



TWDB Drought Management Costing Tool User Manual

March 2024

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1 Introduction

Inexpensive and readily available water is obviously a very key resource in modern society, and shortages in supplies may have adverse impacts. Measuring such impacts is a challenging task, especially in the context of a drought of record within the regional water planning effort for the State of Texas. The accompanying costing tool provides a means of estimating *the possible costs to residents* of municipal water user groups (WUGs) by estimating foregone consumer surplus¹ of reduced residential water use due to drought management practices. The tool relies on household size, projected populations, WUG-specific residential water use and price data, and user-determined reductions in water use to estimate lost consumer surplus by WUG. Potential users should note that consumer surplus lost (cost) estimates are ***not equivalent nor necessarily similar*** to estimates of the additional costs borne or lost revenue experienced by utilities or WUGs as they employ water use restrictions or similar efforts. The two are different measures of the many possible adverse impacts of drought.

This information is provided to aid the regional water planning groups (RWPGs) in evaluating the feasibility of various drought management strategies to address anticipated water needs. However, this tool does not estimate possible costs associated with drought management practices within categories of water use other than the municipal residential use (i.e. municipal commercial use or non-municipal use).

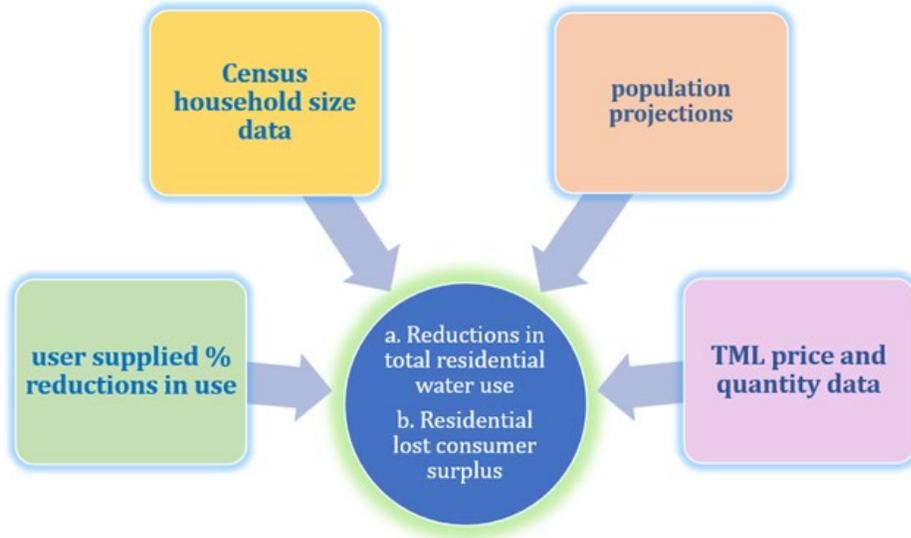
2 Overview of the Costing Tool

The primary purpose of the tool is to provide WUG-level lost consumer surplus estimates and the expected household-level residential reductions in available water use associated with policy-imposed restrictions or reduction on residential outdoor water use. Figure 1 depicts the data utilized by the tool to produce two major outputs: WUG-level reductions in residential outdoor water use and costs to consumers. These costs are then aggregated to the WUG level. Users only need to provide the desired percent reductions in residential outdoor water use (up to 30 percent)². The final estimates provided by the tool represent the foregone value to the consumers within the WUG associated with outdoor water use restrictions.

¹ Foregone consumer surplus cost estimates are not out-of-pocket costs, but rather are estimates of the consumer's willingness to pay to be restored back to their normal levels of water usage. Such estimates are commonly used in determining the monetary value of adverse impacts upon consumers, especially when explicit out-of-pocket costs are not incurred or are difficult to estimate.

² The Grass Is Always Greener...Outdoor Residential Water Use in Texas, 2012, Sam Marie Hermitte and Robert E. Mace, Texas Water Development Board Technical Note 12-01 – study to estimate the percent of outdoor water use.

Figure 1. Costing Data and Output



Foregone consumer surplus per acre-foot (ac-ft) of reduced use is employed to determine estimates of consumer costs. Household level price and quantity data are also key components of the tool and are based on data from the city water utilities survey performed by the Texas Municipal League (TML). The tool uses the TML data and resulting estimated demand functions to estimate costs per acre-foot of reduction for a given percent water use reduction at the household level. The result is then multiplied by the anticipated quantity of water not available to the residential user based upon the respective TML survey or average use per household and the user provided reduction in use.

2.1 TML Data

A key component of determining the economic impacts of water use restrictions or reductions for residential use is estimating water demand curves for WUGs in the various regional water planning areas. Annual cost and usage surveys, performed by the TML, provide the best avenue for obtaining the needed data. Table 1 portrays sample residential water use data available from the year 2023 TML survey. Variables provided include fees charged by the utility for 5,000 and 10,000 gallons of usage as well as the average usage for each household within the surveyed cities. The survey results were linked to the relevant WUGs where possible, resulting in survey data for approximately one-third of the 1,705 non-County-Other municipal WUGs in the state water plan. The TML data was then used to determine the expected price for the average monthly water use for the WUGs. Representative price and quantity values were developed and assigned to the remaining WUGs using state average values by three city size classifications: large (population greater than 100,000), medium (5,001 to 100,000), and small (5,000 or less).

Table 1. Sample Output, Texas Municipal League Water Cost/Use Survey (2023, monthly)

Population group	Entity	Population	Fee (5,000 gal)	Fee (10,000 gal)	Total customers	Average use (gal/month)
More than 500,000	Houston	2,232,502	\$39.36	\$82.32	486,785	4,900
350,001 - 500,000	Arlington	398,112	\$22.71	\$36.66	104,388	7,000
	Corpus Christi	327,248	\$33.01	\$66.26	97,301	6,000
	Plano	291,296	\$30.61	\$51.21	82,849	7,000
Source: https://www.tml.org/Archive.aspx?AMID=40						

2.2 Demand and Consumer Surplus as a Cost Measure

Micro-economic theory deals with the notion of people’s utility functions and the accompanying pleasure or value derived from using or having access to one or more goods. That is, we all derive value from inexpensive and readily available water supplies so much so that we take that resource very much for granted. This value manifests itself in so-called demand functions which may be defined as:

demand = a schedule of the maximum price a consumer is willing and able to pay for various quantities of a desired good.

Key to this definition is the notion that the consumer is both **willing** (i.e., wants the good) and **able** (can afford it) to pay for the good. Demand curves are generally downward sloping, implying that people derive less and less benefit from additional units of the good, and are therefore less willing to trade their hard-earned dollars for more water or some other good.

Representative demand functions for each WUG were developed assuming a given level of sensitivity to the price of water. Outdoor demand use is more price sensitive than indoor use. Within the economic demand literature, this concept is referred to as the price elasticity of demand (ϵ). Values for ϵ generally vary from -0.3 to -0.8 depending on the service and use type or location (i.e., water plus wastewater, water only, indoor/outdoor use, region). A representative value of -0.5³ was assumed for the outdoor water demand examined here, implying that for every one percent increase in price, the quantity demanded would fall by 0.5 percent.

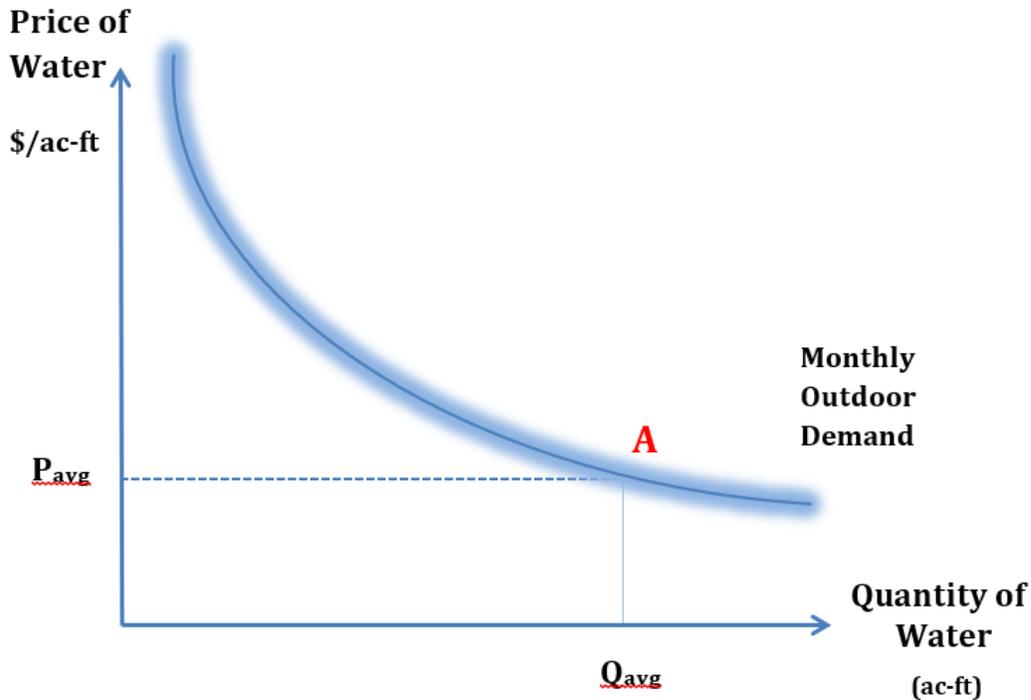
Figure 2 portrays a sample demand curve for water. Note that price/ac-ft is on the vertical axis and quantity of water demanded (ac-ft) is on the horizontal axis. The graph portrays the monthly demand, with point A corresponding to the price/quantity pair (P_{avg}, Q_{avg}) for the average price and quantity consumed per month by the household.

Note that the representative homeowner associated with this demand curve benefitted greatly from the market price of P_{avg} . The household consumed Q_{avg} units of water, most of which they paid much less than the maximum willingness to pay price portrayed by the demand curve. This notion of a gap between the maximum willingness to pay and the actual price one has to pay introduces the concept of consumer surplus. When a consumer pays less than their maximum willingness to

³ Bell, D.R. and Griffin, R.C. “Community Water Demand in Texas as a Century is Turned.” Research contract report prepared for the Texas Water Development Board. May 2006.

pay for a good, they experience a benefit, either in actual dollars saved or in dollars one might spend on something else.

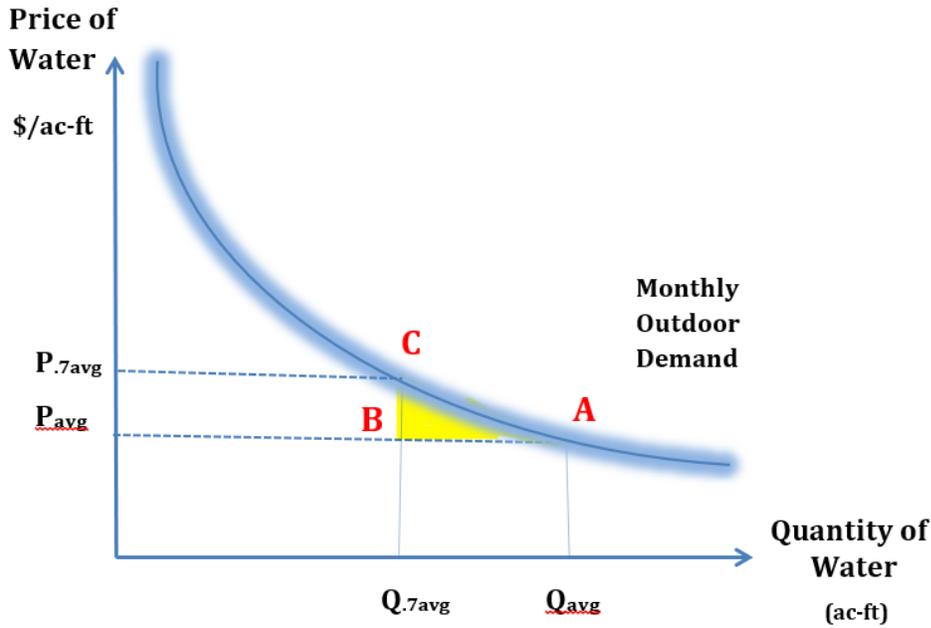
Figure 2. Sample Outdoor Water Demand Curve



Consumer surplus is then defined as the difference between how much one is willing to pay and what they actually have to pay. This measure, placed on a per acre-foot basis, places a monetary value on the adverse economic impacts due to the quantity of restrictions imposed by the utility.

As a specific example, consider the situation portrayed in Figure 3 and assume that a drought occurs, or a drought contingency plan is implemented, and only 70 percent of the normal water use is possible. The individual can only consume $0.7W_{avg}$ units of water, and they lose the benefits shown in the area bounded by points A, B, and C. Lost consumer surplus is the area below the demand curve and above the original purchase price. One may estimate the lost consumer surplus for varying levels of reductions by simply varying the location of the left-hand side of area ABC. For linear demand functions, lost consumer surplus may be estimated as the value $0.5 \times (\text{base}) \times (\text{height})$ of the triangle ABC. Similar estimates for nonlinear demand functions require the use of integral calculus for estimating the lost consumer surplus.

Figure 3. Sample Consumer Surplus Change for 30 Percent Reduction



Note that the functional form for the WUG specific water demand functions employed in this tool appears below:

$$\text{[Equation 1]: } Q_{\text{water}} = k \cdot P^{\varepsilon}$$

where Q_{water} = the monthly household quantity of water (ac-ft),

P = the price of water (\$/ac-ft),

k = a constant to be determined using WUG specific data, and

ε = the price elasticity of demand for water.

As noted earlier, the value of ε is assumed to be -0.5 for the outdoor water demand functions, and integral calculus techniques are used to determine the foregone consumer surplus associated with the WUG specific water reductions.

Once the foregone consumer surplus is calculated for a given degree of water reduction, the cost per acre-foot is calculated for each municipal WUG. This is simply the foregone consumer surplus divided by the quantity of water. For example, if the consumer surplus estimate totals \$2,000, and the reduction is 5 acre-feet of water, the cost per acre-foot estimate assigned to the WUG equals \$400/acre-foot. These cost estimates may then be used by the RWPGs to determine potential impacts of water reductions on residents.

2.3 Analysis Assumptions

Several key assumptions accompanied the development of the drought management costing tool.

1. The relevant demand functions are only for residential outdoor water use. Historical studies have revealed that approximately 30 percent of residential use within the state is for outdoor water use. Therefore, this tool only allows potential reductions less than or equal to 30 percent of normal water use due to drought management strategies.
2. A representative value of -0.5 was assumed for the outdoor water demand.
3. Only residential water use reductions are examined. Available data did not support similar estimates for commercial water use.
4. County-Other WUGs are not included in this costing tool.
5. Year 2020 WUG-specific household size data are employed to determine the number of households in each decade, based upon the Board-adopted projected populations. These baseline household sizes are not assumed to adjust over time.
6. Baseline data from the TML for average monthly prices and quantities (per household) from the most recent years 2020-2023 was used in developing the demand functions for the various WUGs. Where possible, WUG specific data was used. Proxy values based upon three city size classification state averages were assigned to WUGs with no TML survey results.
7. Final lost consumer surplus estimates are expressed in year 2023 dollars to be consistent with the water management strategy costing requirements in the 2027 State Water Plan.

3 Use of the Costing Tool

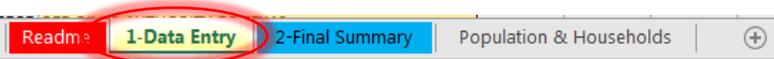
The tool consists of a Microsoft (MS) Excel spreadsheet with three major components (tabs):

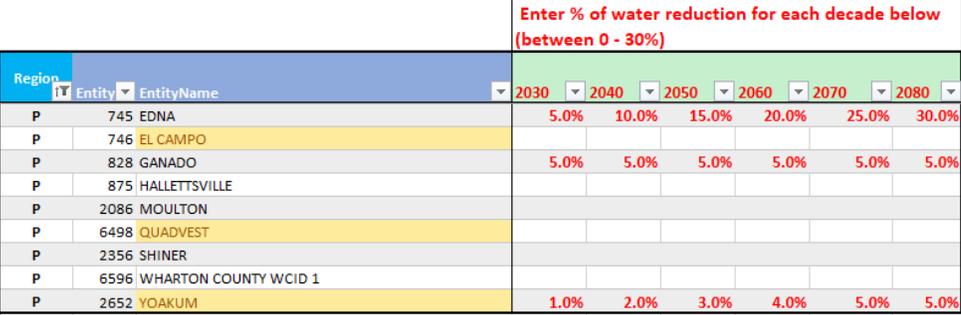
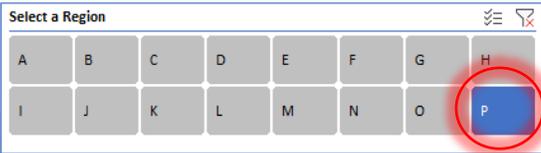
- 1-Data Entry: User data entry form for decade specific desired reductions in water use by region and WUG.
- 2-Final Summary: A summary of the key parameters and final lost consumer surplus and reduction in available water use estimates.
- Population & Households: Reference tab with background information on the number of households based on the 2020 Census data by system boundary and the Board-adopted 2030-2080 WUG population projections split by region.

When using the tool, the user employs the 1-Data Entry tab to enter the desired percent reductions in water use, and then may view or export the summary input data and output via the 2-Final Summary tab. Step-by-step instructions for using the tool are provided in Table 2 below and [Section 3.1](#).

Table 2. Steps for Using the Tool, Data Entry and Output Export

Step	Action
1	Open the Drought Management Costing Tool MS Excel file
2	Respond yes or ok to any prompts for permission to accept macros or enable editing
3	Select the tab labeled 1-Data Entry (Figure 4)



Step	Action																																																																																										
4	<p>Click on the region of interest within the dashboard at the top of the page. The entry form will filter to display only municipal WUGs within the selected region.</p> 																																																																																										
5	<p>Enter the decade specific desired reductions in household water use for the WUG/region of interest. –</p> <ul style="list-style-type: none"> One may copy and paste entries from one cell to another, or use the drag cell operation to copy the percent reduction entry from a parent cell to fill in the same value to multiple cells. The tool only allows values from 0 to 30 percent.  <table border="1"> <thead> <tr> <th>Region</th> <th>Entity</th> <th>EntityName</th> <th>2030</th> <th>2040</th> <th>2050</th> <th>2060</th> <th>2070</th> <th>2080</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>745</td> <td>EDNA</td> <td>5.0%</td> <td>10.0%</td> <td>15.0%</td> <td>20.0%</td> <td>25.0%</td> <td>30.0%</td> </tr> <tr> <td>P</td> <td>746</td> <td>EL CAMPO</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td>828</td> <td>GANADO</td> <td>5.0%</td> <td>5.0%</td> <td>5.0%</td> <td>5.0%</td> <td>5.0%</td> <td>5.0%</td> </tr> <tr> <td>P</td> <td>875</td> <td>HALLETTSVILLE</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td>2086</td> <td>MOULTON</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td>6498</td> <td>QUADVEST</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td>2356</td> <td>SHINER</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td>6596</td> <td>WHARTON COUNTY WCID 1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td>2652</td> <td>YOAKUM</td> <td>1.0%</td> <td>2.0%</td> <td>3.0%</td> <td>4.0%</td> <td>5.0%</td> <td>5.0%</td> </tr> </tbody> </table>	Region	Entity	EntityName	2030	2040	2050	2060	2070	2080	P	745	EDNA	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%	P	746	EL CAMPO							P	828	GANADO	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	P	875	HALLETTSVILLE							P	2086	MOULTON							P	6498	QUADVEST							P	2356	SHINER							P	6596	WHARTON COUNTY WCID 1							P	2652	YOAKUM	1.0%	2.0%	3.0%	4.0%	5.0%	5.0%
Region	Entity	EntityName	2030	2040	2050	2060	2070	2080																																																																																			
P	745	EDNA	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%																																																																																			
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6	Check all entries for accuracy. (All calculations are updated continuously as one enters the desired reduction percentages.)																																																																																										
7	To view the output summary, click on the tab 2-Final Summary																																																																																										
																																																																																											
8	<p>Select the region of interest from the dashboard at the top of the page.</p>  <p>Drought Management Lost Consumer Surplus Summary</p>																																																																																										
9	<p>Examine the results. (See Section 3.2 for more details concerning the tool output)</p> <ul style="list-style-type: none"> Final total water volumes and cost estimates are displayed under <i>“Total annual water reduction in ac-ft”</i> and <i>“Total annual lost consumer surplus (in 2023 \$)”</i> 																																																																																										
10	Select the headings and output and then copy and paste them into a new spreadsheet.																																																																																										
11	Save and close the Tool.																																																																																										

3.1 Details: Data Entry Tab

Figure 4 depicts the data entry form where the user inputs the decade specific desired reduction in water use percentages by WUG and region. Reductions are not cumulative across decades meaning that a 10 percent reduction in 2030 will not result in a 10 percent reduction in later decades. Reductions must be entered accordingly in all desired decades. Several WUGs are located in multiple regions and are highlighted in yellow within the entry form. The associated costs and water use reductions are calculated using WUG-region specific population projections. For example, the El Campo WUG shown below in Figure 4 also has service area in Region K. The RWPGs may be interested in the costs for all residences in a particular WUG, regardless of the planning region. In that case, the tool should be used to provide cost and water reduction estimates for all affected regions.

Figure 4. Data Entry Tab

The screenshot shows the 'Data Entry Tab' interface. At the top left is a 'Select a Region' dropdown menu with a grid of buttons labeled A through P. To the right is an instruction box with three steps: 1) Select a Region by clicking on a region button in the box left, 2) Enter % of water reduction for each decade by entity to the table below, and 3) Go to 2-Final Summary tab to get a regional summary for drought management cost by entity. A note below the instructions states: '*Note: EntityNames highlighted in yellow operate in multiple regions.' Below the instructions is a table with a header row: 'Enter % of water reduction for each decade below (between 0 - 30%)'. The table has columns for decades: 2030, 2040, 2050, 2060, 2070, 2080. The rows list entities with their IDs and names. Entities 746 EL CAMPO, 828 GANADO, 6498 QUADVEST, and 2652 YOAKUM are highlighted in yellow. The table shows reduction percentages for each entity across the decades.

Region	Entity	EntityName	2030	2040	2050	2060	2070	2080
P	745	EDNA	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%
P	746	EL CAMPO						
P	828	GANADO	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
P	875	HALLETTSVILLE						
P	2086	MOULTON						
P	6498	QUADVEST						
P	2356	SHINER						
P	6596	WHARTON COUNTY WCID 1						
P	2652	YOAKUM	1.0%	2.0%	3.0%	4.0%	5.0%	5.0%

3.2 Details: Final Summary Tab

The 2-Final Summary tab within the tool summarizes the user input desired reductions as well as key output data such as total volume of water reduced and the associated lost consumer surplus by decade. Information for understanding the data on this tab appears below, both in text form (Table 3) and pictorially (Figure 5). Both the table and the figure make use of a shorthand single letter name for each data/section type within the summary tab. The shorthand letter names (shown in a blue halo) appear within the section headings within Figure 5, with details of the calculation procedures shown below the sections where appropriate. All monetary values are expressed in year 2023 dollars.

Table 3. Final Summary Tab Components (See also Figure 5)

Shorthand Letter Name	Item	Description and or Use	Source/Calculation (units)
	Region	Regional water planning area	
	Entity Name	Water user group (WUG) name	
A	Household Size	Persons per household	Year 2020 Census
B	Monthly water use per household in gallons	Average monthly billed household water use in gallons.	TML data and/or Water Use Survey data (gallons/household/mo)
C	Cost for monthly water use per household	Average monthly utility billed cost for household water use.	TML data (\$/mo)
D	Percent of Reduction (drought management)	Percent reductions in average use specified by the tool user for each decade to attain the desired level of water use reductions. Tool multiplies these percentages by the average water use per household to determine average reductions in water use per household in gallons.	User supplied via the 1-Data Entry tab (percent, by decade)
E	Monthly reduction per household in gallons	Estimated reductions in household monthly water use imposed by the drought management based on percent of reduction entered by users. Calculated as the average monthly use multiplied by the percent reduction.	$B * D$ (gal/mo)
F	Average unit lost consumer surplus per acre-foot (in 2023 \$)	WUG and percent reduction specific estimate of foregone consumer surplus, divided by the corresponding reduction in average monthly water use due to drought management.	Area beneath WUG level demand function and above the average price, divided by the ac-ft of reduction in use. (\$/ac-ft)
G	Total annual water reduction in ac-ft	Total annual reduction in ac-ft of all household water use due to drought management plan implementation based on percent of reduction entered by users. Calculated as the number of households * 12 months * monthly household reduction in use, then converted to acre-feet.	$[(\text{population}/A) * 12 * E] / 325,851 \text{ gal/ac-ft}$ (ac-ft/year)
H	Total annual lost consumer surplus (in 2023 \$)	Total annual lost consumer surplus for foregone water use. Calculated as total annual water reduction * average unit cost per ac-ft. (Note: values shown in this column may appear to differ from the product (F * G) due to rounding of the component parts F and G)	$F * G$ (\$/year)

Figure 5. Final Summary Tab Components

Region	Entity Name	2020 HH Size	Monthly water use per household in gallons	Cost for monthly water use per household	% of Reduction (drought management)						Monthly reduction per household in gallons						Average unit lost consumer surplus per acre-foot					
					2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
P	Edna	2,4190	5,000	\$ 34.02	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%	250	500	750	1,000	1,250	1,500	\$ 131	\$ 277	\$ 439	\$ 623	\$ 830	\$1,067
P	El Campo	2,7700	6,825	\$ 43.76	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
P	Ganado	2,7360	5,766	\$ 46.94	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	288	288	288	288	288	288	\$ 157	\$ 157	\$ 157	\$ 157	\$ 157	\$ 157
P	Hallettsville	2,3790	5,000	\$ 25.59	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
P	Moulton	2,1540	5,766	\$ 46.94	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
P	Quadvest	3,0660	6,825	\$ 43.76	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
P	Shiner	2,4360	5,000	\$ 19.68	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
P	Wharton County WCID 1	3,0210	5,766	\$ 46.94	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
P	Yoakum	2,5630	5,000	\$ 31.90	1.0%	2.0%	2.0%	3.0%	4.0%	5.0%	50	100	100	150	200	250	\$ 24	\$ 48	\$ 48	\$ 72	\$ 97	\$ 123

$$E = B \times D$$

Total Annual Water Reduction in acre-feet						Total annual lost consumer surplus (in 2023 \$)					
2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
22	47	75	104	135	169	\$ 2,917	\$ 13,084	\$ 32,782	\$ 64,510	\$ 111,970	\$ 179,870
0	0	0	0	0	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
7	7	7	7	7	7	\$ 1,126	\$ 1,103	\$ 1,106	\$ 1,079	\$ 1,051	\$ 1,020
0	0	0	0	0	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
0	0	0	0	0	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
0	0	0	0	0	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
0	0	0	0	0	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
0	0	0	0	0	0	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
3	6	6	10	13	17	\$ 65	\$ 278	\$ 291	\$ 692	\$ 1,299	\$ 2,145

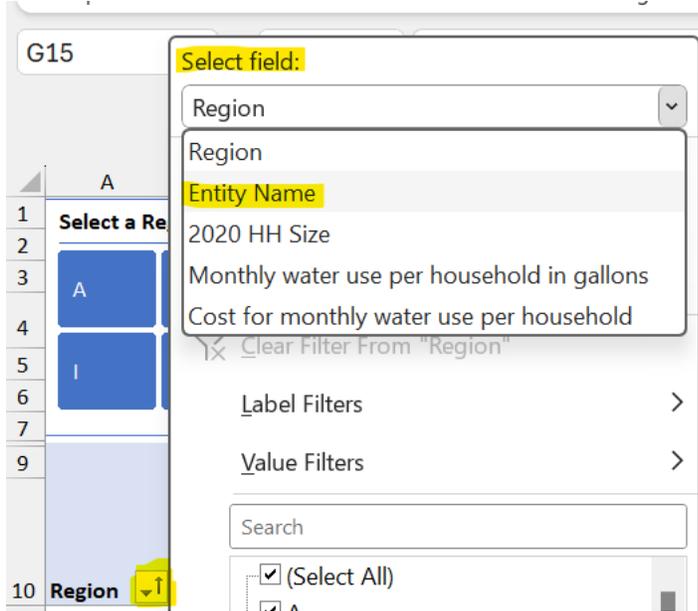
$$G = \frac{\text{Population}}{A} \times E \times \frac{12}{325,851}$$

$$H = F \times G$$

Note: Values shown in this column may appear to differ from the product (F * G) due to rounding of the component parts F and G.

The Entity Name column can be filtered using the drop-down arrow next to Region. Click the drop-down arrow and at the top of the dialog pane that opens, change Select Field from Region to Entity Name. See Figure 6 below.

Figure 6. Final Summary Tab, Filter by Entity Name



3.3 Details: Population and Households

The Population and Households tab (Table 4) is included as a convenient data reference source for users and includes household size, number of households, and the Board-adopted projected population values for each WUG/region combination. Household size was developed using 2020 Census Block data and WUG boundaries from the Texas Water Service Boundary Viewer⁴. The number of households parameter is calculated simply as the decade-specific population projection divided by the household size.

Table 4. Sample Data, Population and Households Tab

Region	EntityId	EntityName	2020 Census based WUG Household Size	Number of Households						Projected Population					
				2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
P	745	Edna	2.42	2,418	2,569	2,701	2,814	2,931	3,051	5,848	6,213	6,534	6,807	7,089	7,381
P	746	El Campo	2.77	4,493	4,539	4,541	4,538	4,537	4,534	12,447	12,575	12,580	12,573	12,568	12,562
P	828	Ganado	2.74	676	663	664	648	631	613	1,850	1,813	1,817	1,773	1,727	1,676
P	875	Hallettsville	2.38	1,272	1,368	1,462	1,577	1,694	1,815	3,027	3,255	3,479	3,751	4,031	4,319
P	2086	Moulton	2.15	360	346	333	320	307	295	776	746	717	689	662	636
P	6498	Quadvest	3.07	18	24	29	35	40	46	55	75	89	107	124	142
P	2356	Shiner	2.44	937	1,002	1,066	1,142	1,219	1,300	2,282	2,441	2,598	2,781	2,970	3,166
P	6596	Wharton County WCID 1	3.02	242	244	257	267	278	289	730	738	777	807	840	874
P	2652	Yoakum	2.56	1,503	1,583	1,659	1,734	1,814	1,896	3,852	4,057	4,251	4,445	4,648	4,860

⁴ <https://www3.twdb.texas.gov/apps/waterserviceboundaries>

4 Limitations

The enclosed tool provides reasonable estimates of the lost consumer surplus for residential consumers faced with water reduction for outdoor water use due to drought management. Lost consumer surplus calculations from the tool may be used as **one possible estimate** of the adverse monetary impacts of possible restrictions on water use for the residential water user. RWPGs using this tool should understand the limitations to the lost consumer surplus calculated by the tool and know that other factors may also be appropriate for consideration if the local data is available. Such factors include the following:

- Reduced revenue to the utility due to smaller sales of water;
- Increased enforcement and monitoring costs of implementation while also considering any collected fees for non-compliance;
- Positive effects of reduced water treatment costs for not sold water;
- Cash flow considerations due to smaller water sales;
- Potential price changes to incentivize reduced water use;
- The tool's focus on only residential household water use; or
- The tool's focus on household water use without considering delivery losses and other non-billed water quantities.

5 Updates from last planning cycle's tool

With each planning cycle, this tool is updated. While the lost consumer surplus demand curve calculations do not change, there are many variables that factor into the calculations that change and can change the output or total annual cost to residents in the WUG. Those variables include:

- Board-adopted population projections,
- WUG average household size,
- WUG's average household price per quantity of water use,
- WUG's average household quantity of residential water used per month, and
- Consumer Price Index.

Updated WUG-level demand curves are estimated using the data above and the assumed elasticity of demand parameters ([section 2.2](#)). Derivation of such curves is then coupled with the user assigned percent reductions in normal use to determine the updated estimates of lost consumer surplus.

As described in [section 2.1](#), if a WUG reports its household monthly price and quantity to the TML, then that data is used for the WUG in this tool. Otherwise, average price per quantity of household use is utilized. If the WUG reports to the TWDB Water Use Survey, then an average price (using TML data for similar sized WUGs) is applied to the quantity reported to the survey. Otherwise, both average price and average quantities are applied for the WUG.

In the last planning cycle, regional water planning area-population size averages were applied. However, due to a decline in data collected by the TML, statistical analysis showed that size was a better determinant for WUG's average price and/or quantity than regional planning area, thus statewide size averages were utilized instead.

Population size classifications:

Large > 100,000

Medium 5,001 – 100,000

Small ≤ 5,000

All of these factors can cause the total annual cost to vary from previous iterations of this tool, therefore, it is advised to use the updated tool for the planning cycle.

6 Contact Information

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