



Municipal Water Conservation Planning Tool

VERSION 1

User Guide

A TOOL FOR PLANNING AND TRACKING MUNICIPAL
WATER CONSERVATION PROGRAMS

NOVEMBER 2018

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1 About This Guide

1.1 Who Should Use This Guide

This guide is intended for users with different degrees of knowledge and experience with the Municipal Water Conservation Planning Tool. The guide provides first-time users an overview of the purpose and uses of the Conservation Tool, describes system and software requirements, and explains how to set up and use the Conservation Tool to develop a Conservation Plan and estimate water savings from past implementation of conservation measures. More experienced users will find the guide a useful reference document for using the Conservation Tool. This guide assumes that you have basic knowledge of the Windows or OS X operating systems and Excel.

1.2 User Guide Terminology

Excel Terminology

This guide uses the following Excel terminology:

Workbook – a workbook is an Excel file containing a collection of worksheets, chart sheets, and possibly macros.

Worksheet – a worksheet is a spreadsheet inside an Excel workbook file. A workbook can contain multiple worksheets.

Worksheet Cell – worksheet cells are where data and formulas are stored on worksheets. Each cell on a worksheet has a unique address given by its row and column number. For example, a cell at the intersection of column B and row 5 has the cell address B5.

Cell Range – a cell range is a collection of worksheet cells. Cell ranges are usually, but not necessarily, contiguous.

Worksheet Formula – a worksheet formula is a formula entered in one or more cells. A formula entered into multiple cells is called an array formula. Worksheet formulas use cells and cell ranges as their arguments.

Excel Chart – an Excel chart is a graph based on data stored in worksheet cell ranges. An Excel chart can reside on its own sheet or be embedded as a chart object on a worksheet. All of the charts in the Conservation Tool are embedded on worksheets.

Excel Macro – an Excel macro is a set of programming instructions that tell Excel to perform specific actions or tasks when the macro is executed.

Visual Basic for Applications – Excel macros use the programming language Visual Basic for Applications.

Visual Basic Editor – The Visual Basic Editor is used to create and edit macros in Excel. The Visual Basic Editor is part of the Excel application.

Conservation Tool Terminology

This guide may use any of the following terms when referring to the Municipal Water Conservation Planning Tool: **Conservation Tool**, **Tool**, or **Model**.

Water Savings Terminology

This guide uses the following terminology for differentiating between water savings due to plumbing codes/appliance standards versus water savings due to utility conservation programs:

Active Water Savings – this is the share of physical (or gross) water savings that directly results from conservation program implementation. It is equal to gross water savings minus water savings that would have been realized anyway because of plumbing code requirements or because of program freeriders. A program freerider is a participant that would have taken the same water conserving action in the same timeframe even without the program. For example, with a toilet rebate program, the active savings from a toilet rebate is the portion of water savings from toilet replacement that would not be expected to be generated by the plumbing code. See Appendix A for a worked example.

Passive Water Savings – this is the share of physical (or gross) water savings that results from (1) plumbing codes/appliance standards interacting with the natural replacement of toilets, showerheads, and other water using appliances whose current or future minimum efficiency is dictated by national, state, or local code regulations, plus (2) water savings from program freeriders. For example, with a toilet rebate program, the passive savings from a toilet rebate is the portion of water savings from toilet replacement that would be expected to be generated by the plumbing code in the absence of the rebate. See Appendix A for a worked example.

2 Introducing the Conservation Tool

2.1 Purpose

The Conservation Tool was developed to assist water utilities with their water conservation planning and reporting, and regional water planning groups with development of their municipal conservation water management strategies. It provides an accounting framework for projecting future conservation program costs and water savings as well as estimating the water savings from previous implementation of conservation measures. Water utilities can use the Conservation Tool in a variety of ways to aid their water conservation planning and reporting. For example:

- The Conservation Tool can be used to develop long-range conservation plans. Indeed, this is the primary intended use of the Conservation Tool.
- The Conservation Tool can be used to quickly compare alternative conservation measures in terms of their water savings potential, implementation cost, and cost effectiveness.
- The Conservation Tool can be used to estimate water savings from previous implementation of conservation measures.
- Regional water planning groups can use the Conservation Tool to develop municipal conservation water management strategies with future volumes based upon quantified water savings from specific conservation measures.

2.2 Key Features

The following lists some of the key features of the Conservation Tool:

- **Flexible Modeling of Water Savings** – Water savings for a conservation measure can be modeled as finite or persistent; unit savings can be modeled as static or dynamic; program freerider and plumbing code interactions can be specified to avoid double counting water savings.
- **Pre-Defined Conservation Measures** – The Conservation Tool includes a library of pre-defined, fully parameterized conservation measures that users can use in their conservation plan or regional water plan. At their option, users can customize these pre-

defined measures to better match their service area conditions and program characteristics.

- **User-Defined Conservation Measures** – Users can define their own conservation measures for inclusion in their Conservation Plan. The Conservation Tool allows the user to define up to 80 user-defined conservation measures.
- **Water Use Projections** – The Conservation Tool uses two different, but related, water use projections: the Baseline Projection and the Plan Projection. The Baseline Projection represents future water use given expected increases in population as well as expected water savings from state and federal plumbing codes and appliance standards, but not expected water savings from conservation measures the utility expects to implement. The Plan Projection equals the Baseline Projection less Active Savings from planned implementation of conservation measures.
- **Pre-Loaded Baseline Projections** – The Conservation Tool comes with Baseline Projections pre-loaded for 462 Texas municipal water systems. Users can elect to use the pre-loaded Baseline Projection or enter their own Baseline Projection. Note that unlisted utilities will have to enter their own Baseline Projection.
- **Scenario Management** – Users can save conservation plan scenarios and retrieve them for later use. This makes it easy to see how different program mixes or assumptions about water savings or program costs impact the overall results.
- **Open Source** – The Conservation Tool is open source and can be fully audited.

2.3 Hardware and Software Requirements

The Conservation Tool is an Excel spreadsheet application. The following are required in order to run it:

- A computer running Windows or OS X, preferably one with a fast processor and ample memory.
- A copy of Excel 2010 or later version.

Note: While the Conservation Tool can be run with OS X versions of Excel, it was designed and tested for Windows computers. Some help screens and dialog boxes may not display correctly in OS X versions of Excel.

3 Opening and Navigating the Conservation Tool

This chapter describes how to open and navigate the Conservation Tool.

3.1 Installing, Saving, and Backing Up the Conservation Tool

After you have downloaded or copied the workbook file to your computer's hard disk you can store it in any directory you like. The Conservation Tool is simply a large Excel workbook and, as such, you can treat it as you would any other Excel workbook on your hard disk.

It is recommended that you frequently save the file when you have it open and are working in it. Additionally, users are encouraged to make regular external backups of their workbook files so they will be protected should something happen to the computer on which the primary file is stored.

Note: You can set Excel to periodically save a temporary copy of the file you are working on. See Excel's documentation of its auto recover settings.

Note: It is good practice to make a backup of your workbook file before you make significant changes to it. You can revert to this backup if something happens to the file while it is open.

3.2 Excel Macro Settings

The Conservation Tool requires macros to run. This means you have to run Excel with Macros enabled. If macros are not enabled, do the following:

1. Open Excel's Options (File > Options)
2. Click Trust Center
3. Click the Trust Center Settings button
4. Click Macro Settings
5. Select "Disable all macros with notification"
6. Click OK
7. Click OK

3.3 Opening the Conservation Tool

When you open the Conservation Tool Excel may warn you that the file contains macros and ask you if you want to enable or disable them. You must enable the macros for the Conservation Tool to work correctly.

WARNING: The Conservation Tool will not work correctly unless macros are enabled. Section 3.2 of this User Guide describes the necessary Excel macros settings.

3.4 Worksheet Protection

When you open the Conservation Tool, all worksheets will be protected and you will only be able to change data entry cells and drop-down lists. To remove worksheet protection, go to the REVIEW tab on Excel's Ribbon and click Unprotect Sheet. No password is required.

WARNING: Removing worksheet protection will allow you to edit the worksheet's content, including its cell formulas. Changing cell formulas, adding or deleting columns, or changing range names or worksheet names may cause the Conservation Tool to stop working correctly.

3.5 The Start Worksheet

Opening the Conservation Tool activates the Start worksheet. This is the first worksheet in the workbook. It provides a brief overview and two Quick Start Guides – one for developing a Conservation Plan and the other for using the Reporting Year Calculator. There is no data entry on this worksheet.

3.6 Navigating from the Start Worksheet

You navigate through the Conservation Tool as you would any Excel workbook. There are two basic ways to navigate to a different worksheet in Excel. The most common way is to click on the worksheet's tab you want to navigate to at the bottom of the screen. You can also right-click the worksheet scroll buttons in the bottom left corner of the screen and then select the worksheet you want to activate from the list and click OK.

3.7 Outline Groups and Freeze Panes

Outline groups and Freeze Panes are used extensively in the Conservation Tool. The (+/-) outline buttons in a worksheet's margins allow you to show or hide row and column detail (Figure

3-1). This lets you adjust the amount of workspace shown on your screen. Users with small screens may find hiding the worksheet's top rows helpful. Hiding columns containing unwanted detail may also be useful. Users can adjust the row and column groups controlled by the outline buttons to their liking. Outline settings are on the DATA tab of Excel's Ribbon. See Excel's documentation for more information on setting or removing Outline groups.

Freeze Panes is used on worksheets to keep important row and column names clearly visible. You can adjust the Freeze Panes settings to your liking. Freeze Panes settings are on the VIEW tab of Excel's Ribbon. See Excel's documentation for more information on setting or removing Freeze Panes.

Note: To change either setting you will first need to unprotect the worksheet. See Section 3.4 on how to unprotect a worksheet.

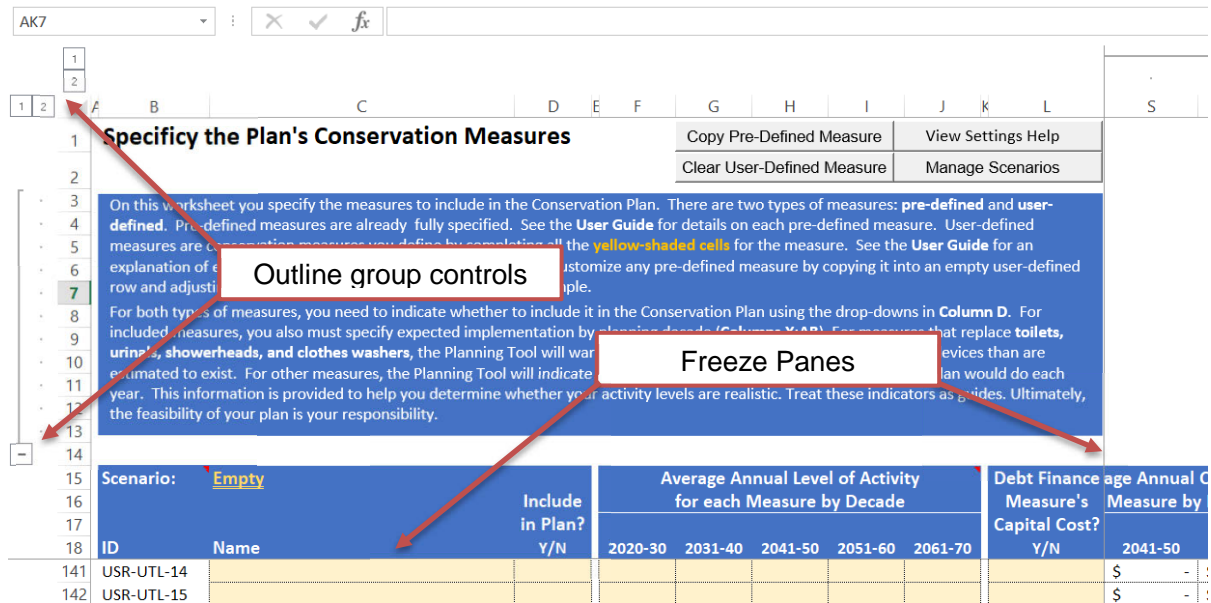


Figure 3-1. Outline Groups and Freeze Panes

4 Baseline Projection

This chapter describes how to load or enter a Baseline Projection. The Conservation Tool uses two different, but related, water use projections: the Baseline Projection and the Plan Projection. The Baseline Projection represents future water use given expected increases in population as well as expected water savings from state and federal plumbing codes and appliance standards for toilets, clothes washers, showers, and faucets, but not expected water savings from utility conservation measures. Water savings from plumbing codes and appliance standards are commonly termed Passive Savings while water savings from utility conservation programs are called Active Savings. Thus the Baseline Projection includes Passive Savings but not Active Savings. The Plan Projection represents future water demand given expected increases in population as well as expected Passive and Active Savings. The Plan Projection therefore equals the Baseline Projection minus Active Savings.

The Conservation Tool has been pre-populated with a Baseline Projections for 462 Texas water systems using data compiled by the TWDB. If you are one of these water systems you can choose to use this projection. Alternatively, you may choose to customize the TWDB data or enter your own Baseline Projection. You will have to enter your own Baseline Projection if the TWDB did not have data for your water system.

Note: The TWDB pre-populated water demand projections differ from the Board-adopted 2021 Regional and State Water Plan (SWP) municipal water demand projections. The SWP projections use a 2011 base year whereas the Conservation Tool's pre-populated projections use a 2016 base year. Per capita municipal water use was generally higher in 2011 than in 2016. Consequently, the SWP projections are higher than the pre-populated projections in most cases. These differences do not affect the estimated water savings of Conservation Tool's pre-defined conservation measures (described in Section 5), but they could impact the estimated savings of user-defined measures if those measures are based on a percentage of Baseline demand. Users of the Conservation Tool should be aware of the differences in the two projections and, if necessary, make appropriate adjustments to their water conservation measure savings specifications.

4.1 Using a TWDB-Generated Baseline Projection

Click the Find My Utility button at the top of the worksheet and select your utility from the dialog box. The Conservation Tool will load the Baseline Projection for your utility. Use the drop-down list to indicate you want to use the TWDB-generated projection by choosing Use TWDB Baseline Projection.

Note: If the TWDB did not have data for your utility, you will have to enter your own Baseline Projection. If the TWDB did have data for your utility, you can still choose to enter your own projection.

The TWDB-generated Baseline Demand Projection uses the following assumptions:

1. The base year for the calculations is 2016. This data was reported to the TWDB by your utility.
 - a. The pre-loaded 2016 population-served is the population-served submitted by the utility in the 2016 TWDB water use survey.
 - b. The pre-loaded 2016 categorical connection count and metered water uses were submitted by the utility in the 2016 TWDB water use survey.
 - c. The pre-loaded 2016 Other Uses and Water Loss volumes were submitted in the 2016 Water Loss audit.
2. The population projections have been approved for use in the 2021 regional water plans and the 2022 State Water Plan.
3. Service connections are generally assumed to increase at the same rate as population, though there are exceptions to this rule for some utilities.
4. Water sales are assumed to increase at the same rate as population, less adjustments for expected water savings from plumbing codes and appliance standards. These efficiency adjustments can be downloaded from the [TWDB website](#).
5. If the base year data did not include water loss information, a water loss rate of 10% is assumed for the Baseline Projection. Otherwise, the water loss rate reported in 2016 is used to project future baseline water losses.

Note: For some utilities the pre-loaded 2016 population is greater than the pre-loaded 2020 population projection. This can occur because these population estimates come from two different sources. The 2016 estimate, as noted in 1.a. above, is the value reported by the utility in the 2016 TWDB water use survey. The population projections for 2020 and thereafter, as noted in 2 above, are the projections approved for use in the 2021 regional water plans and the 2022 State Water Plan. If you do not want to use the regional population projections, you can modify the pre-loaded data, as described in Section 4.3.

4.2 What if Your Utility is not on the List?

If your utility is not listed, then select UNLISTED, which is first item on the list of utilities, and enter your Planning Region and utility name when prompted. If you are UNLISTED, you will have to enter your own Baseline Projection.

4.3 Customizing the Pre-Loaded Baseline Projection

You can customize the pre-loaded baseline projection by selecting “Customize TWDB Projection” from the Select Projection to Use drop-down list. This will activate the User Entered Projection tables that are to the right of the TWDB Pre-Populated Projection tables on the Baseline Demand Projection worksheet. The Conservation Tool will ask if you want it to copy the pre-populated projection over to the user-entered projection tables. Click “Yes” if you want this data copied over. You can then edit the pre-populated projection. If you click “No”, you will have to enter the data manually.

Note: You cannot edit the pre-populated projection data directly in the TWDB Pre-Populated Projection tables. To edit these data, select “Customize TWDB Projection” from the Select Projection to Use drop-down list and follow the prompts to copy the data over to the User Entered Projection tables.

4.4 Entering Your Own Baseline Projection

If you intend to use your own Baseline Projection, select Enter My Own Projection from the Select Projection to Use drop-down list. Enter the required data in the yellow-shaded cells.

Note: If your utility is UNLISTED, you will have to enter your own Baseline Projection and the Conservation Tool will automatically set the Select Projection to Use drop-down list to show this.

Note: If your utility is LISTED, you can still choose to enter your own Baseline Projection.

Note: If you want to customize your TWDB-generated projection, set the Select Projection to Use drop-down to Customize TWDB Projection. You can then choose whether to have the Conservation Tool copy the TWDB data into the User Entered Projection tables for editing, as described in Section 4.3.

Your baseline demands should include adjustments for future water savings from plumbing codes and appliance standards. If you do not have estimates of these future savings, you can use the estimates developed by the TWDB, which can be downloaded from their [website](#). These estimates are sorted by Planning Region and utility and are in gallons per capita-day (gpcd) by planning decade.

Note: If TWDB did not prepare a plumbing code/appliance standard savings estimate for your utility, use the average gpcd savings for your Planning Region.

Since the Conservation Tool needs baseline demands in thousands of gallons per year, you will need to convert the gpcd savings into annual savings in thousands of gallons (kGal) using the following formula, where x is TWDB's savings estimate in gpcd:

$$\text{Annual Savings in kGal} = x \frac{\text{gallons}}{\text{person} - \text{day}} \cdot 365 \frac{\text{days}}{\text{year}} \cdot \frac{\text{population projection}}{1000}$$

Note: The base year for TWDB's plumbing code/appliance standard savings projection is 2010. If your Base Projection uses a different base year, then you will need to recalibrate the plumbing code/appliance standard savings projection to this different base year. The TWDB pre-populated projection, for example, uses 2016 for the base year. This means that approximately 60% of the 2020 plumbing code/appliance standard savings will already be included in the 2016 base water use. In this example, recalibration requires subtracting 60% of the 2020 savings from the savings projection.

Note: When entering your own projection, you are not required to use 2016 as the base year. You can choose a different year or an average of years as the base period for your projection.

Find Utility

Enter Search String to Filter Utility List

Select your utility from the list. If your utility is not listed, choose UNLISTED.

- UNLISTED
- ABILENE
- ACTON MUD
- ADDISON
- AFTON GROVE WSC
- ALAMO
- ALBANY
- ALEDO
- ALICE
- ALLEN
- ALVIN
- AMARILLO
- ANDREWS
- ANGLETON
- ANTHONY
- ANTON
- AQUA WSC
- ARANSAS PASS
- ARLINGTON
- ATASCOSA RURAL WSC
- ATHENS

Use the filter box to narrow your search. Enter a search string and only entries containing this string will be listed.

Click the Find My Utility button. Select you utility from the list. If your utility is not listed, choose UNLISTED.

Year	2016	2020	2030	2040
Single Family	402,754	486,174	518,074	
Multi Familv	15,792	15,370	16,620	17,972

Figure 4-1. Baseline Projection Worksheet

Select Projection to Use: Use TWDB Projection

User Entered Projection: If you are using your own Baseline Demand Projection, enter values # tables below in the units specified.

After loading your data, use the drop-down list to indicate whether you want to 1) use the TWDB data, 2) customize the TWDB data, or 3) enter your own Baseline Projection.

Ave Annual	Reported				Projected			
	2016	2020	2030	2040	2016	2020	2030	2040
Single Family	402,754	486,174	518,074					
Multi Familv	15,792	15,370	16,620	17,972	19,434	21,015		

Figure 4-2. Baseline Projection Worksheet

5 Conservation Measures

On this worksheet you specify the conservation measures to include in your Conservation Plan. There are two types of measures: pre-defined and user-defined. Pre-defined measures are already fully specified. Appendix B provides the specification and data sources for each pre-defined measure. User-defined measures are conservation measures you define by completing all the yellow-shaded cells for the measure, as explained later in this chapter.

For either type of measure, you need to indicate whether to include it in the Conservation Plan using the Y/N drop-down in Column D.

Note: Only measures marked for inclusion using the Y/N drop-down in Column D will show up in the Conservation Plan summary worksheets.

5.1 Using Pre-Defined Conservation Measures

Pre-defined conservation measures are grouped into Single-Family Measures, Multi-Family Measures, and ICI (Institutional, Commercial, and Industrial) Measures. Each pre-defined measure comes fully specified. All you need to do is indicate which measures you want to include in your Conservation Plan.

If a pre-defined measure has a capital cost, you can choose whether this capital cost will be debt financed using the Y/N drop-down list in Column Q. If you choose to debt-finance the measure's capital cost, the Conservation Tool assumes a 20-year repayment period and a real interest rate of 3.5%.

Why aren't Public Education and Conservation Rates in the list of pre-defined measures? Educating the public is a necessary facet of every consumer water conservation program. Education programs are implemented for a variety of reasons, but successful efforts all share common attributes. The key goals of an education program are to inform and educate water users regarding the: reasons water conservation is necessary, benefits of conserving water, liabilities of not conserving water, and actions needed to achieve the utility's water conservation goals. The effectiveness of an education program depends on many factors and there is no standard set of assumptions that can be applied to estimate water savings and implementation costs for public education. There are simply too many factors involved. This is why public education is not included as a pre-defined measure in the Conservation Tool. However, users with specific information on education program costs and expected water savings for their utility can include public education in their conservation plan by defining a user-defined public education program. User-defined conservation measures are discussed in Section 5.3.

A similar situation exists for conservation rates. A conservation rate design's effect on water use depends on multiple factors which cannot be distilled into a simple formula of water savings for a broad range of water utilities. These factors include, among other things, the composition of households and businesses, the level and distribution of household income, the utility's cost of service and revenue requirement, service area climate, the extent of indoor versus outdoor water uses, and, of course, the rate design itself. All of these factors can be expected to vary from utility to utility and so it is not possible to define a generic "conservation rate" measure that would reliably predict water savings. That said, as with public education, users with specific information about the rate design that will be implemented and its expected effect on water use can include conservation rates in their conservation plan by defining a user-defined conservation rate measure.

5.2 Customizing Pre-Defined Conservation Measures

You can copy any pre-defined conservation measure and paste it to any row in the corresponding user-defined measures table. You can then customize the pre-defined measure you copied for use in your Conservation Plan. For example, you could adjust the measure's cost or water savings parameters to better match your local conditions.

Follow these steps to copy and customize a pre-defined conservation measure:

1. Click the Copy Pre-Defined Measure button at the top of the worksheet.
2. Click on the ID (column B) of the measure you want to copy.
3. Click OK.
4. Click on the ID (column B) of the user-defined measure row where you want to paste the copy.
5. Click OK.
6. Click OK again to paste the measure, or Cancel to cancel the paste operation.

7. Adjust the savings and cost parameters as appropriate and change the measure's name if desired.

5.3 Using User-Defined Conservation Measures

You just learned how to turn a pre-defined conservation measure into a user-defined conservation measure by copying and customizing it. You can also build user-defined conservation measures from scratch.

User-defined measures are grouped into four categories: Single-Family Measures, Multi-Family Measures, ICI Measures, and Utility & General Measures. Grouping the measures in this way lets the Conservation Tool know where water savings are expected to occur. Water savings for Single-Family Measures, for example, are deducted from the Single-Family Baseline Demand Projection.

With Utility & General Measures, you must tell the Conservation Tool which water use will be affected using the drop-down list in Column L. There are three choices: Water Loss, Other, and All. If you select Water Loss, the measure's savings will be deducted from the Water Loss Baseline Projection. If you choose Other, the measure's savings will be deducted from the Other Baseline Projection. If you choose All, the measure's savings will be deducted from each Baseline water use category in proportion to its share of total production.

Note: With Utility & General Measures, you must tell the Conservation Tool which water use will be affected using the drop-down list in Column L.

To create a user-defined measure from scratch, select an unused row in the User-Defined Conservation Measures table and enter a name for the measure. You can then tab across the data entry fields and provide values for each field.

Note: You may want to save entering the average annual activity levels in Columns F:J until the end, after you have specified the measure's implementation cost and water saving parameters.

Creating a User-Defined Conservation Measure from scratch requires entering values for the following parameters:

Measure Accounting Unit (Column L): The measure accounting unit defines the basic unit of account for the measure. For example, for a toilet replacement program the basic unit of account is a toilet. The Conservation Tool uses measure accounting units to help you determine whether the level of activity you specify for the measure is realistic, as explained later. Select the appropriate unit from the drop-down menu. Select 'Other' if none of the units listed are appropriate to your measure.

Note: Measure Accounting Unit is not applicable to Utility & General Measures. Instead, you specify the Affected Water Use in Column L for these measures.

Measure Delivery Method (Column M): The measure delivery method defines how the measure will be delivered. The basic delivery methods are: Rebate, Direct Installation, Site Visit, Ordinance/Regulation, and Other. Select the appropriate method from the drop-down menu. Select 'Other' if none of the methods listed are appropriate to your measure.

O&M Implementation Cost per Unit of Activity (Column O): This is the expected O&M cost per one unit of activity of the measure. O&M costs are comprised of labor and material costs required to implement the measure. For more information on cost accounting for Regional Water Plan Development, see [Exhibit C: General Guidelines for Fifth Cycle of Regional Water Plan Development](#). These costs should be expressed in 2018 constant dollars.

Capital Implementation Cost per Unit of Activity (Column P): This is the expected Capital cost per one unit of activity of the measure. Capital costs consist of construction funds and other capital outlays including, but not limited to, costs for engineering, contingencies, financial, legal, administration, environmental permitting and mitigation, land, and interest during construction. For more information on cost accounting for Regional Water Plan Development, see [Exhibit C: General Guidelines for Fifth Cycle of Regional Water Plan Development](#). These costs should be expressed in 2018 constant dollars.

Debt Finance Capital Cost? Y/N (Column Q): If capital costs will be debt-financed, select Y, otherwise select N or leave blank. If you choose to debt-finance the measure's capital cost, the Conservation Tool assumes a 20-year repayment period and a real interest rate of 3.5%.

Unit Savings gpd (Column S): This is the expected initial daily water savings in gallons from one unit of activity of the measure.

Note: Unit Savings must be specified in gallons per day (gpd) per unit of activity.

Freerider Rate %/yr (Column T): This is the percentage of participants that it is expected would take the same water savings action even without implementation of the measure. Freeriders don't generate new water savings, only costs. Freeridership has been documented in utility rebate programs and can be especially problematic where rebates are targeting devices already subject to efficiency standards, such as toilets and clothes washers. If freeridership is not expected to be an issue, enter zero or leave the cell empty.

Decay Rate %/yr (Column U): This is the annual rate at which water savings are expected to decay. Water savings for measures that target water user behavior, such as water audits or

training classes, have been shown to decay over time in some cases. If savings decay is not expected to be an issue, enter zero or leave the cell empty.

Plumb. Code Interaction Y/N (Column V): If the measure is advancing what would otherwise be expected to occur due to plumbing codes and/or appliance standards, select Y from the drop-down menu. Otherwise select N. If your measure would replace toilets, urinals, showerheads, clothes washers, dishwashers, faucets, or faucet aerators, select Y.

Nat. Repl. Rate %/yr (Column W): The natural replacement rate is the annual rate at which the plumbing fixture/appliance normally turns over. This can be approximated by taking the reciprocal of the plumbing fixture/appliance's useful life. For example, if the plumbing fixture/appliance has a useful life of, say, 15 years, the natural replacement rate can be approximated as 1/15, or 6.7%.

Useful Life years (Column X): This is the number of years the measure is expected to generate water savings before having to be replaced or renewed. If you entered Y for Plumb. Code Interaction, then set this to 99. Otherwise, set it to the expected useful life of the water savings.

Note: The Conservation Tool assumes that water savings from replacement of toilets, urinals, showerheads, clothes washers, dishwashers, faucets, or faucet aerators will last indefinitely because of plumbing codes and appliance standards. Setting the Useful Life to 99 for measures that replace these plumbing fixtures/appliances tells the Conservation Tool to assume the water savings will persist over the entire planning period.

Note: When Plumb. Code Interaction Y/N is set to Y, the Conservation Tool dynamically apportions the water savings between Active and Passive savings to avoid double counting water savings. See Appendix A for a detailed explanation of how the Conservation Tool calculates the water savings for a measure.

5.4 Clearing User-Defined Conservation Measures

To erase a user-defined conservation measure, click the Clear User-Defined Measure button at the top of the worksheet. Click on the ID of the measure you want to clear, and then click OK. This will erase the measure from the table and its row can be recycled.

Note: You can also overwrite an existing user-defined measure by copying and pasting a pre-defined measure into the existing measure's row. See Section 5.2 for instructions on how to copy and paste a pre-defined measure into the user-defined measures table.

5.5 Setting a Measure's Annual Activity Level

You need to set the average annual level of activity by planning decade for each measure you include in your plan. This is done in Columns F:J. For example, if you include the pre-defined single-family toilet rebate measure and you expect to rebate, on average, 100 toilets per year between 2020 and 2030, you would enter 100 in the column for 2020-2030. If you expect to discontinue toilet rebates after 2030, you would enter 0 in the remaining columns, or leave them empty.

Conservation Tool Warning Flags

The Conservation Tool keeps track of the estimated number of inefficient toilets, urinals, showerheads, and clothes washers in your service area by planning year, and it will warn you if your Conservation Plan would replace more of these devices than are estimated to exist. In this case, the activity levels you enter in Columns F:J will turn red and a warning flag will appear at the top of the table. This is illustrated in Figure 5-1.

In Panel A, the user has indicated it will replace, on average, 100 toilets per year via a rebate and 100 toilets per year via a bathroom retrofit direct install program through 2040. In total, the user is proposing to replace 4,200 toilets between 2020 and 2040. This is within the estimated number of inefficient single-family toilets that could be replaced over this time period.

In Panel B, the user has decided to increase the number of rebates in 2020-30 from 100 per year to 500 per year, leaving everything else unchanged. In total, the user is now proposing to replace 8,600 toilets between 2020 and 2040. This would replace more toilets than the Conservation Tool estimates would exist and therefore this change triggers the warning flag and turns the activity levels red for all measures that replace single-family toilets.

Panel A

Scenario: Residential Focus		Include in Plan? Y/N	Average Annual Level of Activity for each Measure by Decade				
ID	Name		2020-30	2031-40	2041-50	2051-60	2061-70
Single-Family Measures							
23	PRE-SF-01	HE Toilet Rebate	Y	100	100		
24	PRE-SF-02	Bathroom Retrofit	Y	100	100		
25	PRE-SF-03	Showerhead and Aerator Kit	Y	50	25		
26	PRE-SF-04	Clothes Washer Rebate	Y	50	50		

Panel B

Scenario: Residential Focus		Include in Plan? Y/N	Average Annual Level of Activity for each Measure by Decade				
ID	Name		2020-30	2031-40	2041-50	2051-60	2061-70
Single-Family Measures							
23	PRE-SF-01	HE Toilet Rebate	Y	500	100		
24	PRE-SF-02	Bathroom Retrofit	Y	100	100		
25	PRE-SF-03	Showerhead and Aerator Kit	Y	50	25		
26	PRE-SF-04	Clothes Washer Rebate	Y	50	50		

Figure 5-1. Conservation Tool will warn users if proposed activity levels for toilet, urinal, showerhead, and clothes washer replacement are not feasible

Note: The warning flags illustrated in Figure 5-1 only apply to measures that replace toilets, urinals, and residential showerheads and clothes washers.

Annual % of Measure Accounting Units Receiving Measure by Decade

The Conservation Tool also keeps track of the annual percentage of measure accounting units that would receive the measure by planning decade. This tracking is tabulated in Columns AI:AM. You can use this table to guide your choice of annual implementation for each measure. Very high percentages may indicate an unrealistic implementation level for the conservation measure. For example, providing toilet rebates to more than 10% of customers each year is unlikely to be feasible.

The tracking table is illustrated in Figure 5-2. Note in this example, the user wanted to distribute Home Water Reports to two-thirds of its single-family customers. It used the tracking table to determine how many Home Water Reports would be needed, on average, for each planning decade.

Specify the Plan's Conservation Measures															
View Settings Help		Clear User-Defined Measure			Copy Pre-Defined Measure			Manage Scenarios							
											Hide Cost & Water Savings Parameters				
Utility: HOUSTON					Average Annual Level of Activity for each Measure by Decade			Annual % of Measure Accounting Units Receiving Measure by Decade							
Scenario: Test 2		Include in Plan?													
ID	Name	Y/N	2020-30	2031-40	2041-50	2051-60	2061-70	2020-30	2031-40	2041-50	2051-60	2061-70			
Pre-Defined Conservation Measures															
Single-Family Measures															
PRE-SF-01	HE Toilet Rebate	Y	7,500	5,000				0.9%	0.6%	0.0%	0.0%	0.0%			
PRE-SF-02	Bathroom Retrofit	Y	1,000	1,000				0.1%	0.1%	0.0%	0.0%	0.0%			
PRE-SF-03	Showerhead and Aerator Kit	Y	2,500	2,500				0.3%	0.3%	0.0%	0.0%	0.0%			
PRE-SF-04	Clothes Washer Rebate	Y	5,000	2,500				1.2%	0.6%	0.0%	0.0%	0.0%			
PRE-SF-05	Home Water Reports	Y	100,000	100,000	100,000	100,000	100,000	24.5%	22.8%	21.3%	19.9%	18.7%			
PRE-SF-06	Irrigation Audits - High Users	Y	4,000	4,000	4,000	4,000	4,000	1.0%	0.9%	0.9%	0.8%	0.7%			
PRE-SF-07	High-Efficiency Sprinkler Nozzle Rebate	Y	4,000	4,000	4,000	4,000	4,000	1.0%	0.9%	0.9%	0.8%	0.7%			
PRE-SF-08	Smart Irrigation Controller Rebate	Y	4,000	4,000	4,000	4,000	4,000	1.0%	0.9%	0.9%	0.8%	0.7%			
PRE-SF-09	WaterWise Landscape Rebate	Y	4,000	4,000	4,000	4,000	4,000	1.0%	0.9%	0.9%	0.8%	0.7%			
PRE-SF-10	Rainwater Harvesting Rebate	N						0.0%	0.0%	0.0%	0.0%	0.0%			
PRE-SF-11	Rain Barrel	Y	4,000	4,000	4,000	4,000	4,000	1.0%	0.9%	0.9%	0.8%	0.7%			

Figure 5-2. Annual % of Measure Accounting Units Receiving Measure by Decade

5.6 User-Defined Measure Example: Watering Restrictions

The following example illustrates a user-defined measure that quantifies savings from year-round, no more than twice a week watering restrictions. These watering restrictions are assumed to be permanent. That is, they are not a short-term response to drought.

Note: For this example, a regression analysis was conducted to estimate water savings resulting from permanent watering restrictions for a specific water provider. Savings resulting from watering restrictions will vary greatly among water providers. These numbers are for example purposes only and should not be copied.

The year-round, no more than twice a week watering restrictions used in this example affect more than one customer class, so the parameters of this measure are specified in the Utility & General Measures table. Figure 5-3 displays this section and shows the name entry for measure id USR-UTL-01.

Specify the Plan's Conservation Measures															
View Settings Help		Clear User-Defined Measure			Copy Pre-Defined Measure			Manage Scenarios							
On this worksheet you specify the measures to include in the Conservation Plan. There are two types of measures: pre-defined and user-defined. Pre-defined measures are already fully specified. See the User Guide for details on each pre-defined measure. User-defined measures are conservation measures you define by completing all the yellow-shaded cells for the measure. See the User Guide for an explanation of each parameter you will need to specify. You can customize any pre-defined measure by copying it into an empty user-defined row and adjusting its parameters. See the User Guide for an example. For both types of measures, you need to indicate whether to include it in the Conservation Plan using the drop-downs in Column D. For included measures, you also must specify expected implementation by planning decade (Columns F-J). For measures that replace toilets, urinals, showerheads, and clothes washers, the Planning Tool will warn you if your plan would replace more inefficient devices than are estimated to exist. For other measures, the Conservation Tool will indicate how much activity as a % of total inventory your plan would do each year. This information is provided to help you determine whether your activity levels are realistic. Treat these indicators as guides. Ultimately, the feasibility of your plan is your responsibility.															
Hide Cost & Water Savings Parameters															
Utility: Watering Restrictions Example		Include in Plan?			Average Annual Level of Activity for each Measure by Decade					Measure Accounting Unit		Measure Delivery Method			
Scenario: Clear Cells		Y/N								Affected Water Use					
ID	Name	Y/N			2020-30	2031-40	2041-50	2051-60	2061-70	Affected Water Use		Measure Delivery Method			
Utility & General Measures															
128	USR-UTL-01	Twice A Week Watering Restrictions													
129	USR-UTL-02	Enter a name for the conservation measure you are defining.													
130	USR-UTL-03														
131	USR-UTL-04														
132	USR-UTL-05														

Figure 5-3: Utility & General Measures Location and Measure Name Entry

Next the user selects “Y” from the drop down menu in column D so the measure is included in the Conservation Plan.

This ordinance is assumed to be in place for 10 years and reduce water use by 2.5%. The 2.5% water use reduction was applied to the 2016 sales subtotal for this example water provider. As was previously noted, this estimate is based on statistical analysis and should not be applied broadly to other water providers. The Average Annual Level of Activity for the Measure by Decade is entered as “1” for 2020-30 in column F. Since this measure is assumed to be in effect for only 10 years, the other cells in the Average Annual Level of Activity table are left blank. The Affected Water Use is selected as “All” from the drop-down menu in column L and the Measure Delivery Method is specified as “Ord/Reg” (Ordinance/Regulation) using the drop-down menu in column M. The Implementation Cost per Unit of Activity is entered as \$100,000. These costs are related to administration and enforcement. For example, warnings are processed and sent to customers that are not complying with the ordinance which requires materials and staff time. Staff time is also required to patrol the service area to monitor compliance. For some utilities, this may also include responding to water waste complaints received from the public. These inputs are illustrated in Figure 5-4.

Specify the Plan's Conservation Measures													
View Settings Help		Clear User-Defined Measure		Copy Pre-Defined Measure		Manage Scenarios							
On this worksheet you specify the measures to include in the Conservation Plan. There are two types of measures: pre-defined and user-defined. Pre-defined measures are already fully specified. See the User Guide for details on each pre-defined measure. User-defined measures are conservation measures you define by completing all the yellow-shaded cells for the measure. See the User Guide for an explanation of each parameter you will need to specify. You can customize any pre-defined measure by copying it into an empty user-defined row and adjusting its parameters. See the User Guide for an example. For both types of measures, you need to indicate whether to include it in the Conservation Plan using the drop-downs in Column D. For included measures, you also must specify expected implementation by planning decade (Columns F-J). For measures that replace toilets, urinals, showerheads, and clothes washers, the Planning Tool will warn you if your plan would replace more inefficient devices than are estimated to exist. For other measures, the Conservation Tool will indicate how much activity as a % of total inventory your plan would do each year. This information is provided to help you determine whether your activity levels are realistic. Treat these indicators as guides. Ultimately, the feasibility of your plan is your responsibility.													
Hide Cost & Water Savings Parameters													
Utility:	Watering Restrictions Example			Average Annual Level of Activity for each Measure by Decade						Measure Accounting Unit	Measure Delivery Method	Cost Parameters	
Scenario:	Clear Cells			Include in Plan?						Implementation Cost \$ per Unit of Activity	Debt Finance Capital Cost?		
ID	Name		Y/N	2020-30	2031-40	2041-50	2051-60	2061-70			O&M	Capital	Y/N
Utility & General Measures										Affected Water Use			
128	USR-UTL-01	Twice-A-Week Watering Restrictions	Y	1						All	Ord/Reg	\$ 100,000	N
129	USR-UTL-02												

Figure 5-4: Utility & General Measures – User Specified Example Parameters

The Unit Savings value is entered as 2,280,000 gallons per day in column S. This value represents 2.5% of the 2016 sales subtotal across all customer classes. There are no freeriders (column T), decay rate (column U), Plumbing Code Interaction (column V), or Natural Replacement Rate (column W) values to enter for this activity. The Useful Life is entered as 1-year in column X. With a useful life of 1-year the savings associated with the ordinance will end in 2030 (1 unit will be implemented each year for 2020-2030). That is, 2030 will be the final year with savings resulting from the ordinance. A useful life of 1-year also prevents the savings values associated with the ordinance from incorrectly compounding over time. For example, if the useful life was entered as 10-years the effective activity of the ordinance would increase over time and the savings would be grossly overestimated. With a 10-year useful life it would be incorrectly assumed that 10 ordinances would be in place in 2030. The Water Savings Parameters are displayed in Figure 5-5.

Water Savings Parameters					
Unit Savings (u)	Freerider Rate (f)	Decay Rate (d)	Plumb. Code Interaction	Nat. Repl. Rate (n)	Useful Life (T)
gpd	%/yr	%/yr	Y/N	%/yr	years
2,280,000.00	0%	0%	N	0%	1

Figure 5-5: Utility & General Measures – User Specified Example Water Savings Parameters

The user has now completed specifying this custom measure and can evaluate costs and savings on the Conservation Plan worksheet. The results are displayed in Figure 5-6 and Figure 5-7 and show the unit cost of savings in dollars per acre-foot, annual implementation, and water savings by year in thousands of gallons.

Conservation Plan		Savings Unit Cost \$/AF	Annual Measure Implementation							
ID	Name		2020	2024	2029	2030	2040	2050	2060	2070
Utility & General Measures										
USR-UTL-01	Twice A Week Watering Restrictions	\$ 39	1	1	1	1	0	0	0	0
Subtotal		\$ 39								
Grand Total for Plan		\$ 39								

Figure 5-6: Conservation Plan Outputs, Unit Cost and Measure Implementation

Active Water Savings by Planning Year (kGal)						
	2020	2024	2029	2030	2040	2050
	832,200	832,200	832,200	832,200	0	0
	832,200	832,200	832,200	832,200	0	0
	832,200	832,200	832,200	832,200	0	0

Figure 5-7: Conservation Plan Outputs, Active Water Savings

For more information about watering restrictions, users of the Municipal Water Conservation Planning Tool can review the following references.

References:

1. Water Conservation Advisory Council. (2018). Outdoor Water Schedules BMP. <http://www.savetexaswater.org/bmp/municipal/index.asp>
2. San Antonio Water System. (2017). Water Management Plan, Page 95. http://www.saws.org/Your_Water/WaterResources/2017_WMP/docs/20171107_SAWS-2017-Water-Management-Plan.pdf
3. Tarrant Regional Water District. (2013). Strategic Water Conservation Plan, Appendix I. http://www.savetarrantwater.com/docs/default-source/default-document-library/strategic_water_conservation_plan.pdf?sfvrsn=2

6 Creating and Managing Scenarios

Use the Scenario Manager to save new scenarios, load or update existing scenarios, rename scenarios, and delete unwanted scenarios. You access the Scenario Manager by clicking the Manage Scenarios button at the top of the worksheet. Use the buttons on the Scenario Manager form to do the following:

Load Scenario – Select a scenario from the Scenario List and click the button Load Scenario. All of the data contained in the scenario will be imported into the Conservation Tool.

WARNING: Loading a scenario will overwrite any data you have entered on the Conservation Measures worksheet. If you do not want to lose this data, save it as a scenario before loading a different scenario.

Save New Scenario – Click the Save New Scenario button to create a new scenario. You will be prompted to give the scenario a name. All of the data you have entered on the Conservation Measures worksheet will be saved in this scenario.

WARNING: Saving a scenario is the same as copying all the data entered on the Conservation Measures worksheet and storing it on a separate worksheet for later use. If you save a scenario and then change some of the data on the Conservation Measures worksheet, the scenario is not automatically updated to reflect these changes. To have these changes reflected in a scenario, you will need to update the previously saved scenario or save the changes to a new scenario.

Update Scenario – Select a scenario from the Scenario List and click the button update it. The scenario will be updated to reflect the data you have entered on the Conservation Measures worksheet.

Rename Scenario – Select a scenario from the Scenario List and click the button to change its name. Enter a new name for the scenario when prompted.

Delete Scenario – Select a scenario from the Scenario List and click the Delete Scenario button. The scenario will be erased.

WARNING: You cannot undo a scenario deletion.

7 Conservation Planning & Plan Projection

This chapter describes the Conservation Plan and Plan Demand Projection worksheets. These worksheets summarize the results of the information you entered on the Conservation Measures worksheet.

Note: There is no data entry on these two worksheets.

7.1 Conservation Plan Worksheet

The conservation measures you specified and selected on the Conservation Measures worksheet are summarized on this worksheet. It shows the expected unit cost, annual implementation level, annual water savings, and annual O&M, capital, and debt service costs for each measure in the Conservation Plan. These quantities are subtalled for each measure category and the Plan's grand totals are displayed at the bottom of the tables.

Outline groups are used extensively on the columns of this worksheet. The default setting shows annual quantities for 2020, 2024, 2029, and then by decade thereafter up to 2070. You can view values for intervening years by clicking the + buttons in the top margin of the worksheet. Likewise, you can hide values for intervening years by clicking the – buttons in the top margin of the worksheet.

There are seven summary tables on this worksheet, as follows:

Savings Unit Cost \$/AF (Column F): This table shows the expected unit cost in \$/AF of saved water for each measure, each measure grouping, and the grand total for the Conservation Plan. See Appendix A for a detailed explanation of how the Conservation Tool calculates the savings unit cost.

Annual Measure Implementation (Columns H:BF): This table shows the average annual implementation of each measure by planning year through 2070.

Active Water Savings by Planning Year (kGal) (Columns BH:DF): This table shows the active annual water savings for each measure, measure grouping, and the grand total for the Conservation Plan through 2070. Annual water savings are reported in thousands of gallons (kGal).

Total Cost by Planning Year (2018 \$) (Columns DH:FF): This table shows the total annual cost for each measure, measure grouping, and the grand total for the Conservation Plan through 2070. Costs are reported in 2018 constant dollars.

O&M Cost by Planning Year (2018 \$) (Columns FH:HF): This table shows the O&M annual cost for each measure, measure grouping, and the grand total for the Conservation Plan through 2070. Costs are reported in 2018 constant dollars.

Capital Cost by Planning Year (2018 \$) (Columns HH:JF): This table shows the capital annual cost for each measure, measure grouping, and the grand total for the Conservation Plan through 2070. Costs are reported in 2018 constant dollars.

Debt Service by Planning Year (2018 \$) (Columns JH:LF): This table shows the annual debt service for each measure, measure grouping, and the grand total for the Conservation Plan through 2070. Costs are reported in 2018 constant dollars.

Note: If a measure's capital cost is debt financed, then its capital cost will be reported as zero. This is because the capital cost has been converted into a stream of future debt repayments. The present value of these debt repayments is equal to the original capital cost.

7.2 Plan Demand Projection Worksheet

The Baseline and Plan Projections are summarized on this worksheet. The population and connection projections are the same for both projections. As noted previously, the Baseline Demand Projection represented expected demands given projected population growth and passive savings from plumbing codes and appliance standards. The Plan Demand Projection represents expected demands given projected population growth and both passive and active water savings. The active water savings are the expected water savings from your selected conservation measures, as estimated by the Conservation Tool.

Baseline and Plan Demand Projections are reported in thousands of gallons per year (kGal) and gallons per capita-day (GPCD). GPCD values are reported for total production, residential water sales, and system water loss. The percentage reduction from the Baseline Demand Projection is shown for each of these quantities.

Negative Projected Demand Warning Flag

The Conservation Tool will show a warning flag if any of the Plan Demands are negative. Negative demands can occur if the user has incorrectly specified one or more user-defined

conservation measures or has entered infeasible implementation levels for one or more conservation measures. This is illustrated in Figure 7-1. The user's selected conservation measures have grossly overestimated potential water savings for Multi-Family, resulting in negative demands. This triggered the Conservation Tool's warning flag that the projection includes negative demands.

Scenario: All Sectors										Avg Ann Growth %
Projections	2020	2024	2029	2030	2040	2050	2060	2070	2020-70	
Plan Demand Projection (in kGal)										
Single Family	541,989	640,650	776,275	804,172	986,764	1,098,838	1,225,515	1,364,505	1.9%	
Multi Family	1,745	-3,724	-10,287	-11,517	-16,267	-15,046	-13,951	-12,915	#NUM!	
ICI	24,655	27,235	31,415	32,297	40,904	46,954	53,196	59,927	1.8%	
Sales Subtotal	568,389	664,162	797,403	824,952	1,011,401	1,130,746	1,264,760	1,411,518	1.8%	
Other Uses	553	683	853	887	1,111	1,228	1,357	1,500	2.0%	
Water Loss	9,113	11,126	14,127	14,748	18,947	21,635	24,652	27,957	2.3%	
Production Total	578,056	675,971	812,384	840,586	1,031,459	1,153,608	1,290,769	1,440,974	1.8%	
Water Loss %	2%	2%	2%	2%	2%	2%	2%	2%	0.4%	
WARNING: Negative Demands in Projection										
Plan GPCD										
Total	81	76	73	73	71	72	73	74	-0.2%	
% Reduction from Baseline	7%	10%	11%	11%	11%	9%	8%	7%		
Residential	76	71	69	69	67	68	69	69	-0.2%	
% Reduction from Baseline	7%	9%	10%	10%	10%	9%	7%	6%		

Figure 7-1. Conservation Tools Negative Demands Warning Flag

8 Single-Year Savings Calculator

You can use the Single-Year Savings Calculator to estimate the water savings from conservation measures you implemented in the Reporting Year. Follow these instructions to use the calculator:

1. First load the Plan scenario with your conservation measures.
2. If you implemented measures that are not in your Plan, go to the Conservation Measures Worksheet and select Y in the Include in Plan? column for the additional measures you want to calculate savings for. If any of these additional measures are user-defined measures, make sure they are fully specified before returning to the Reporting Year Calculator worksheet.

Note: You can also define a new user-defined measure if you implemented a measure that doesn't currently exist in your Conservation Plan.

3. Go back to the Single-Year Savings Calculator worksheet. Enter the level of activity implemented for each measure listed. The water savings and savings unit cost will be calculated in columns H and J, respectively. Water savings over the entire life of the measure are calculated in columns BZ:BW. Water savings is reported in thousands of gallons (kGal) and unit cost is reported in \$/AF.

Note: Click the Clear Activity button at the top of the worksheet to erase Reporting Year Activity you have previously entered.

9 Plumbing Fixture Inventory

The Conservation Tool compares the running total of inefficient toilets, urinals, showerheads, and clothes washers expected to be converted to efficient fixtures/appliances by natural replacement and conservation measures in your Conservation Plan to an estimate of the starting population of inefficient fixtures/appliances calculated on this worksheet. If the running total exceeds the estimated starting population, the Conservation Tool will warn you that your Conservation Plan is infeasible. -- i.e. would replace more fixtures/appliances than exist.

The Conservation Tool estimates the number of inefficient fixtures/appliances at the start of the planning period and tracks their level over the course of the planning period on this worksheet.

Note: You can ignore this worksheet if you want to use the Conservation Tool's default fixture/appliance counts. If you want to develop your own fixture/appliance counts, use the radio buttons on the worksheet and enter the requested information in the yellow-shaded cells.

Estimating the Starting Number of Inefficient Devices

The Conservation Tool estimates the starting number of inefficient devices as follows:

Single-Family Toilets, Showerheads, and Clothes Washers:

Device Ownership Rate x (1-Device Saturation Rate) x Single-Family Connections

Multi-Family Toilets and Showerheads:

Device Ownership Rate x (1-Device Saturation Rate) x Households per Complex x Multi-Family Connections

Multi-Family Common Area Clothes Washers:

(Households per Common Washer / Households per Complex) x (1- Device Saturation Rate) x Multi-Family Connections

ICI Toilets:

(Service Area Population / Population per ICI Toilet) x (1-Device Saturation Rate)

ICI Urinals:

Urinals per ICI Toilet x ICI Toilets x (1-Device Saturation Rate)

Default Device Saturation Rates

The Conservation Tool’s default saturation rates of efficient toilets, clothes washers, and showerheads are from “Residential End Uses of Water, Version 2.” Water Research Foundation, PDF report #4309b, 2016. The default saturation rate for efficient urinals is estimated based on Texas’s 0.5 gpf standard taking effect on January 1, 2014 and an annual turnover rate of 4% for urinals, which is equivalent to a 25-year average useful life.

Users can replace the default saturation rates with their own values by selecting the radio button Use My Own Saturation Rates and then entering their values in the yellow-shaded cells in the saturation rates table.

Default Ownership Rates

The Conservation Tool’s default residential device ownership rates and multi-family housing unit parameters are from “Quantifying the Effectiveness of Various Water Conservation Techniques in Texas,” GDS Associates, Inc., May 2002. This report can be downloaded from the TWDB [website](#).

The Conservation Tool’s default ICI toilet and urinal counts are derived from data on ICI toilet and urinal populations compiled by the California Urban Water Conservation Council (CUWCC).

The average estimate of service area population per ICI toilet is based on a linear regression model of ICI toilets regressed on population for 54 zip-code areas across California.

```
. regress toilets population [weight=wt],robust noconstant
(analytic weights assumed)
(sum of wgt is 4.6419e+01)
```

```
Linear regression                Number of obs    =           54
                                F(1, 53)         =        1409.74
                                Prob > F              =           0.0000
                                R-squared              =           0.9641
                                Root MSE           =           13532
```

toilets	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
population	.1053693	.0028064	37.55	0.000	.0997404	.1109981

The average number of urinals per ICI toilet is taken from the 2005 CUWCC report [Evaluation of Potential Best Management Practices: High-Efficiency Plumbing Fixtures – Toilets & Urinals](#).

Users can replace the default ownership rates with their own values by selecting the radio button Use My Own Ownership Rates and then entering their values in the yellow-shaded cells in the ownership rates tables.

Viewing the Annual Inventory of Inefficient Plumbing Fixtures/Appliances

The running tally of inefficient plumbing fixtures/appliances is maintained in a table on this worksheet starting on Row 65.

10 Special Worksheets and Macros

This chapter briefly describes the purpose of the tool's data storage and background calculation worksheets. It also explains how to access the underlying Visual Basic macros used by the tool.

10.1 Special Worksheets

Pre-Defined Measures -- This worksheet holds the pre-defined conservation measures for each Planning Region.

Passive Savings – This worksheet pulls the single-family and multi-family passive savings estimated by the TWDB for your utility from the TWDB Data worksheet. It also calculates passive savings for ICI water use using per capita savings estimates developed by the California Department of Water Resources.

TWDB Data – This worksheet holds the Baseline Demand Projection data from the TWDB.

Lists & Settings – This worksheets holds lists and parameter settings used by the Conservation Tool.

Scenarios – This worksheet holds the scenarios saved by the user.

10.2 Visual Basic Macros

The Conservation Tool's Visual Basic macros can be audited via Excel's Visual Basic Editor. Consult Excel's documentation for how to access the Visual Basic Editor.

WARNING: IT IS RECOMMENDED THAT USERS DO NOT MAKE CHANGES TO THE CONSERVATION TOOL'S MACROS, USER FORMS, OR CUSTOM FUNCTIONS UNLESS THEY HAVE EXPERIENCE PROGRAMMING WITH VISUAL BASIC FOR APPLICATIONS.

11 Error Handling and Troubleshooting

This chapter describes what to do if the Conservation Tool behaves unexpectedly or crashes during an operation.

11.1 Visual Basic Errors

The Conservation Tool uses Visual Basic macros. In the event that one of these macros generates an error, you will see an error dialog like the one in Figure 11-1. If this occurs, click the End button and you will be returned to the worksheet you were working in.

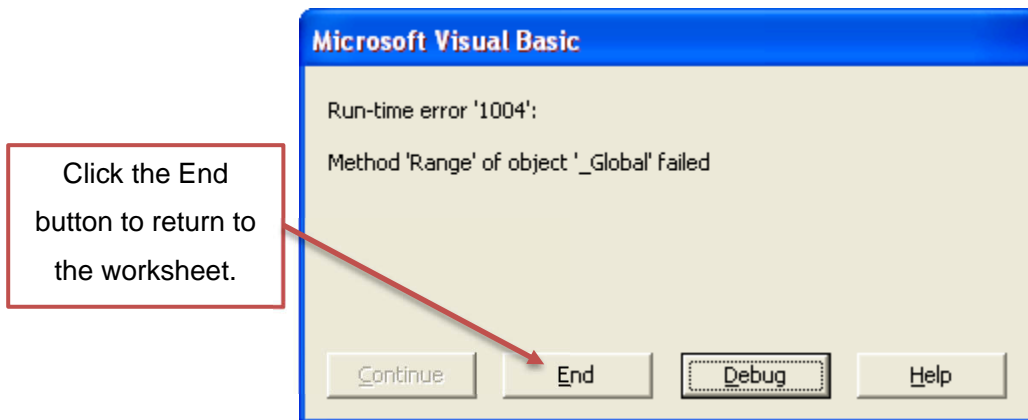


Figure 11-1. Visual Basic Error Dialog

WARNING: Clicking the Debug button rather than the End button will open the Visual Basic Editor and take you to the code that generated the error, which will be highlighted in yellow. To return to the Conservation Tool, do the following:

1. Click the Run menu at the top of the editor.
 2. Select Reset.
 3. Click the green Excel icon in the top left corner of the editor.
-

11.2 Deleted or Overwrote Cells with Formulas

If you delete or overwrite cells with formulas, the Conservation Tool will stop working correctly.

You have three options:

1. Try undoing the action from the Edit Menu or by typing Ctrl-z.
2. If you saved the file after you deleted the cells, you can revert to your backup copy. You may need to re-enter information into this file and you should make a new backup copy.
3. Download a new copy of the Conservation Tool from the TWDB website.

11.3 Changed a Worksheet Name

Some of the Visual Basic macros reference specific worksheet names. Changing the worksheet names may prevent the Conservation Tool from working correctly.

WARNING: Do not change the names of the Conservation Tool's worksheets. Doing so may cause the Conservation Tool to stop working correctly.

Appendix A - Water Savings and Unit Cost of Water Savings Formulas

Measure Savings

Five parameters are used to calculate the water savings over time from the implementation of one unit of a measure:

- The annual unit savings of the measure; $u > 0$
- The rate of freeridership for the measure; $f \in [0 \dots 1]$
- The natural replacement rate of the measure in percent per year; $n \in [0 \dots 1]$
- The savings decay rate of the measure in percent per year; $d \in [0 \dots 1]$
- The life of the measure in years; $T > 0$

$$s_t = \begin{cases} u(1-f)[(1-d)(1-n)]^t, & 0 \leq t \leq T-1 \\ 0, & t > T-1 \end{cases}$$

The annual unit savings, u , determines the magnitude of the initial savings of the measure. Unit savings can be expressed in any volumetric units. Typical units are gallons, hundred cubic feet, or acre-feet. Unit savings are based on empirical evaluations of water conservation programs. Preference is given to programs evaluated in Texas.

The freeridership parameter f represents the fraction of participants receiving the measure that would have taken the same action, and hence generated the same water savings, even had they not participated. These participants are termed freeriders. For example, a participant replacing a toilet that has a broken bowl is likely a freerider since in all likelihood it would have chosen to replace the toilet even without the rebate. Savings generated by freeriders are included in the calculation of passive savings from plumbing codes and appliance standards and hence should not be included here to avoid double counting.

The natural replacement parameter n represents the rate that a fixture like a toilet normally turns over. For example, previous research has suggested that the residential toilet stock turns over at a rate of 3-5% per year. Consider a toilet that is replaced by a toilet rebate program. Each

year the new toilet will generate annual savings equal to, say, u gallons. Now assume the toilet is not replaced by the rebate program. At some future period, the toilet would have turned over due to natural causes. At that point, assuming the plumbing code requires all new toilets to meet the same efficiency standard, the new toilet would start generating annual savings equal to u gallons. For sake of example, assume the toilet would have turned over four years after the rebate was offered. Savings for the “with rebate” and “without rebate” cases are shown in the table below. The savings for the “with rebate” case represents the savings generated by replacing the toilet through the rebate. The savings for the “without rebate” case represents the savings that would have occurred if the toilet had not been replaced by the rebate. These latter savings are included in the calculation of passive savings from plumbing codes and appliance standards and hence should not be included here to avoid double counting. Therefore, in this example the net effect of the rebate is to provide additional savings in Years 0-3. After Year 3, the plumbing code would have generated the same savings as the rebate and therefore the net savings of the rebate after Year 3 is zero.

Savings	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	...
w/ rebate	u	u	u	u	u	u	u	u	
w/o rebate	0	0	0	0	u	u	u	u	
Net Effect of Rebate	u	u	u	u	0	0	0	0	

In this example, we assumed we knew when the toilet would have naturally turned over absent the rebate. In the real world we don’t have this knowledge. We only know the likelihood that the toilet would turnover as represented by the natural replacement rate, n . Suppose n is equal to 4%. Then without knowing anything else about the toilet receiving the rebate, we would estimate the likelihood that the toilet would have turned over the year following the rebate is 4%. The expected savings w/o rebate in the first year following the rebate is therefore $0.04 \times u$. The likelihood the toilet would have turned over two years following the rebate is 7.8% and the expected savings w/o rebate in the second year following the rebate is therefore $0.078 \times u$. In general, the likelihood the toilet would have turned over t years following the rebate is $(1 - 0.96^t)$ and the expected savings w/o rebate is $(1 - 0.96^t) \times u$. The expected net effect of the rebate in year t is therefore:

$$u - (1 - 0.96^t) \times u = 0.96^t \times u$$

Generalizing to any replacement rate, n , the expected net effect of the rebate in year t is:

$$(1 - n)^t \times u$$

The savings decay rate, d , represents a different process than fixture natural replacement. It represents the physical decay in water savings over time. This physical decay may be due to any number of factors. For example, previous research has shown that water savings from water audits tend to decay over time. This is largely thought to be caused by changes in the behavior of water users receiving the audit. Other causes for savings decay may be physical wear or incorrect calibration of equipment installed by the measure. For example, physical wear of flappers is thought to have caused a decay in water savings over time in early ULFTs. The savings decay parameter is used in the savings model to allow for these possible effects. In practice, however, the decay parameter is set to zero for most measures other than water audits where there is good empirical evidence of savings decay.

The last parameter used in the savings model is the measure life, T . This parameter can take any positive value. Once t is greater than $T-1$, the model assumes savings are zero.¹ However, if a measure is subject to natural replacement (i.e., $n > 0$), then the savings is governed by the natural replacement parameter, n , rather than T . In effect, the savings are treated as permanent because the underlying efficiency standard assures that when the measure reaches the end of its useful life it will be replaced by another fixture with the same savings characteristics. What does change overtime, as discussed above, is the amount of the savings that is credited to the measure. As time passes, more and more of the measure's savings is treated as passive savings and the net savings credited to the measure asymptotically approaches zero. The rate at which this occurs is determined by n .

Measure Unit Cost

Unit cost is defined as the constant unit price of conserved water that would exactly recover the present value cost of the measure. Denoting unit cost as c , this can be expressed mathematically as:

$$measure\ cost = \sum_{t=0}^{T-1} \frac{c \cdot S_t}{(1 + r)^t}$$

where r is the utility's discount rate.

Since c is constant, we can pull it out of the summation operator and solve for it:

¹ T-1 rather than T because the model starts counting at Year 0, not Year 1.

$$c = \frac{\text{measure cost}}{\sum_{t=0}^{T-1} \frac{S_t}{(1+r)^t}}$$

Note that the units for c depends on the units for savings. For example, if savings are given in gallons, then unit cost is dollars per gallon. If instead savings are in acre-feet, then unit cost is dollars per acre-foot.

Through additional algebraic manipulation (see Attachment 1), this formula simplifies to:

$$c = \frac{\text{measure cost}}{u(1-f)} \cdot \frac{b-1}{b^T-1}$$

where b is equal to:

$$b = \frac{(1-d)(1-n)}{1+r}$$

Note that when $d=n=0$, which corresponds to constant unit savings, the formula becomes the familiar cost amortization formula:

$$c = \frac{\text{measure cost}}{u(1-f)} \cdot \frac{\frac{1}{1+r} - 1}{\left(\frac{1}{1+r}\right)^T - 1}$$

if $d=n=0$.

Also note that when $T \rightarrow \infty$ then $b^T \rightarrow 0$ since b is nonnegative and less than one. Thus, if unit savings are permanent, the unit cost simplifies to:

$$c = \frac{\text{measure cost}}{u(1-f)} \cdot (1-b) = \frac{\text{measure cost}}{u(1-f)} \cdot \frac{r+n+d-dn}{1+r}$$

if $T \rightarrow \infty$.

And if unit savings are permanent and constant, the unit cost is:

$$c = \frac{\text{measure cost}}{u(1-f)} \cdot \frac{r}{1+r}$$

if $d=n=0$ and $T \rightarrow \infty$.

Average Unit Cost across Measures

The average unit cost of savings for a group of conservation measures is the constant unit price of conserved water that would exactly recover the present value cost of the group of measures. Denoting the cost of the i th measure as m_i , and savings of the i th measure in period t as s_{it} , then

$$\sum_i m_i = \sum_i \sum_{t=0}^{T-1} \frac{\bar{c} \cdot s_{it}}{(1+r)^t}$$

Solving for \bar{c} and rearranging gives

$$\bar{c} = \frac{\sum_i m_i}{\sum_i \sum_{t=0}^{T-1} \frac{s_{it}}{(1+r)^t}}$$

Denote the unit cost for the i th measure as c_i , then

$$\bar{c} = \frac{\sum_i c_i \cdot \sum_{t=0}^{T-1} \frac{s_{it}}{(1+r)^t}}{\sum_i \sum_{t=0}^{T-1} \frac{s_{it}}{(1+r)^t}}$$

Define w_i as

$$w_i = \frac{\sum_{t=0}^{T-1} \frac{s_{it}}{(1+r)^t}}{\sum_i \sum_{t=0}^{T-1} \frac{s_{it}}{(1+r)^t}}$$

Then

$$\bar{c} = \sum_i w_i \cdot c_i$$

Thus \bar{c} is equal to the weighted-average of the unit costs of the individual measures, where each measure's weight is equal to its share of total discounted water savings.

Attachment 1

Proof that

$$c = \frac{\text{measure cost}}{u(1-f)} \cdot \frac{b-1}{b^T-1}$$

where

$$b = \frac{(1-d)(1-n)}{1+r}$$

Unit cost is defined as:

$$c = \frac{\text{measure cost}}{\sum_{t=0}^{T-1} \frac{S_t}{(1+r)^t}}$$

where

$$s_t = \begin{cases} u(1-f)[(1-d)(1-n)]^t, & 0 \leq t \leq T-1 \\ 0, & t > T-1 \end{cases}$$

and

$$\sum_{t=0}^{T-1} \frac{s_t}{(1+r)^t} = \sum_{t=0}^{T-1} \frac{u(1-f)[(1-d)(1-n)]^t}{(1+r)^t} = u(1-f) \sum_{t=0}^{T-1} \left[\frac{(1-d)(1-n)}{1+r} \right]^t$$

Let

$$S = \sum_{t=0}^{T-1} b^t, \text{ where } b = \frac{(1-d)(1-n)}{1+r}$$

then

$$S = 1 + b + b^2 + b^3 + \dots + b^{T-1}$$

and

$$bS = b + b^2 + b^3 + \dots + b^T$$

and

$$bS - S = b^T - 1$$

and

$$S = \frac{b^T - 1}{b - 1}$$

and

$$\sum_{t=0}^{T-1} \frac{s_t}{(1+r)^t} = u(1-f) \frac{b^T - 1}{b - 1}$$

and

$$c = \frac{\text{measure cost}}{u(1-f) \frac{b^T - 1}{b - 1}} = \frac{\text{measure cost}}{u(1-f)} \frac{b - 1}{b^T - 1}$$

Appendix B – Pre-Defined Conservation Measures

This appendix provides the specifications and data sources for the pre-defined conservation measures included in the Conservation Tool.

ID: PRE-SF-01

Name: High-Efficiency (HE) Toilet Rebate

Class: Single-Family (SF)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their existing low-efficiency toilet with an HE toilet. HE toilets have flush volume ratings of 1.28 gpf or less.

Unit Savings (u): HE toilet unit savings are estimated with the savings extrapolation equation developed for ULF toilet replacement (CUWCC 2005). The savings extrapolation equation assumes that only household density (persons per household or PPH) information is available and savings estimates are desired on a per toilet basis. The savings extrapolation equation is based on rigorous statistical evaluations of ULF toilet savings (A&N Technical Services 1992).

$$\text{Unit saving of SF ULF toilet in gpd} = 6.693 \cdot \text{PPH} - 0.529 \cdot \text{PPH}^2 + 7.826$$

AWE (2015) estimates that HE toilets save, on average, 23% more water than ULF toilets, all else equal. Unit savings for HE toilet replacement is therefore:

$$\text{Unit saving of SF HE toilet in gpd} = 1.23 \cdot (6.693 \cdot \text{PPH} - 0.529 \cdot \text{PPH}^2 + 7.826)$$

Useful Life (T): HE toilet savings are assumed to be permanent due to state plumbing code requirements.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership can be a problem with toilet rebate programs (CUWCC 2002). It is assumed that 20% of program participants will be free riders.

Plumbing Code Natural Replacement (n): Texas plumbing code requires all new toilets have flush volume ratings of 1.28 gpf or less. The natural replacement rate of toilets (n) is assumed to be 4% annually, per AWE (2015).

Rebate Cost: An analysis of conservation measure savings and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average toilet rebate cost of \$60 per toilet in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$85.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28.

ID: PRE-MF-01

Name: High-Efficiency (HE) Toilet Rebate

Class: Multi-Family (MF)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their existing low-efficiency toilet with an HE toilet. HE toilets have flush volume ratings of 1.28 gpf or less.

Unit Savings (u): HE toilet unit savings are estimated with the savings extrapolation equation developed for ULF toilet replacement (CUWCC 2005). The savings extrapolation equation assumes that only household density (persons per household or PPH) information is available and savings estimates are desired on a per toilet basis. The savings extrapolation equation is based on rigorous statistical evaluations of ULF toilet savings (A&N Technical Services 1992).

$$\text{Unit saving of MF ULF toilet in gpd} = 19.138 \cdot \text{PPH} - 0.942 \cdot \text{PPH}^2 + 2.181$$

AWE (2015) estimates that HE toilets save, on average, 23% more water than ULF toilets, all else equal. Unit savings for HE toilet replacement is therefore:

$$\text{Unit saving of MF HE toilet in gpd} = 1.23 \cdot (19.138 \cdot \text{PPH} - 0.942 \cdot \text{PPH}^2 + 2.181)$$

Useful Life (T): HE toilet savings are assumed to be permanent due to state plumbing code requirements.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership can be a problem with toilet rebate programs (CUWCC 2002). It is assumed that 20% of program participants will be free riders.

Plumbing Code Natural Replacement (n): Texas plumbing code requires all new toilets have flush volume ratings of 1.28 gpf or less. The natural replacement rate of toilets (n) is assumed to be 4% annually, per AWE (2015).

Rebate Cost: An analysis of conservation measure savings and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average toilet rebate cost of \$60 per toilet in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$85 per toilet.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28.

ID: PRE-ICI-01

Name: High-Efficiency (HE) Toilet Rebate

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their existing low-efficiency toilet with an HE toilet. HE toilets have flush volume ratings of 1.28 gpf or less.

Unit Savings (u): ULF toilets were estimated to save, on average, 25 gpd in ICI locations (CUWCC 2001). AWE (2015) estimates that HE toilets save, on average, 23% more water than ULF toilets, all else equal. Unit savings for HE toilet replacement is therefore:

$$\text{Unit saving of ICI HE toilet in gpd} = 1.23 \cdot 25 = 31 \text{ (rounded to nearest gallon)}$$

Useful Life (T): HE toilet savings are assumed to be permanent due to state plumbing code requirements.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership can be a problem with toilet rebate programs (CUWCC 2002). It is assumed that 20% of program participants will be free riders.

Plumbing Code Natural Replacement (n): Texas plumbing code requires all new toilets have flush volume ratings of 1.28 gpf or less. The natural replacement rate of toilets (n) is assumed to be 4% annually, per AWE (2015).

Rebate Cost: Rebates for ICI toilets are typically set higher than rebates for residential toilets due to the higher cost of toilets designed for commercial and public facilities. It is assumed that ICI toilet rebates are 25% greater than residential toilet rebates, rounded to the nearest ten dollars, which is \$110 per toilet.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28.

ID: PRE-SF-02

Name: Bathroom Retrofit

Class: Single-Family (SF)

Delivery: Direct Installation

Description: Direct installation of qualified toilets with high-efficiency toilets, and retrofit of qualified showerheads and bathroom faucet aerators when needed through a licensed plumbing contractor.

Unit Savings (u): Unit savings are based on statistical evaluations of water savings from similar programs operated in California (M.Cubed and A&N Technical Services, 2018). Average savings were 31 gpd per retrofitted bathroom. Unit savings are scaled by average persons per household in each region relative to the state average in order to preserve consistency with toilet rebate unit savings, which scale by household density.

$$\text{Unit savings of SF bathroom retrofit in gpd} = 31 \cdot \frac{PPH}{\text{State Average PPH}}$$

Useful Life (T): Bathroom retrofit savings are assumed to be permanent due to state plumbing code requirements.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed for direct installation programs, where participant screening can remove freeriders from participation.

Plumbing Code Natural Replacement (n): Texas plumbing code requires all new toilets have flush volume ratings of 1.28 gpf or less. Bathroom retrofit savings primarily come from toilet replacement. The natural replacement rate of toilets (n) is assumed to be 4% annually, per AWE (2015).

Rebate Cost: This measure does not entail rebates.

Other Cost: The average cost of bathroom retrofits was estimated at \$329 per single-family bathroom (California Water Service, 2018).

ID: PRE-MF-02

Name: Bathroom Retrofit

Class: Multi-Family (MF)

Delivery: Direct Installation

Description: Direct installation of qualified toilets with high-efficiency toilets, and retrofit of qualified showerheads and bathroom faucet aerators when needed through a licensed plumbing contractor.

Unit Savings (u): Unit savings are based on statistical evaluations of water savings from similar programs operated in California (M.Cubed and A&N Technical Services, 2018). Average savings were 52.6 gpd per retrofitted bathroom. Unit savings are scaled by average persons per household in each region relative to the state average in order to preserve consistency with toilet rebate unit savings, which scale by household density.

$$\text{Unit savings of MF bathroom retrofit in gpd} = 52.6 \cdot \frac{\text{PPH}}{\text{State Average PPH}}$$

Useful Life (T): Bathroom retrofit savings are assumed to be permanent due to state plumbing code requirements.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed for direct installation programs, where participant screening can remove freeriders from participation.

Plumbing Code Natural Replacement (n): Texas plumbing code requires all new toilets have flush volume ratings of 1.28 gpf or less. Bathroom retrofit savings primarily come from toilet replacement. The natural replacement rate of toilets (n) is assumed to be 4% annually, per AWE (2015).

Rebate Cost: This measure does not entail rebates.

Other Cost: The average cost of bathroom retrofits was estimated at \$329 per single-family bathroom (California Water Service, 2018).

ID: PRE-SF-04

Name: Clothes Washer Rebate

Class: Single-Family (SF)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their existing low-efficiency clothes washer with a high-efficiency (HE) clothes washer. HE clothes washers are defined as having a water factor of 6 or less. Water factor is equal to gallons of water use per cubic foot of washer capacity. It is assumed the rebate program is operated jointly with the local energy utility and that the water utility is responsible for roughly half the total rebate cost, including processing and marketing costs.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 5.6 gallons per person per day.

$$\text{Unit savings of SF clothes washer rebate in gpd} = 5.6 \cdot \text{PPH}$$

Useful Life (T): Water savings from a clothes washer rebate are assumed to be permanent due to federal clothes washer efficiency standards.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership is assumed to be 20%, the same as for HE toilet rebate programs.

Plumbing Code Natural Replacement (n): Federal clothes washer efficiency standards require that new clothes washers have water factors equal to or less than 4.7 for front-loading washers and 6.5 for top-loading washers. The maximum water factor for Energy Star compliant top- and front-loading washers is currently 3.7 and 4.3, respectively. EPA estimates that Energy Star washers comprised at least 60 percent of the residential market and 30 percent of the commercial market in 2011. DOE (2012) estimated residential clothes washers have an average useful life of 14 years. This is equivalent to a natural replacement rate of 7.1%.

Rebate Cost: An analysis of conservation measure savings and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average washer rebate of \$200 per washer in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$284 per washer. The water utility is assumed to be responsible for half this amount, or \$142 per washer.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28 per rebate. The water utility is assumed to be responsible for half this amount, or \$14 per rebate.

ID: PRE-MF-04

Name: Common Area Clothes Washer Rebate

Class: Multi-Family (MF)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to MF complex operators to replace their existing low-efficiency clothes washers in common area laundry rooms with a high-efficiency (HE) clothes washers. HE clothes washers are defined as having a water factor of 6 or less. Water factor is equal to gallons of water use per cubic foot of washer capacity. It is assumed the rebate program is operated jointly with the local energy utility and that the water utility is responsible for roughly half the total rebate amount.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 1.2 gallons per person per day at multi-family complexes, with an average of 18 multi-family units served per washer.

$$\text{Unit savings of MF common area clothes washer rebate in gpd} = 1.2 \cdot \text{PPH} \cdot 18$$

Useful Life (T): Water savings from a clothes washer rebate are assumed to be permanent due to federal clothes washer efficiency standards.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership is assumed to be 20%, the same as for HE toilet rebate programs.

Plumbing Code Natural Replacement (n): Federal clothes washer efficiency standards require that new clothes washers have water factors equal to or less than 4.7 for front-loading washers and 6.5 for top-loading washers. The maximum water factor for Energy Star compliant top- and front-loading washers is currently 3.7 and 4.3, respectively. EPA estimates that Energy Star washers comprised at least 60 percent of the residential market and 30 percent of the commercial market in 2011. GDS Associates, Inc. (2001) estimated multi-family common area clothes washers have an average useful life of 8 years. This is equivalent to a natural replacement rate of 12.5%.

Rebate Cost: An analysis of conservation measure savings and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average washer rebate of \$200 per washer in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$284 per washer. The water utility is assumed to be responsible for half this amount, or \$142 per washer.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28 per rebate. The water utility is assumed to be responsible for half this amount, or \$14 per rebate.

ID: PRE-ICI-03

Name: Coin-Op Washer Rebate

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to commercial coin-op operators to replace their existing low-efficiency clothes washers with high-efficiency (HE) clothes washers. HE clothes washers are defined as having a water factor of 6 or less. Water factor is equal to gallons of water use per cubic foot of washer capacity. It is assumed the rebate program is operated jointly with the local energy utility and that the water utility is responsible for roughly half the total rebate amount, including marketing and processing costs.

Unit Savings (u): Unit savings are assumed to average 86 gpd per washer. This is the average of estimated water savings reported in FEMP (2000) and Hazen and Sawyer, Inc. (2003)

Useful Life (T): Water savings from a clothes washer rebate are assumed to be permanent due to federal clothes washer efficiency standards.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership is assumed to be 20%, the same as for HE toilet rebate programs.

Plumbing Code Natural Replacement (n): Federal clothes washer efficiency standards require that new clothes washers have water factors equal to or less than 4.7 for front-loading washers and 6.5 for top-loading washers. The maximum water factor for Energy Star compliant top- and front-loading washers is currently 3.7 and 4.3, respectively. EPA estimates that Energy Star washers comprised at least 60 percent of the residential market and 30 percent of the commercial market in 2011. GDS Associates, Inc. (2001) estimated coin-op clothes washers have an average useful life of 8 years. This is equivalent to a natural replacement rate of 12.5%.

Rebate Cost: An analysis of conservation measure savings and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average washer rebate of \$300 per washer in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$426 per washer. The water utility is assumed to be responsible for half this amount, or \$213 per washer.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28 per rebate. The water utility is assumed to be responsible for half this amount, or \$14 per rebate.

ID: PRE-SF-03 and PRE-MF-03

Name: Showerhead and Aerator Kits

Class: Single- and Multi-Family (SF and MF)

Delivery: Distribution

Description: Provide low-flow showerhead and faucet aerators to replace less efficient devices installed before 1992 when the Texas Plumbing Efficiency Standards went into effect. The standards required that toilets, urinals, showerheads, and faucet aerators sold or manufactured in the state meet more water efficient criteria than under previous regulations. Generally, these are free kits that can be picked up at the water utility, local events, or dispensed with other utility programs such as when free toilets are distributed.

Unit Savings (u): CUWCC (2005) estimated average device savings of 5.5 gpd for low-flow showerheads and 1.5 gpd for faucet aerators. Kit savings are therefore assumed to be 7 gpd, on average. Unit savings are scaled by average persons per household in each region relative to the state average in order to preserve consistency with residential toilet and washer unit savings, which scale by household density.

$$\text{Unit savings of showerhead and aerator kit in gpd} = 7 \cdot \frac{PPH}{\text{State Average PPH}}$$

Useful Life (T): Water savings are assumed to be permanent due to state plumbing efficiency standards.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership is assumed to be 50%. The high freeridership rate accounts for the fact that low-flow showerheads have achieved high rates of penetration in most parts of the country (Water Research Foundation 2016).

Plumbing Code Natural Replacement (n): GDS Associates, Inc. (2001) estimated showerhead and aerator devices have an average useful life of 15 years. This is equivalent to a natural replacement rate of 6.7%.

Rebate Cost: This measure does not entail rebates.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$7 per kit, including labor and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$10 per kit.

ID: PRE-SF-05

Name: Single Family Home Water Reports

Class: Single Family (SF)

Delivery: Distribution

Description: Home water reports (HWRs) provide households with periodic (usually monthly or bimonthly) information on their current water use and compare it to their past use, use by similar households, and efficient use. This data is coupled with actionable information on ways to use water around the home more efficiently. HWRs aim to motivate households to reduce their water use through simple to implement changes in behavior or adoption of more water efficient technology. HWRs have been shown to increase the uptake of other utility conservation programs by customers. The approach is based on social norms marketing and has been widely adopted in the energy sector and its use is rapidly growing in the water sector.

Unit Savings (u): Mitchell and Chesnutt (2013) conducted a robust statistical evaluation of a large scale HWR program operated in California. This study estimated an average water savings equal to approximately 5.5% of participant water use. This result has been replicated in a number of other studies of HWR savings.

$$\text{Unit savings of HWR } gpd = 0.055 \cdot \text{avg daily water use of SF households in region}$$

Useful Life (T): Water savings are assumed to persist as long as the HWR is provided.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed

Plumbing Code Natural Replacement (n): No natural replacement is assumed

Rebate Cost: This measure does not entail rebates.

Other Cost: Mitchell and Chesnutt (2013) reported an average annual cost of \$6.50 per household in 2013 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$7 per household.

ID: PRE-SF-06

Name: Irrigation Audits – High Users

Class: Single Family (SF)

Delivery: Site Visit

Description: Irrigation audits are provided to customers that have underground irrigation systems and use 20,000 gallons of water or more per month for outdoor irrigation during the summer months (May through September). With these audits water utility personnel identify ways to increase the efficiency of SF customer irrigation systems and reduce SF customer water use. Some ways may include, but are not limited to, proper scheduling, repairing breaks or leaks, and replacing broken sprinkler heads. Additionally, the customer could be offered rebates for items that would allow their system to operate more efficiently such as rain sensor devices.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 33 gpd. The savings estimate assumes average outdoor water use of 20,000 gallons per month during the irrigation season (6 months) and an average audit savings of 10%. Annual savings are $20,000 \times 6 \times 0.1 \div 365 = 33$ gpd (rounded to nearest gallon)

Useful Life (T): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average useful life of 3 years for single-family irrigation audits

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: This measure does not entail rebates.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$70 per audit, including labor, administrative, and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$99 per audit.

ID: PRE-MF-05 and PRE-ICI-06

Name: Irrigation Audits – High Users

Class: Multi Family and Industrial, Commercial, and Institutional (MF and ICI)

Delivery: Site Visit

Description: Irrigation audits are provided to customers that have underground irrigation systems and use 50,000 gallons of water or more per month for outdoor irrigation during the summer months (May through September). With these audits water utility personnel identify ways to increase the efficiency of SF customer irrigation systems and reduce SF customer water use. Some ways may include, but are not limited to, proper scheduling, repairing breaks or leaks, and replacing broken sprinkler heads. Additionally, the customer could be offered rebates for items that would allow their system to operate more efficiently such as rain sensor devices.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 123 gpd. The savings estimate assumes average outdoor water use of 50,000 gallons per month during the irrigation season (6 months) and an average audit savings of 15%. Annual savings are $50,000 \times 6 \times 0.15 \div 365 = 123$ gpd (rounded to nearest gallon)

Useful Life (T): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average useful life of 3 years for single-family irrigation audits

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: This measure does not entail rebates.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$150 per audit, including labor, administrative, and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$213 per audit.

ID: PRE-SF-10

Name: Rainwater Harvesting Rebate

Class: Single Family (SF)

Delivery: Rebate

Description: Provide a rebate for the installation of a rainwater harvesting system. The average system is assumed to include a 1,000-gallon collection tank and cost approximately \$670 (2001 dollars) including tank, pump, and roof washer.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 35.2 gpd for City of Austin. The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions: (1) 2000 sqft roof; (2) irrigation demand of 500 gallons every 5 days; (3) a 1000 gallon tank; and (4) no irrigation water demand for five days following rainfall of 0.2 inches or more. Unit savings for City of Austin are scaled by the ratio of each region's average annual rainfall and City of Austin's average annual rainfall to get units savings for each region.

$$\text{Unit savings of rainwater harvesting rebate gpd} = 35.2 \cdot \frac{\text{Region Avg Rainfall}}{31.9}$$

Useful Life (T): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average useful life of 15 years for single-family rainwater harvesting systems.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate of \$200 in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$284 per rebate.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$50 per rebate, for rebate processing and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$71 per rebate.

ID: PRE-MF-09

Name: Rainwater Harvesting Rebate

Class: Multi Family and Industrial, Commercial, and Institutional (MF and ICI)

Delivery: Rebate

Description: Provide a rebate for the installation of a rainwater harvesting system. The average system is assumed to include a 10,000-gallon collection tank and cost approximately \$7,500 (2001 dollars) including tank, pump, filter, pressure tank, site preparation, labor, downspouts, and trunk line.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 408 gpd for City of Austin. The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions: (1) 50000 sqft roof; (2) irrigation demand of 5000 gallons every 5 days; (3) a 10000 gallon tank; and (4) no irrigation water demand for five days following rainfall of 0.2 inches or more. Unit savings for City of Austin are scaled by the ratio of each region's average annual rainfall and City of Austin's average annual rainfall to get units savings for each region.

$$\text{Unit savings of rainwater harvesting rebate gpd} = 408 \cdot \frac{\text{Region Avg Rainfall}}{31.9}$$

Useful Life (T): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average useful life of 15 years for multi-family rainwater harvesting systems.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate of \$2,000 in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$2,840 per rebate.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$50 per rebate, for rebate processing and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$71 per rebate.

ID: PRE-SF-11

Name: Rain Barrel Rebate

Class: Single Family (SF)

Delivery: Rebate

Description: Provide 75-gallon rain barrels at a reduced cost or offer a rebate on the purchase of a barrel.

Unit Savings (u): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average unit savings of 408 gpd for City of Austin. The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions: (1) 500 sqft roof; (2) irrigation demand of 75 gallons per day; (3) a 75 gallon barrel; and (4) no irrigation water demand for five days following rainfall of 0.2 inches or more. Unit savings for City of Austin are scaled by the ratio of each region's average annual rainfall and City of Austin's average annual rainfall to get units savings for each region.

$$\text{Unit savings of rain barrel rebate gpd} = 3.8 \cdot \frac{\text{Region Avg Rainfall}}{31.9}$$

Useful Life (T): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average useful life of 15 years for rain barrels.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate of \$35 in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$50 per rebate.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$10 per rebate, for rebate processing and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$14 per rebate.

ID: PRE-ICI-04

Name: Commercial General Rebate

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Rebate

Description: Provide a cash rebate for the installation of water efficient equipment. This incentive would depend on the amount of daily water savings. For example, the rebate could be set to \$1.40 per 1 gpd of water savings. The rebate would also need to scale according to expected life of the savings. For this measure, it is assumed that rebated savings have a useful life of 15 years.

Unit Savings (u): Unit savings are 1 gpd.

Useful Life (T): An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) estimated an average useful life of 15 years for commercial general rebate water savings.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Financial incentive programs of this type have significant potential to attract freeriders. It is assumed that 50% of participants are freeriders.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate of \$1 per gpd of savings in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$1.40 per gpd of savings.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average cost of \$0.20 per gpd of savings, for rebate processing and marketing costs, in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$0.28 per gpd of savings.

ID: PRE-ICI-05

Name: Kitchen Pre-Rinse Spray Valve Installation

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Direct Installation

Description: Pre-rinse spray valves control water flow in sprayers that rinse food waste from pots, pans, utensils, and dishware before they enter a dishwasher. Water conserving valves consume less water and have equal or better rinsing effectiveness because of improved spray pattern design. This measure would retrofit commercial kitchens with high efficiency valves.

Unit Savings (u): Research by AWE (2015) concluded that pre-rinse spray valves have an average savings potential of 77 gpd, based on empirical studies reported in SBW Consulting (2007) and CUWCC (2004a).

Useful Life (T): Water savings are assumed to be permanent due to state plumbing efficiency standards.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): AWE (2015) estimated pre-rinse spray valves have an average useful life of 10 years. This is equivalent to a natural replacement rate of 10%.

Rebate Cost: This measure does not entail a rebate.

Other Cost: An AWE (2015) review of pre-rinse spray valve direct installation program cost concluded that the typical cost is \$150 per replaced valve in 2008 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$213 per replaced valve.

ID: PRE-ICI-02

Name: Urinal Rebate

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their existing low-efficiency urinals with an HE urinals. HE urinals have flush volume ratings of 0.5 gpf or less.

Unit Savings (u): AWE (2015) concluded that HE urinals save, on average, 17 gpd, based on savings estimates in Koeller & Company (2005).

Useful Life (T): Water savings are assumed to be permanent due to state plumbing efficiency standards.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Freeridership can be a problem with toilet and urinal rebate programs (CUWCC 2002). It is assumed that 20% of program participants will be free riders.

Plumbing Code Natural Replacement (n): Texas plumbing code requires all new urinals have flush volume ratings of 0.5 gpf or less. The natural replacement rate of urinals (n) is assumed to be 4% annually, per AWE (2015).

Rebate Cost: Rebates for urinals are typically set higher than rebates for residential toilets due to the higher cost of toilets and urinals designed for commercial and public facilities. It is assumed that ICI toilet and urinal rebates are 25% greater than residential toilet rebates, rounded to the nearest ten dollars, which is \$110 per toilet or urinal.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28.

ID: PRE-SF-09

Name: WaterWise Landscape Rebate – High Users

Class: Single Family (SF)

Delivery: Rebate

Description: Provide a financial incentive (rebate) to customers using over 20,000 gallons per month for outdoor irrigation during the summer months (May through September) to convert existing landscape to xeric landscaped areas. Landscape plans must consist of qualifying plants, and not more than 50% of the landscaped area can be planted to turf grass. This measure is based on the City of Austin's WaterWise Landscape Rebate Program.

Unit Savings (u): The City of Austin (1999) reports average water savings per participant site of 214 gpd during the summer compared to preexisting landscapes. Assuming these saving accrue May-September, average annual daily savings are $217 \text{ gpd} \times 5/12 = 90 \text{ gpd}$. Regional savings are scaled by the ratio of average annual rainfall for City of Austin to regional average annual rainfall.

$$\text{Unit savings of WaterWise landscape rebate gpd} = 90 \cdot \frac{31.9}{\text{Region Avg Rainfall}}$$

Useful Life (T): An average useful life of 15 years is assumed. Potentially the savings will be permanent, assuming the new landscape is retained and maintained. There is, however, the possibility that the landscape will be converted to something requiring more intensive irrigation in the future.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Financial incentive programs of this type have the potential to attract freeriders. It is assumed that 20% of participants are freeriders.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An average rebate cost of \$500 is assumed, consistent with the rebate City of Austin has historically offered for its single-family WaterWise landscape program.

Other Cost: Marketing, plan review, and rebate processing are assumed to cost \$50 per rebate, on average.

ID: PRE-MF-08 and PRE-ICI-09

Name: WaterWise Landscape Rebate – High Users

Class: Multi Family and Industrial, Commercial, and Institutional (MF and ICI)

Delivery: Rebate

Description: Provide a financial incentive (rebate) to customers using over 50,000 gallons per month for outdoor irrigation during the summer months (May through September) to convert existing landscape to xeric landscaped areas. Landscape plans must consist of qualifying plants and 75% of area to be converted must consist of healthy turf grass. Turf grass cannot be replaced with another type of turf grass. Converted area must have at least 50% plant cover and no more than 5% annuals. This measure is based on the City of Austin's WaterWise Landscape Rebate Program for multi-family home owners associations.

Unit Savings (u): Unit savings are assumed to be ten times greater, on average, than unit savings for the single family WaterWise Landscape Rebate measure. Regional savings are scaled by the ratio of average annual rainfall for City of Austin to regional average annual rainfall.

$$\text{Unit savings of WaterWise landscape rebate gpd} = 900 \cdot \frac{31.9}{\text{Region Avg Rainfall}}$$

Useful Life (T): An average useful life of 15 years is assumed. Potentially the savings will be permanent, assuming the new landscape is retained and maintained. There is, however, the possibility that the landscape will be converted to something requiring more intensive irrigation in the future.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): Financial incentive programs of this type have the potential to attract freeriders. It is assumed that 20% of participants are freeriders.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An average rebate cost of \$5,000 is assumed, consistent with the rebate City of Austin has historically offered for its multi-family WaterWise landscape program.

Other Cost: Marketing, plan review, and rebate processing are assumed to cost \$250 per rebate, on average.

ID: PRE-SF-07

Name: High-Efficiency Sprinkler Nozzle Rebate

Class: Single Family (SF)

Delivery: Rebate

Description: Provide a financial incentive (rebate) to customers to replace existing sprinkler nozzles with high-efficiency nozzles. Water efficient sprinkler nozzles (popup and rotating) and integrated pressure-regulated spray bodies use significantly less water than a standard sprinkler head by distributing water more slowly and uniformly to the landscape. In addition to reducing water use, water directed from these nozzles reduces run-off onto streets and sidewalks with a more directed flow. This measure assumes participants can obtain the nozzles either directly from their utility or via a web-voucher program. The measure assumes single family participants are limited to 25 nozzles each, the average for HE nozzle program participants reported in A&N Technical Services (2015).

Unit Savings (u): HE nozzles are estimated to save, on average, 1.2 gpd, based on a robust statistical evaluation of savings of approximately 2,300 single family households participating in HE nozzle programs operated mainly in Southern California (A&N Technical Services 2015). Regional savings are scaled by the ratio of average annual rainfall for Southern California to regional average annual rainfall.

$$\text{Unit savings of HE nozzle rebate gpd} = 1.2 \frac{\text{gpd}}{\text{nozzle}} \cdot 25 \frac{\text{nozzle}}{\text{household}} \cdot \frac{15}{\text{Region Avg Rainfall}}$$

Useful Life (T): An average useful life of 10 years is assumed.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An average rebate of \$4 per nozzle is assumed, or \$100 per participant. This is the rebate amount currently offered by City of Austin.

Other Cost: Marketing and rebate processing are assumed to average 10% of rebate cost, or \$10 per participant.

ID: PRE-MF-06 and PRE-ICI-07

Name: High-Efficiency Sprinkler Nozzle Rebate

Class: Multi Family and Industrial, Commercial, and Institutional (MF and ICI)

Delivery: Rebate

Description: Provide a financial incentive (rebate) to customers to replace existing sprinkler nozzles with high-efficiency nozzles. Water efficient sprinkler nozzles (popup and rotating) and integrated pressure-regulated spray bodies use significantly less water than a standard sprinkler head by distributing water more slowly and uniformly to the landscape. In addition to reducing water use, water directed from these nozzles reduces run-off onto streets and sidewalks with a more directed flow. This measure assumes participants can obtain the nozzles either directly from their utility or via a web-voucher program. The measure assumes multifamily and ICI participants are limited to 100 nozzles each, the typical limit placed on participation in nozzle rebate programs operated in Southern California.

Unit Savings (u): HE nozzles are estimated to save, on average, 1.2 gpd, based on a robust statistical evaluation of savings of approximately 2,300 single family households participating in HE nozzle programs operated mainly in Southern California (A&N Technical Services 2015). This study also examined water savings in multi-family and commercial sites and did not detect a significant difference in average savings per nozzle. Regional savings are scaled by the ratio of average annual rainfall for Southern California to regional average annual rainfall.

$$Unit\ savings\ of\ HE\ nozzle\ rebate\ gpd = 1.2 \frac{gpd}{nozzle} \cdot 100 \frac{nozzle}{site} \cdot \frac{15}{Region\ Avg\ Rainfall}$$

Useful Life (T): An average useful life of 10 years is assumed.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An average rebate of \$4 per nozzle is assumed, or \$100 per participant. This is the rebate amount currently offered by City of Austin.

Other Cost: Marketing and rebate processing are assumed to be the same as for the single family HE nozzle rebate program, \$10 per participant.

ID: PRE-SF-08

Name: Smart Irrigation Controller Rebate – High User

Class: Single Family (SF)

Delivery: Rebate

Description: Provide a financial incentive (rebate) to high-use customers using 20,000 gallons or more per month in outdoor water use during the summer (May-September) to replace their existing irrigation controller with a smart irrigation controller (also referred to as a weather-based irrigation controller).

Unit Savings (u): A review of smart irrigation controller savings evaluations (Lawrence Berkeley National Laboratory 2014) concluded that smart irrigation controllers installed in single-family sites save 14% of outdoor water use, on average. Regional savings are scaled by the ratio of average rainfall for all planning regions to average rainfall for the region.

$$\text{Unit savings of smart controller rebate gpd} = \frac{0.14 \cdot 20000 \cdot 5}{365} \cdot \frac{29.6}{\text{Avg Rainfall for Region}}$$

Useful Life (T): An average useful life of 10 years is assumed.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An average rebate of \$200 per controller is assumed.

Other Cost: Marketing and rebate processing are assumed to be the same as for the single family HE nozzle rebate program, \$10 per participant.

ID: PRE-MF-07 and PRE-ICI-08

Name: Smart Irrigation Controller Rebate – High User

Class: Multi Family and Industrial, Commercial, and Institutional (MF and ICI)

Delivery: Rebate

Description: Provide a financial incentive (rebate) to high-use customers using 50,000 gallons or more per month in outdoor water use during the summer (May-September) to replace their existing irrigation controller with a smart irrigation controller (also referred to as a weather-based irrigation controller).

Unit Savings (u): A review of smart irrigation controller savings evaluations (Lawrence Berkeley National Laboratory 2014) concluded that smart irrigation controllers installed in at commercial sites save 21% of outdoor water use, on average. Regional savings are scaled by the ratio of average rainfall for all planning regions to average rainfall for the region.

$$\text{Unit savings of smart controller rebate gpd} = \frac{0.21 \cdot 50000 \cdot 5}{365} \cdot \frac{29.6}{\text{Avg Rainfall for Region}}$$

Useful Life (T): An average useful life of 10 years is assumed.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: An average rebate of \$500 per controller is assumed.

Other Cost: Marketing and rebate processing are assumed to be the same as for the single family smart irrigation controller rebate program, \$10 per participant.

ID: PRE-ICI-11

Name: Dishwasher Rebate

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their commercial dishwashers.

Unit Savings (u): AWE (2015) concluded that ICI dishwasher rebates save 158 gpd based on savings reported by Natural Resources Canada (2008).

Useful Life (T): Useful life is assumed to be 20 years.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: \$1,000/rebate. Equal to ½ the cost differential between conventional and high-efficiency dishwasher assumed by EPA's life cycle cost calculator for Energy Star rated commercial dish-washers.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28.

ID: PRE-ICI-12

Name: Food Steamer Rebate

Class: Industrial, Commercial, Institutional (ICI)

Delivery: Rebate

Description: This measure provides a financial incentive (rebate) to utility customers to replace their commercial kitchen food steamers.

Unit Savings (u): AWE (2015) concluded that food steamer replacements save 223 gpd on average based on savings reported by the Metropolitan Water District's (2008) Save Water, Save A Buck Program.

Useful Life (T): The useful life is assumed to be 20 years based on Metropolitan Water District's (2008) Save Water, Save A Buck Program.

Decay (d): No physical decay of water savings is assumed.

Freeridership (f): No freeridership is assumed.

Plumbing Code Natural Replacement (n): No plumbing code interaction is assumed.

Rebate Cost: \$485/rebate. Metropolitan Water District's (2008) Save Water, Save A Buck Program.

Other Cost: An analysis of conservation measures and costs for the TWDB by GDS Associates, Inc. (2001) assumed an average rebate processing and marketing cost of \$20 per rebate in 2001 dollars. This amount is escalated for inflation to 2018 dollars and is equal to \$28.