESTONE
CITY OF WYLIE	COLLIN
COLLEGE MOUND WSC	KAUFMAN
COMBINE WSC	DALLAS
COPEVILLE WSC	COLLIN
COUNTRY CLUB WATER SUPPLY INC	KAUFMAN
COUNTRY RIDGE WATER	COLLIN
COYOTE RIDGE ADDITION	WISE
CRAZY HORSE RANCH WATER CO	PARKER
CRESCENT HEIGHTS WSC	HENDERSON
CULLEOKA WSC	COLLIN
DALLAS COUNTY WCID 6	DALLAS
DALLAS WATER UTILITY	DALLAS
DENTON CREEK ESTATES	DENTON
DESERT WSC	COLLIN
DIAL WSC	FANNIN
DOGWOOD ESTATES WATER COMPANY	HENDERSON
DONIE WATER WORKS INC	FREESTONE
DOUBLE ROCK ESTATES	DENTON
EAST CEDAR CREEK FWSD B A MCKAY	HENDERSON
EAST CEDAR CREEK FWSD BROOKSHIRE	HENDERSON
EAST FORK SUD	COLLIN
EAST GARRETT WSC	ELLIS
ELMONT FARMINGTON WSC	GRAYSON
EMERALD FOREST	ELLIS
EMHOUSE WATER SYSTEM	NAVARRO
FOREST HILL TWO WSC	DENTON
FORNEY LAKE WSC	KAUFMAN
FRIENDLY OAKS WSC	TARRANT
FROGNOT WSC	COLLIN
GARRETT COMMUNITY WATER CO	ELLIS
GASTONIA SCURRY WSC	KAUFMAN
GOBER MUD	FANNIN

UTILITY NAME	COUNTY
GRANDE CASA	ELLIS
GREEN ACRES WATER SYSTEM	PARKER
GUNTER RURAL WSC	GRAYSON
HARBOR GROVE WSC	DENTON
HIDDEN ACRES WATER SYSTEM	HENDERSON
HIDDEN HILLS HARBOR & CAROLYNN ESTATES	HENDERSON
HILLS OF OLIVER CREEK THE	WISE
HORSESHOE BEND WATER SYSTEM	PARKER
KENTUCKYTOWN WSC	GRAYSON
KNOB HILL WATER SYSTEM	DENTON
KYKER LANE COMMUNITY WATER SYSTEM	GRAYSON
LAKE CITIES MUNICIPAL UTILITY AUTHORITY	DENTON
LAKEVIEW RANCHETTES	ELLIS
LAKEWOOD WATER EAST	HENDERSON
LAKEWOOD WATER WEST	HENDERSON
LANNIUS MUD	FANNIN
LAWRENCE WSC	KAUFMAN
LONGHORN MEADOWS ADDITION	DENTON
LUELLA WSC	GRAYSON
MARKUM RANCH ESTATES	TARRANT
MEADOW RANCH WATER SYSTEM	DENTON
MICHAELS COVE WATER SUPPLY	HENDERSON
MILLIGAN WSC	COLLIN
MILLSAP WSC	PARKER
MOODY WATER SYSTEM	FREESTONE
MOUNTAIN RIVER WATER COMPANY	PARKER
MOUNTAIN SPRINGS WSC	COOKE
MUSTANG SUD	DENTON
NAVARRO MILLS WSC	NAVARRO
NORTH COLLIN WSC	COLLIN
NORTH FARMERSVILLE WSC	COLLIN
NORTH KAUFMAN WSC	KAUFMAN
NORTHCREST WATER SYSTEM	NAVARRO
NORTHERN HILLS WATER SERVICE	GRAYSON
NORTHWEST GRAYSON COUNTY WCID 1	GRAYSON
OAK RIDGE SOUTH GALE WSC	GRAYSON
PARKERVILLE EAST MOBILE HOME PARK	DALLAS
PARTICIPATION DEVELOPMENT OF TEXAS PINNACLE CLUB	HENDERSON
PAYNE SPRINGS WSC	HENDERSON
PILOT POINT RURAL WATER SUPPLY	DENTON
PINK HILL WSC	GRAYSON
PIONEER VALLEY WATER CO	COOKE
PLEASANT GROVE WSC	FREESTONE
POETRY WSC	KAUFMAN
PONDEROSA ADDITION UTILITIES	DENTON
PRESTON SHORES WATER SYSTEM	GRAYSON
PURDON WATER CO	NAVARRO
RETREAT WATER SYSTEM	NAVARRO
RICE WSC	NAVARRO

UTILITY NAME	COUNTY
RICHLAND SYSTEM	NAVARRO
RIO BRAZOS WSC	PARKER
ROCKETT SUD	ELLIS
ROSE HILL WSC	KAUFMAN
SAGE BRUSH ESTATES	WISE
SARDIS LONE ELM WSC	ELLIS
SEIS LAGOS UTILITY DISTRICT	COLLIN
SILVER SADDLE ACRES	TARRANT
SKY VIEW RANCH ESTATES	WISE
SOUTH WINDOM WSC	FANNIN
SOUTHEAST WATER CO	KAUFMAN
SOUTHERN OAKS WATER SUPPLY	FREESTONE
SOUTHWEST FANNIN COUNTY SUD	FANNIN
SPANISH GRANT SUBDIVISION	ELLIS
SPANISH PARK ESTATES	PARKER
STARR WSC	GRAYSON
STONEBRIDGE WSC	DENTON
STONECREST ESTATES	DENTON
THE COLONY	DENTON
TOWN OF FLOWER MOUND	DENTON
TOWN OF HIGHLAND PARK	DALLAS
TOWN OF PONDER	DENTON
TOWN OF SUNNYVALE	DALLAS
TOWN OF WESTOVER HILLS	TARRANT
VACATION VILLAGE	DENTON
VERONA WSC	COLLIN
VIRGINIA HILL WSC	HENDERSON
WALNUT CREEK SUD	PARKER
WEST WISE RURAL WSC	WISE
WESTERN LAKE ESTATES	PARKER
WESTMINSTER WSC	COLLIN
WESTSIDE RURAL WSC	TARRANT
WESTVIEW	PARKER
WHITE SHED WSC	FANNIN
WHITT WSC	PARKER
WILLOWCREEK FARMS	FREESTONE
WINDMILL TRAIL	WISE
WOODBINE WSC	COOKE
WYLIE NORTHEAST WSC	COLLIN
WYNNWOOD HAVEN ESTATES	DENTON

APPENDIX J

NCTCOG MODEL LANDSCAPE ORDINANCE

APPENDIX K

SAMPLE LANGUAGE TO BE INCLUDED IN WATER WASTE PROHIBITION ORDINANCE

APPENDIX K
SAMPLE LANGUAGE TO BE INCLUDED IN
WATER WASTE PROHIBITION ORDINANCE

It is recommended that the Region C Water Planning Group consider the inclusion of the Water Waste Prohibition BMP in its Basic Conservation package for the 2011 Region C Water Plan. Typically, water providers will include Water Waste Prohibition restrictions in their Water Conservation Plan or in their Landscape Irrigation Ordinances. For water providers that do not have either of those documents or do not currently implement Water Waste Prohibition, sample language has been provided below. This language can be included in the entity's Water Conservation Plan or Landscape Irrigation Ordinance, or it may be used in a stand alone ordinance for Water Waste Prohibition. Enforcement measures should be determined by the entity and included with this sample language. Enforcement of these restrictions generally includes a warning for the first offense, with fines for subsequent offenses.

Sample Language:

Conservation Measures Relating to Lawn and Landscape Irrigation.

Lawn and landscape irrigation practices within the City can cause a waste of valuable water resources. The purpose of this subsection is to assure that water be used for lawn and landscape irrigation in a manner that prevents waste and conserves water resources.

(1) Lawn and Landscape Irrigation Restrictions; Offenses.

a. A person commits an offense if he knowingly or recklessly irrigates, waters or causes or permits the irrigation or watering of a lawn or landscape located on premises owned, leased, or managed by the person in a manner that causes:

i. a substantial amount of water to fall upon impervious areas instead of upon the lawn or landscape, such that a constant stream of water overflows from the lawn or landscape onto a street or other drainage area; or

ii. an irrigation system or other lawn or landscape watering device to operate during any form of precipitation.

b. A person commits an offense if, on premises owned, leased, or managed by him, he operates a lawn or landscape irrigation system or device that:

i. has any broken or missing sprinkler head; or

ii. has not been properly maintained in a manner that prevents the waste of water.

APPENDIX L

TWDB COMMENTS AND RESPONSES TO COMMENTS

Insert *.pdf file of TWDB comment letter here

ATTACHMENT 1

TWDB Contract No. 0704830688

Region C Region-Specific Studies

TWDB Comments on Draft Region-Specific Study Reports

1. Further Implementation of Water Conservation and Reuse Strategies

a. Please consider including definitions for both conservation and reuse in the beginning of the report for the general reader.

b. Please consider including a map of the Region C Water Planning Area in the beginning of the report.

c. Page 3 paragraph two of the Executive Summary states that the 2006 Region C Water Plan reported that existing reuse is over 50,000 acre-feet per year. This amount is almost 100,000 acre-feet per year as correctly referenced in Chapter 4, page 23. Please correct the statement in the Executive Summary of the final report.

d. Scope of Work Task 3, Item G states that the study will "provide a detailed discussion about the criteria being used by different entities to implement certain strategies and identify opportunities to coordinate the criteria to provide consistency across the region." The report does not appear to address this requirement. Please address this in the final report.

e. For Figure 4.1 and Tables 4.2 and 4.4, please use a consistent name for each of the BMPs. For example, In Table 4.2 and Figure 4.1 one of the BMPs is listed as "coin-operated clothes washer rebate", while in Table 4.4, the same BMP is named as "Rebate program for residential water efficient washing machine" and in Figure 4.1, the reuse BMP is listed as "Reuse", while the same BMP is named "Reuse of treated wastewater effluent" in Table 4.2 and 4.4.

f. On page 18, last paragraph, the "Federal Residential Clothes Washer Standards" is not listed as one of the highest effective rated BMPs but according to the Table 4.4, this BMP received 73% of the effectiveness ratings. Please reconcile the text with the data in Table 4.4.

g. Please include, either within the report or as an appendix, a list of all WUGs and Providers surveyed along with a summary of which Best Management Practices are being implemented by each entity. Scope of Work Task 4, Item A requires that an update of all recommended water conservation strategies, including reuse, be included in the report.

h. Scope of Work Task 4, Item C requires that up to two meetings be held with Region H consultants regarding the planning effort for environmental flows considerations. Please

summarize these meetings and their results in the body of the final report or include meeting memoranda as an appendix in the final report.

i. Scope of Work Task 4, Item F requires coordination with Region H consultants to review the TWDB instream flow model and requires that Region C consultants provide their findings to Region H consultants after running the instream flow model. Please summarize these activities in the body of the final report or include the summary as an appendix in the final report

j. The Report skips Section 5.5 -- Section 5.6 is listed after Section 5.4.3. Please consider revising the section numbers in the report.

k. On page 87, please footnote the definition of “RF” in RF Factor in Table 8.1.

l. In Appendix A (References) please include Texas Water Development Board Report number 362, “Water Conservation Implementation Task Force Water Conservation Best Management Practices Guide” as a reference.

Responses to TWDB Comments

Comment a: *Please consider including definitions for both conservation and reuse in the beginning of the report for the general reader.*

The following paragraph has been added in at the beginning of the Executive Summary: "The Texas Water Code §11.002(8)[1] 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 or alternative uses." By this definition, it is clear that reuse of treated wastewater effluent is a water conservation measure. Reuse, which is also referred to as "recycled water" or "reclaimed water", is defined in Title 30, Chapter 210 of the Texas Administrative Code[2] as "domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use"."

Comment b: *Please consider including a map of the Region C Water Planning Area in the beginning of the report.*

A map has been added to the Executive Summary on page 1.2, and the following text was added to the second paragraph of the Executive Summary on page 1.1: "Figure 1.1 is a map of the Region C Water Planning Area."

Comment c: *Page 3 paragraph two of the Executive Summary states that the 2006 Region C Water Plan reported that existing reuse is over 50,000 acre-feet per year. This amount is almost 100,000 acre-feet per year as correctly referenced in Chapter 4, page 23. Please correct the statement in the Executive Summary of the final report.*

The statement has been corrected. (The page number has been changed to page 1-3.)

Comment d: *Scope of Work Task 3, Item G states that the study will "provide a detailed discussion about the criteria being used by different entities to implement certain strategies and identify opportunities to coordinate the criteria to provide consistency across the region." The report does not appear to address this requirement. Please address this in the final report.*

Task 3, Item G of the scope is as follows. "**Review** the criteria being used by different entities to implement certain strategies (i.e., lawn watering days, etc.) and identify opportunities to coordinate the criteria to provide consistency across the region." This topic has been discussed throughout the text of the report. Questions regarding this subject were asked in the original survey. Additional questions were asked in the follow-up telephone survey. A meeting was held with the three largest regional water providers to discuss regional coordination. This information was included throughout the report. Specifically, regional coordination of public education efforts is discussed in the report in Appendix E and on Pages 1-5, 5-6, 5-22 through 5-27 (Section entitled "Regional Coordination and Programs), and 7-3. Lawn watering is discussed in

Section 5.4.3 of the report, and in Section 7.2 a recommendation has been added to include time-of-day lawn watering in the Expanded Conservation Package.

Comment e: *For Figure 4.1 and Tables 4.2 and 4.4, please use a consistent name for each of the BMPs. For example, In Table 4.2 and Figure 4.1 one of the BMPs is listed as "coin-operated clothes washer rebate", while in Table 4.4, the same BMP is named as "Rebate program for residential water efficient washing machine" and in Figure 4.1, the reuse BMP is listed as "Reuse", while the same BMP is named "Reuse of treated wastewater effluent" in Table 4.2 and 4.4.*

Figure 4.1 and Tables 4.2, 4.4, and 4.5 have been changed to reflect consistent naming of BMPs. A footnote has been added to Table 4.4 stating that "Rebate program for residential water efficient washing machine" is a separate BMP from "coin-operated clothes washer rebate" and that none of the entities implementing "coin-operated clothes washer rebate" provided effectiveness ratings for that BMP.

Comment f: *On page 18, last paragraph, the "Federal Residential Clothes Washer Standards" is not listed as one of the highest effective rated BMPs but according to the Table 4.4, this BMP received 73% of the effectiveness ratings. Please reconcile the text with the data in Table 4.4.*

Text has been revised to include "New efficient residential clothes washer standards." (The page number has been changed to page 4-8.)

Comment g: *Please include, either within the report or as an appendix, a list of all WUGs and Providers surveyed along with a summary of which Best Management Practices are being implemented by each entity. Scope of Work Task 4, Item A requires that an update of all recommended water conservation strategies, including reuse, be included in the report.*

Appendix F (BMPs Implemented by all Entities Responding to Survey) has been added to the report. All subsequent appendices have been renamed to reflect the order of appearance in the report. Text introducing this new appendix has been added at the beginning of Section 4.2.

Task 4, Item A of the scope is as follows: "Based on the information developed by this project, update the recommended Region C Water Plan water conservation strategies, including water reuse." Supplemental text has been added to Section 7.2 to satisfy the scope of work.

Comments h & i: *Scope of Work Task 4, Item C requires that up to two meetings be held with Region H consultants regarding the planning effort for environmental flows considerations. Please summarize these meeting and their results in the body of the final report or include meeting memoranda as an appendix in the final report. Scope of Work Task 4, Item F requires coordination with Region H consultants to review the TWDB instream flow model and requires*

that Region C consultants provide their findings to Region H consultants after running the instream flow model. Please summarize these activities in the body of the final report or include the summary as an appendix in the final report

A new report section (Section 8.2) has been added addressing Coordination with Region H Consultants on Instream Flows. The previous Section 8.2 has been renumbered to be Section 8.3.

Comment j: *The Report skips Section 5.5 – Section 5.6 is listed after Section 5.4.3. Please consider revising the section numbers in the report.*

Previous Section 5.6 has been renumbered to be Section 5.5.

Comment k: *On page 87, please footnote the definition of "RF" in RF Factor in Table 8.1.*

In Table 8.1, "RF" has been spelled out as "Return Flow". A definition has been added for Return Flow Factor.

Comment l: *In Appendix A (References) please include Texas Water Development Board Report number 362, "Water Conservation Implementation Task Force Water Conservation Best Management Practices Guide" as a reference.*

This report has been added to the References and identified in the text with superscripted numbers corresponding to references in Appendix A.

Other Changes to the Report

A comment was received from Julie Hunt, Director of Utilities for the City of Arlington. Ms. Hunt's comment was that on page 49, the draft report stated that Arlington is considering wholesale water sales to Mansfield. That is incorrect. Arlington is considering wholesale water sales to the City of Grand Prairie. Text on page 49 was revised to reflect this correction. (The page number has been changed to page 5-21.)

Page numbering was changed to reflect the section number and the page number of that section.

On the cover page and in the body of the report "Chiang, Patel and Yerby, Inc." was changed to "CP&Y, Inc." to reflect the company's name change.

Due to the addition of some references, the superscripted reference numbers were revised to be numbered in the order of appearance in the report.

Due to the addition of some appendices, the appendices were renamed to reflect the order of appearance in the report.