Tucson Water
One Water 2100 Master Plan

Technical Memorandum

WATER CONSERVATION PROGRAM 10-YEAR SAVINGS PROJECTION

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TUCSON WATER

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One Water 2100 Master Plan

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WATER CONSERVATION PROGRAM 10-YEAR SAVINGS PROJECTION

1.0 Executive Summary

Water conservation is an essential component of Tucson Water's long-term strategy to provide high-quality, reliable water service for the future. A water conservation program does not produce additional water resources above and beyond what is physically available. Instead it preserves and extends currently available water supplies by increasing water-use efficiency and reducing per capita use. With this goal in mind, the Tucson Water Conservation Program's investments in the community and outreach to water users has demonstrably and steadily decreased per capita use and total water demand for more than 20 years.

Water conservation is important to the community and vital for the long-term sustainability of the City. This technical memo analyzes the potential of the conservation program's water savings over the next ten years. The analysis supports the water demand projections developed by Jacobs for the One Water 2100 Master Plan. Direct input, ideas, and feedback were obtained from stakeholders and the broader Tucson community in the development of this analysis.

The Water Conservation Program 10-Year Savings Projection (the Technical Memo) was prepared to:

- Examine the impacts of the water conservation program through a review of demand trends in Tucson as a whole and for each customer sector.
- Project water savings likely to be achieved over the next 10 years for a range of program implementation scenarios.[1]
- Develop a deeper understanding of current program impacts and industry trends to inform a strategic planning process for the Conservation Program.

1.1 Conservation Program Recommendations

The Tucson Water Conservation Program (Conservation Program) plays an important role in ensuring Tucson uses water resources wisely and practices water efficiency for the benefit of the community and environment. Peter Mayer, P.E., Principal of WaterDM, prepared a set of recommendations for Tucson Water to consider based on his review of local and national water demand trends and Tucson's current water conservation program offerings. These recommendations are intended to increase the overall effectiveness of the Tucson Water Conservation Program to ensure continued, sustained, equitable demand reductions across all sectors of water customers.

[1] Note: these projections do not take potential future pricing changes into account. Mayor and Council are currently considering differential rates and Tier 2 of the drought plan gives decision makers the option of increasing rates to accommodate higher charges from the Central Arizona Project as there is less water to allocate among customers.

WaterDM's six recommendations are:

1. Adjust rebate levels and increase efficiency of fixtures and appliances for which rebates are offered to increase cost-effectiveness.
2. Increase savings opportunities for commercial customers.
3. Expand focus on outdoor water use, with emphasis on resilient, desert-adapted landscapes.
4. Improve Tucson Water's ability to understand customer water use and ability to target conservation programs with customer-specific water budgets.
5. Increase customer-side leak detection to reduce water waste and loss.
6. Support efforts to improve fixture efficiency in plumbing and building codes and consider additional policies to ensure community water savings.

These recommendations will be incorporated into a planning effort for the Conservation Program. The planning effort will align with the public engagement strategy for the One Water 2100 master plan. The public engagement strategy is currently under development with an anticipated launch in the Fall of 2021.

1.2 Estimated 10-Year Water Savings

Over the next ten years, Tucson Water intends to extend and strengthen its water conservation program with the goal of saving at least an additional 11,805 acre-feet of water directly through the implementation of a wide range of indoor and outdoor measures and substantially more through pricing, codes and standards, and education programs.

A range of three water savings estimates were developed based on the indoor and outdoor measures. The low, mid, and high scenarios in Table 1 are based are varying levels of rebate program activity, reflected as an annual number of incentives, and correlated to a range of costs to achieve estimated savings. Using the mid-level savings estimate, Tucson's incentive programs alone are estimated to reduce Tucson water demand by 11,661 acre-feet over the next ten years. The range of savings estimates is shown in **Error! Reference source not found.** The detailed list developed for the middle water saving scenario can be found in Table 5 on page 20. The detailed list for the high and low water saving scenarios can be found in Appendix B.

Table 1 10-Year Water Savings Estimates

Scenario	10-Year Water Savings Estimate (AF)	Avg. Savings/Yr. (AF)
High	16,931	1,693
Mid	11,661	1,166
Low	7,055	705

Additional demand reductions beyond these estimates are expected through Tucson Water's education and outreach efforts and through the natural replacement of older fixtures and appliances that occurs without incentive from Tucson Water. The water use projections developed by Jacobs for the One Water 2100 project incorporates the active savings from the Tucson Water Conservation Program. Many conservation programs such and landscape transformation and rainwater harvesting can have multiple benefits that are not fully accounted for in an analysis that is intended to look exclusively at water savings.

1.3 Connections with Tucson Water's Drought Response Plan

Water conservation as discussed in this technical memo refers to the program Tucson Water has implemented since the 1970s to promote the efficient use of water and gradually reduce per capita consumption. Tucson Water recognizes that drought planning and drought response are distinct and separate from annual water conservation. Tucson Water updated the Drought Preparedness and Response Plan in 2020. Planning for the conservation program will be an aspect of the One Water 2100 public engagement effort and will include the updated drought response measures.

Tucson's Drought Preparedness and Response Plan recognizes that with proper planning and review it is unlikely the community will find itself in an emergency caused solely by drought. It also ensures that Tucson Water staff will implement drought response measures early enough to avoid crisis-mode decision making and to help the community anticipate what measures will come next if drought impacts become more severe.

The Drought Preparedness and Response Plan aligns Tucson's drought stages to the Drought Contingency Plan. It also introduces the concept of customer-specific "water use guidelines" which will be used to help Tucson Water provide customized water use information to customers based on billing and GIS data.- Water use guidelines are synonymous with the more technical term "water budgets", which is the quantity of water that is required for various indoor and outdoor uses.[2]

Water use guidelines are incorporated into Tucson's drought response tiers as follows:

- Under Tier 0 of a drought Tucson Water develops *water use guidelines* for residential, commercial, and reclaimed customers using historic consumption data for both indoor and outdoor end uses.
- Under Tier 1 & 2, Tucson Water continues the development and implementation of water use guidelines for all customers. Tucson Water will provide targeted conservation program information for customers whose consumption exceeds the water use guidelines.
- Under Tier 3, if water consumption does not decrease as a result of earlier drought tier responses, Mayor and Council may consider water use restrictions for customers whose consumption continues to exceed their water use guidelines.

The Drought Preparedness and Response Plan recognizes that drought does not occur suddenly and without warning. Rather, careful observation of key drought indicators will allow for implementation of responses to avoid reaching emergency conditions. This is the primary motivation for implementing the strategic, data driven approach of targeting customers whose consumption exceeds expected water use guidelines.

Additionally, these water use guidelines will be developed and disseminated by conservation staff and are the nexus between the Drought Preparedness and Response Plan and conservation program. As Tucson Water develops customer specific water budgets for indoor and outdoor use the concept of targeting conservation efforts at customers with high consumption can be an important component of the water conservation program as well.

[2] Mayer, P., et. al. 2008. Water Budges and Rate Structures: Innovative Management Tools. AWWA Research Foundation. Denver, Colorado.

2.0 Analysis of Demand Trends in Tucson

2.1 Forty Years of Water Conservation Experience

The City of Tucson is located at 2,389 feet above sea level in the Sonoran Desert of Arizona, a geography that presents substantial water supply challenges for a growing community. As a groundwater user within the Tucson Active Management Area (AMA), Tucson Water is required participate in a mandatory conservation program for large municipal providers with a designation of Assured Water Supply. Tucson Water currently participates in the Total Gallons Per Capita Per Day (GPCD) program under the Fourth Management Plan for the Tucson AMA. Tucson Water's GPCD requirement is currently set at 162.[3] The Total GPCD program does not specify which conservation actions or programs to implement in the service area.

> Conservation has been a major factor in de-coupling Tucson's population growth and increases in water consumption. Tucson water now delivers the same amount of water that was supplied in 1985 despite a 20% increase in population.

Demand management has been one of the core components of Tucson Water's water resource planning efforts since the early 1970s. The focus of demand management over the last 40 years has shifted from an initial strategy based on resource-management to one with a conservation-driven focus. For Tucson Water, management of available water resources is critical to the community's long-term sustainability. Conservation programs seek to promote efficiency in the use of available water resources. A conservation-based program does not produce additional water resources above and beyond what is physically available. Instead it preserves and extends currently available water supplies by increasing water-use efficiency and reducing per capita use. Conservation programming is an important element in any comprehensive demand management program.

To be effective, the conservation components of a demand management program should provide an equitable distribution of benefits to all customer classes, employ a targeted mix of methods to achieve desired results, and be continuously evaluated to optimize program performance. Tucson Water implements a range of programs that have been developed and refined over the years to accomplish this. Since 1998, Tucson Water steadily achieved state-mandated conservation goals ahead of schedule. This has been accomplished by offering a suite of education and conservation programs coupled with conservation-oriented water pricing, national plumbing codes, and the EPA WaterSense program. Additionally, the Tucson Water conservation program meets all the requirements of the American Water Works Association's G480 Water Conservation Program Operation and Management Standard. A summary of G480 requirements is presented in Appendix C.

2.2 Water Demand in Tucson

Water demand in Tucson has declined steadily since 2006 across nearly every customer category. Since 2006 both non-seasonal (indoor) and seasonal (outdoor) demands have declined and seasonal demand has declined as percent of total demand, indicating reduced outdoor use. WaterDM analyzed Tucson Water's

[3] Arizona DWR. 2016. Fourth Management Plan. Tucson Active Management Area. Arizona Department of Water Resources. May 13, 2016.

recent historic demand trends across the customer categories included in the available water billing dataset. This analysis shows each sector's role in achieving the overall reductions. Water use trend data are essential to the conservation planning process for the design of an effective on-going conservation program and are used to monitor program impacts over time.

2.2.1 Metered Monthly and Annual Deliveries

Monthly billed potable water consumption data were provided to the One Water 2100 project team in an Excel spreadsheet format. WaterDM worked from this dataset to prepare an analysis of water demand trends. Figure 1 shows total metered monthly deliveries by Tucson Water from January 1985 – December 2020. Tucson's seasonal demand patterns swing from winter season minimums in February to peak summer maximums which typically occur in July. Starting in 2005, monthly variability started to reduce as overall demand steadily declined through 2017 and has been stabilized over the past three years.

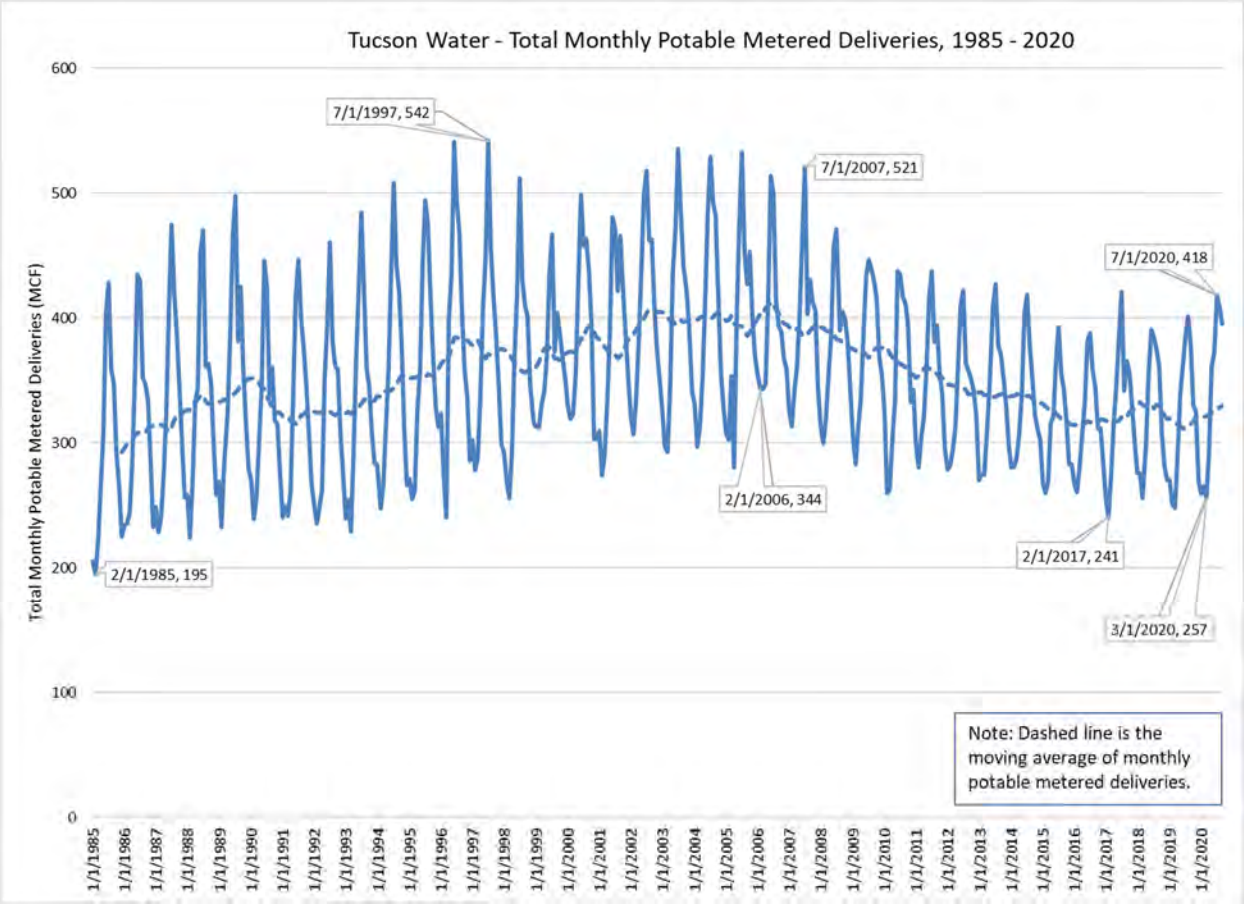

Figure 1 Total Monthly Potable Metered Deliveries, 1985 – 2020

Figure 2 shows 35 years of annual potable metered demand from 1985 – 2020 and it also shows the monthly minimum and maximum (the months with the highest and lowest demand) for each year. Annual water use increased in Tucson until it peaked in 2002 at 48.5 million CCF. From 2002 – 2007 annual use stabilized and starting in 2008 demand declined steadily. Total metered water use in 2019 was 38.5 million CCF, a decline of 10 million CCF and is now as low as it was in the late 1980s. This is a remarkable achievement given the substantial population growth Tucson has experienced over this period.

The trends in minimum and maximum month use reveal important changes in both indoor and outdoor demand in Tucson. Maximum month metered use peaked in the mid-2000s and has been on a declining trend since 2006. Maximum month demands typically occur in June and July and are caused largely by increased outdoor irrigation. The declining trend in maximum month demand is an indication that peak month irrigation in Tucson is declining and reduced outdoor use has contributed to demand reductions.

Minimum month use increased until 2006 but since then has decreased and been on a declining trend ever since (Figure 1). The minimum month use from 2019 had returned to about the same as it was in 1998, after two decades of higher monthly minimums recorded. This suggests a substantial increase in indoor efficiency over this time period that saw significant population growth in Tucson without using any additional water.

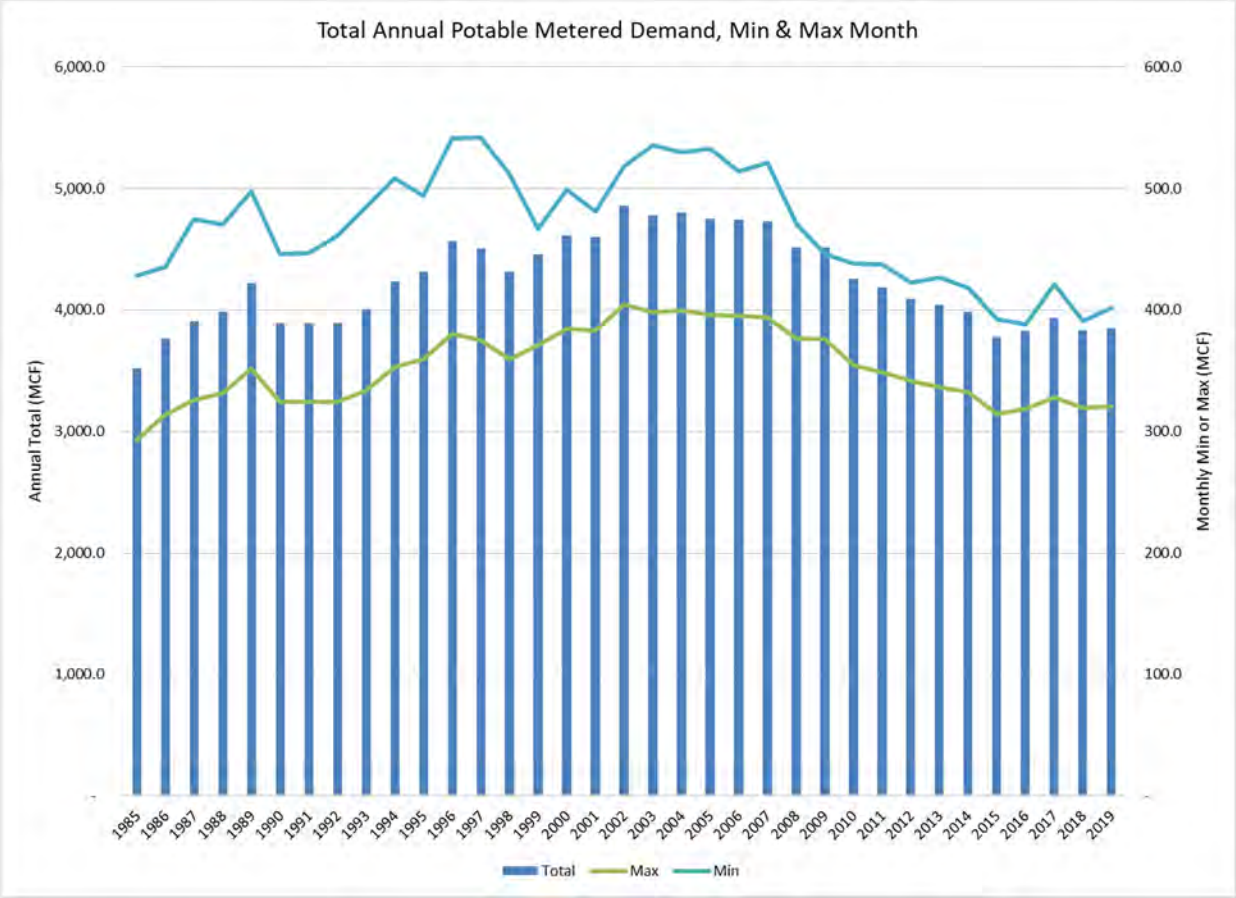

Figure 2 Total Annual Potable Metered Demand with Minimum and Maximum Month

To further examine changes in indoor and outdoor demand over time, WaterDM calculated seasonal and non-seasonal demand in Tucson for each year from 1985-2019. To estimate non-seasonal (indoor) use, WaterDM averaged consumption in Jan, Feb. Mar., and Dec. and then multiplied the average by 12. Seasonal (outdoor and other temperature-driven demand) was estimated by subtracting the calculated non-seasonal use from total annual use. The results are shown in Figure 3 along with the percentage of seasonal use.

Both non-seasonal and seasonal use have declined since 2006, but seasonal use is more variable from year to year. The percentage of seasonal use has generally declined over the long-term but has increased over the past five years. This indicates that reductions (and annual fluctuations) in outdoor use proportionally out-

pacing reductions in indoor use until 2015 and then flattened. The trend in seasonal use shown in Figure 3 is one of the motivations for the recommendation to expand outdoor conservation programs.

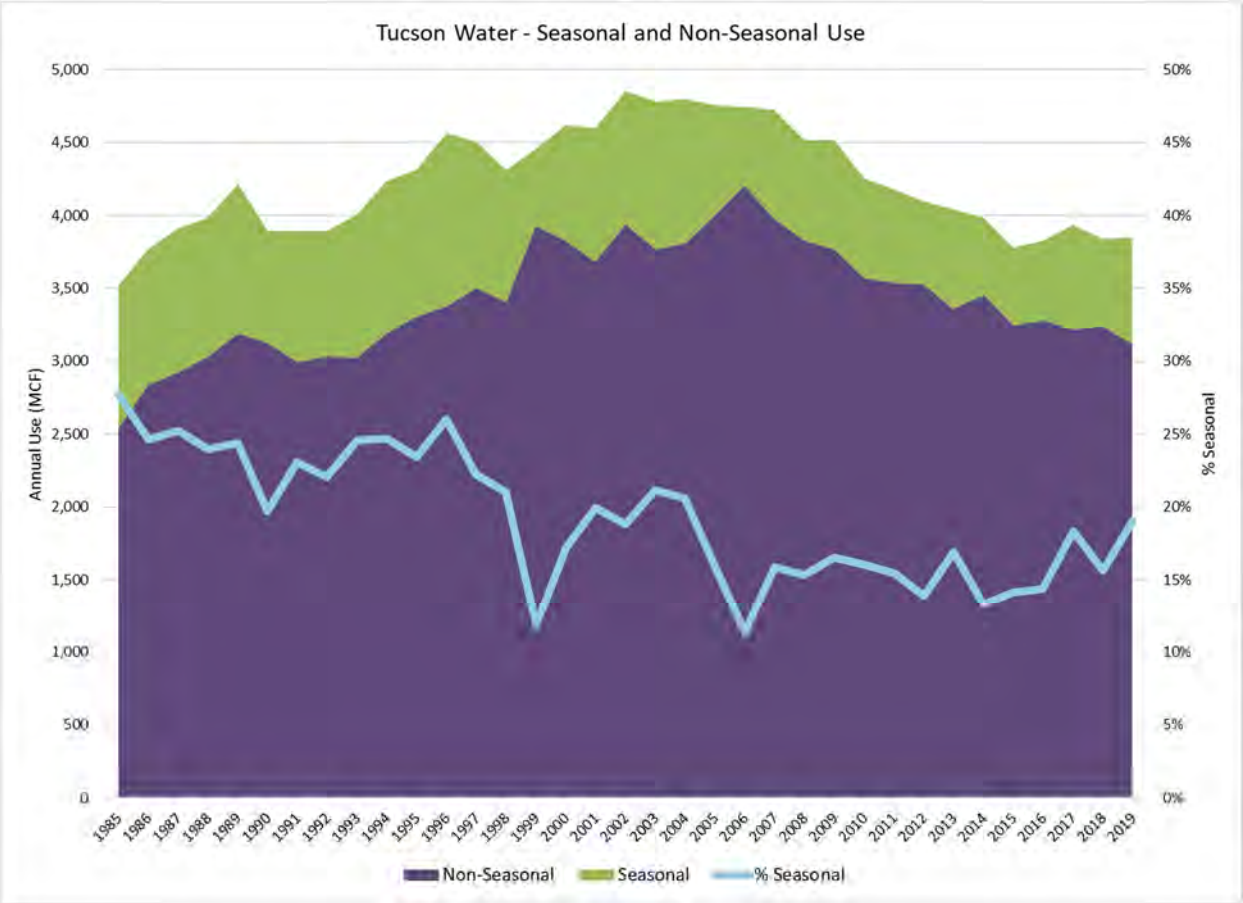

Figure 3 Annual Potable Seasonal and Non-seasonal Use and % Seasonal, 1985 – 2019

2.2.2 Water Use by Customer Category

The three preceding figures show the long-term trends in water demand by Tucson Water customers and provide clear indication of the impacts of water conservation on both indoor and outdoor use. Customers have reduced consumption both indoors and outdoors, particularly since 2006. Tucson Water classifies customers into six categories for billing purposes as follows:

1. Single-family residential
2. Duplex and triplex residential (small multifamily)
3. Multifamily
4. Commercial (includes HOAs and most school districts)
5. Industrial
6. Other

The annual water used by each of these categories in 2019 is shown as a pie chart in Figure 4. The residential sector, including single-family, duplex and triplex, and multifamily accounted for about three-quarters (74%) of the total demand in Tucson with the commercial and industrial sectors accounting for rest (25%).

The demand trends from 2009 – 2019 for each of these categories is more closely examined in the figures below.

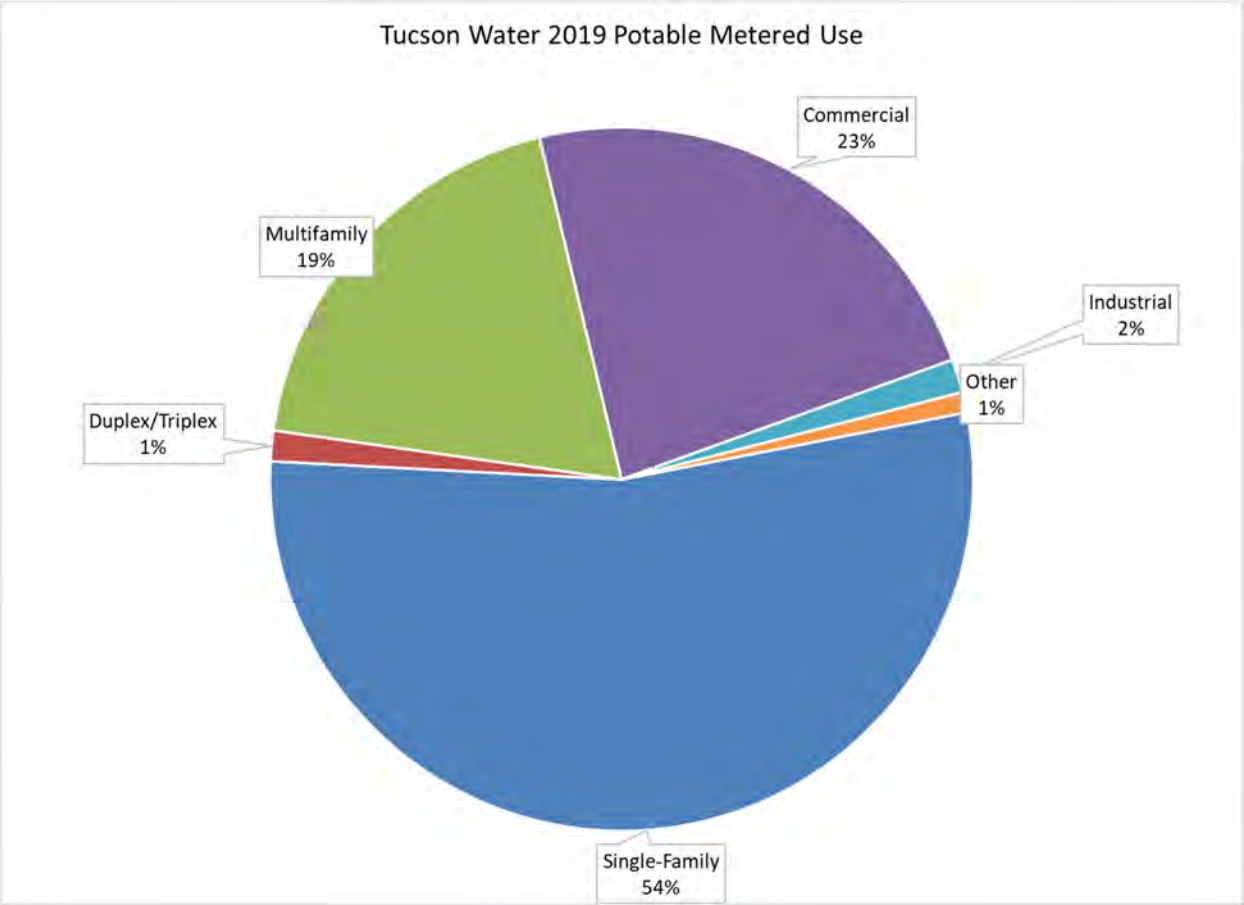

Figure 4 2019 Water Use by Customer Category

Water use by customer category in 2008 and 2018 is presented in Table 2. Annual water use declined in every sector over this ten-year period, even as the number of customer accounts grew by 4.6% overall. Reductions are observed in the minimum month and the maximum month, suggesting reductions in both indoor and outdoor water use have been achieved over this time period. A more detailed analysis of the changes in water use by sector is presented in the next few sections.

Table 2 Tucson customer categories and water use, 2008 and 2018

			Water Demand (MCF)			
Customer Category	**Year**	**# of Accts**	**Annual Total**	**Avg. Month**	**Max. Month**	**Min. Month**
Single-Family	2008	199,008	2,499.2	208.3	261.7	163.4
	2018	209,025	2,068.8	172.4	213.6	138.6
	% Change	*5.0%*	-17.2%	-17.2%	-18.4%	-15.2%
Multifamily	2008	5,711	847.5	70.6	82.6	61.4
	2018	5,645	723.6	60.3	69.1	51.7
	% Change	***-1.2%***	-14.6%	-14.6%	-16.4%	-15.9%
Duplex & Triplex	2008	4,340	67.5	5.6	7.0	4.8
	2018	4,433	54.5	4.5	5.3	3.8
	% Change	*2.1%*	-19.2%	-19.2%	-24.6%	-20.9%
Commercial	2008	14,714	970.8	80.9	105.8	61.4
	2018	15,151	896.6	74.7	93.5	57.0
	% Change	*3.0%*	-7.6%	-7.6%	-11.7%	-7.1%
Industrial	2008	379	84.9	7.1	11.0	3.8
	2018	317	58.3	4.9	7.9	2.5
	% Change	***-16.4%***	-31.4%	-31.4%	-28.3%	-34.3%
Other[4]	2008	477	47.0	3.9	5.6	2.8
	2018	370	34.2	2.9	5.6	1.5
	% Change	***-22.4%***	-27.1%	-27.1%	-0.2%	-45.4%
Total	2008	224,629	4,516.9	376.4	471.3	299.8
	2018	234,941	3,836.0	319.7	390.7	255.8
	% Change	*4.6%*	-15.1%	-15.1%	-17.1%	-14.7%

[4] "Other" includes construction meters, master-metered mobile home communities, and more.

2.2.2.1 Residential Demand Trends

Water use among all of Tucson's residential categories (SF, MF, duplex-triplex), has declined over the past 10 years as shown in Table 2, Figure 5, Figure 6, and Figure 7.

Total annual metered use has reduced steadily in all three residential categories and both the minimum and maximum monthly use has declined. This indicates customers are reducing usage both indoors and outdoors in the residential sector. The decline in maximum monthly demand is steeper suggesting outdoor use reductions are occurring more rapidly than indoor reduction among Tucson's residential customers.

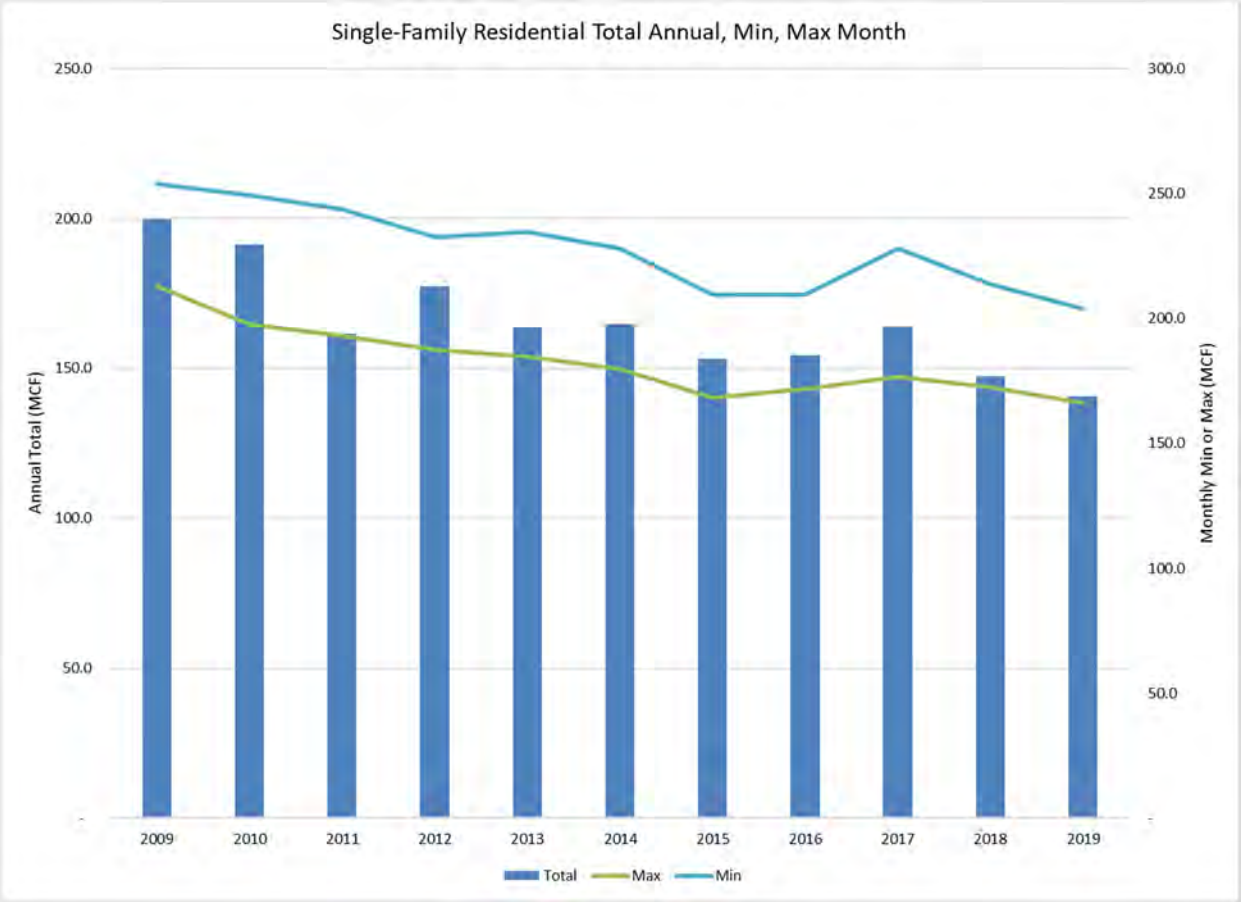

Figure 5 Single-family Residential Annual and Minimum and Maximum Month Water Use, 2009 – 2019

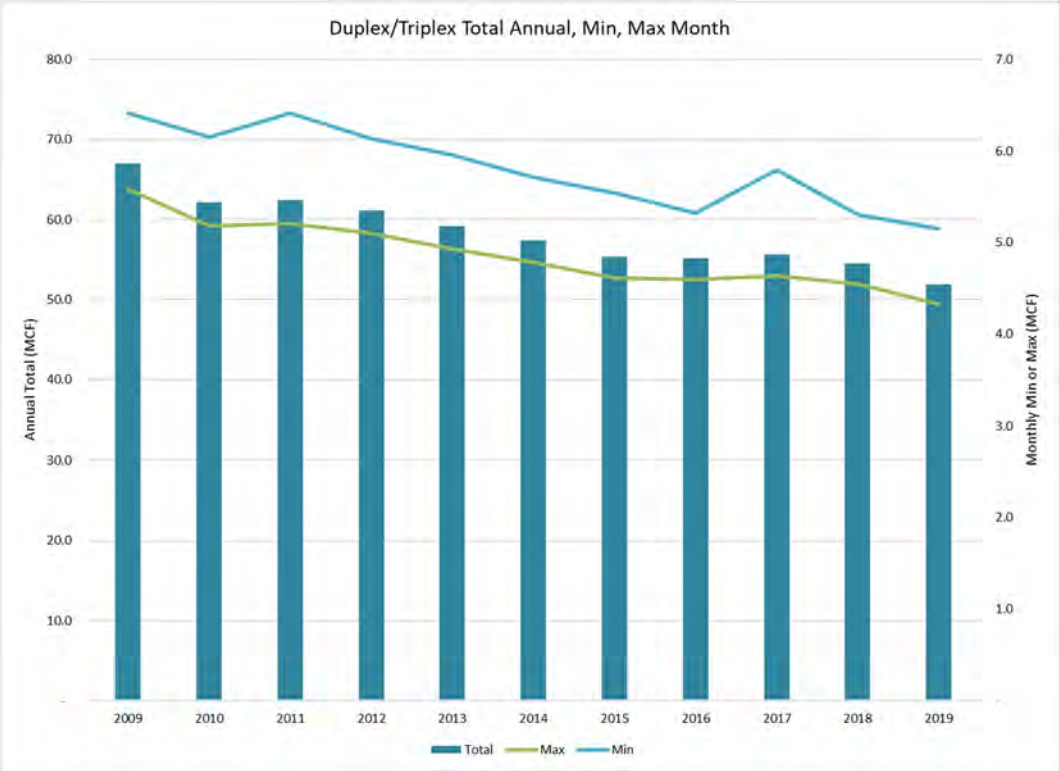

Figure 6 Duplex/Triplex Annual and Minimum and Maximum Month Water Use, 2009 – 2019

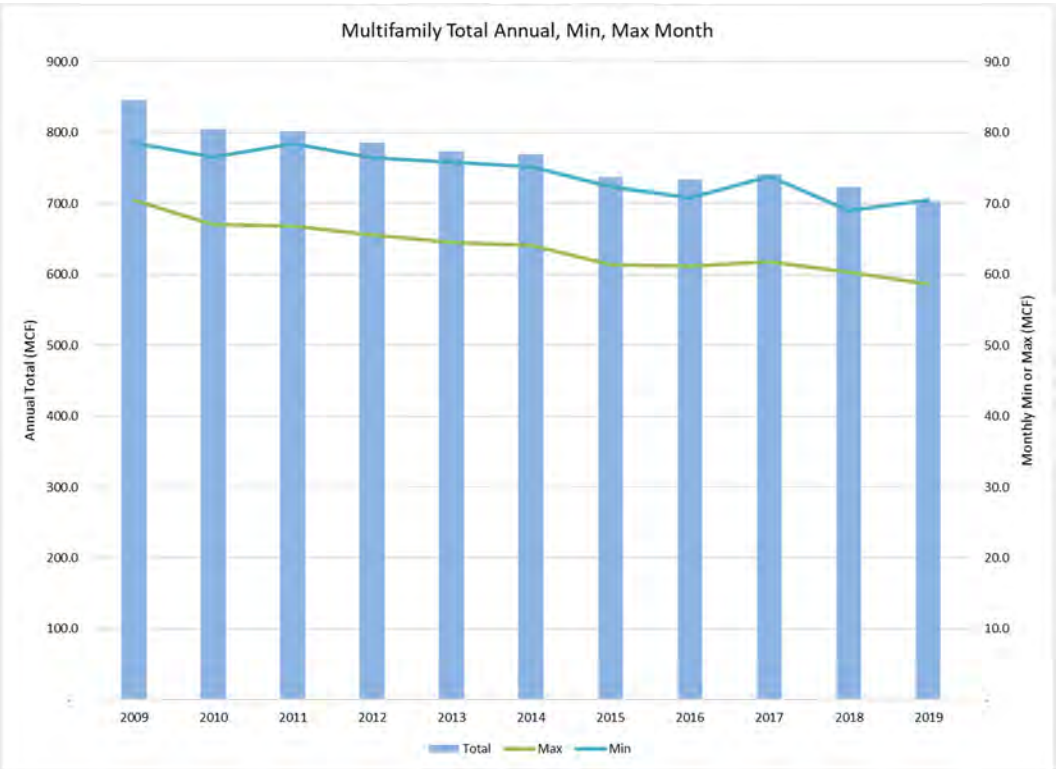

Figure 7 Multifamily Residential Annual and Minimum and Maximum Month Water Use, 2009 – 2019

Multifamily Per Unit Demand - 2018

To better inform the understanding of multifamily water use, a special data set was prepared which enabled the calculation of per unit water demand in 2018 across Tucson. To create the dataset, Tucson Water and WaterDM combined 2018 consumption data from the multifamily and the duplex and triplex categories to create a single multifamily data set that was then linked information about each property including the number of apartment or condominium units associated with each water meter. This combined dataset made it possible to calculate multifamily water use on a per unit per day basis. The results from this analysis are shown in Figure 8 and Figure 9.

The average water use in the multifamily sector is 128.8 gallons per unit per day. The median is 111 gallons per unit per day. About 90% of the multifamily properties in Tucson use less than 220 gallons per unit per day.

In Figure 9 the water use of small and large multifamily buildings is compared. In Tucson, smaller buildings with 10 units or less use a little less water on a per unit basis than larger buildings. This makes sense because larger multifamily properties are more likely to include a swimming pool, an irrigated landscape, and other common amenities that use water. Properties with between 50 and 100 dwelling units had the highest average water use. Properties with more than 100 units have a lower average per unit use.

The analysis of multifamily demand offers Tucson Water the ability to identify multifamily properties with particularly high-water use (>220 gal/unit/day) and to target water conservation efforts including rebates and landscape programs at customers with the most potential to reduce demand.

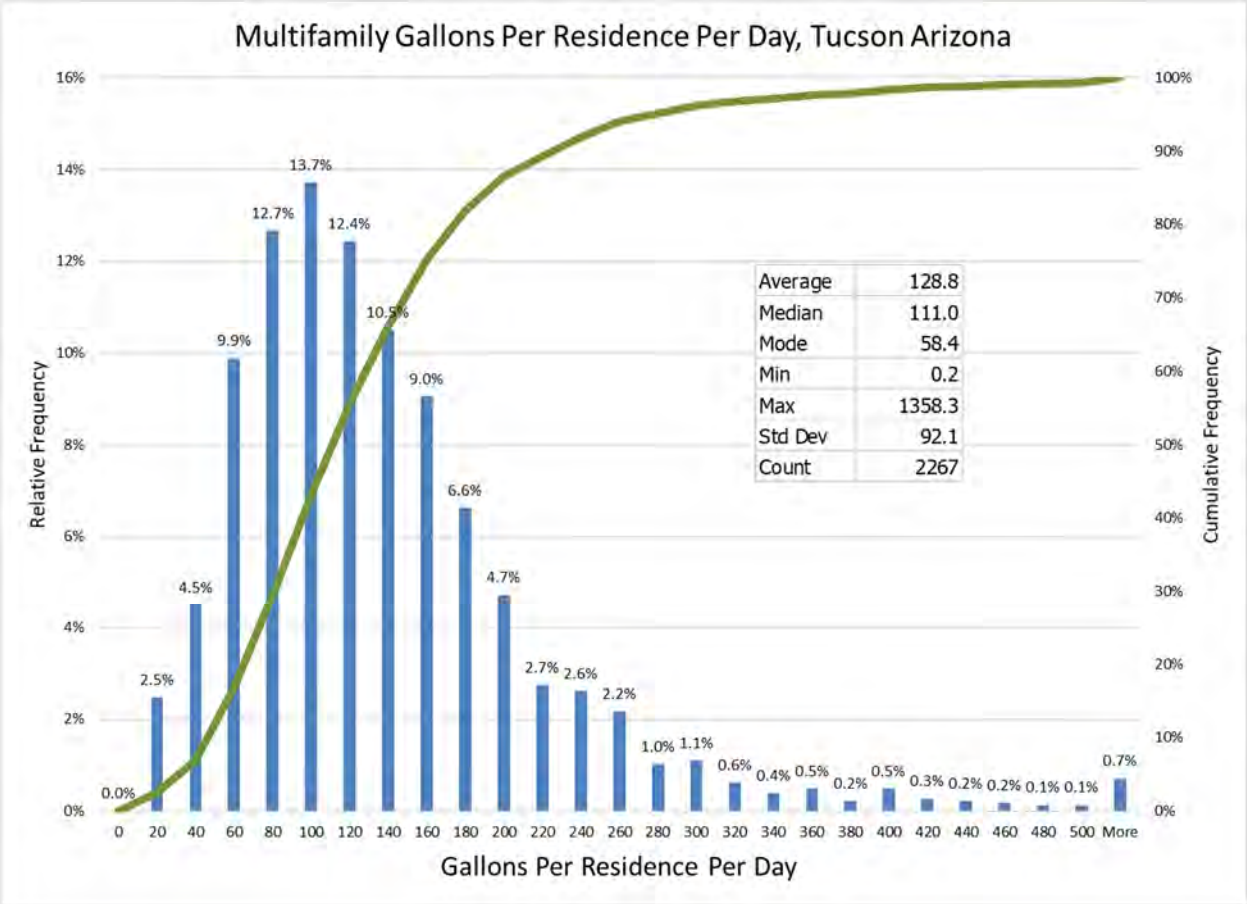

Figure 8 Multifamily Gallons per Residence per Day, 2018

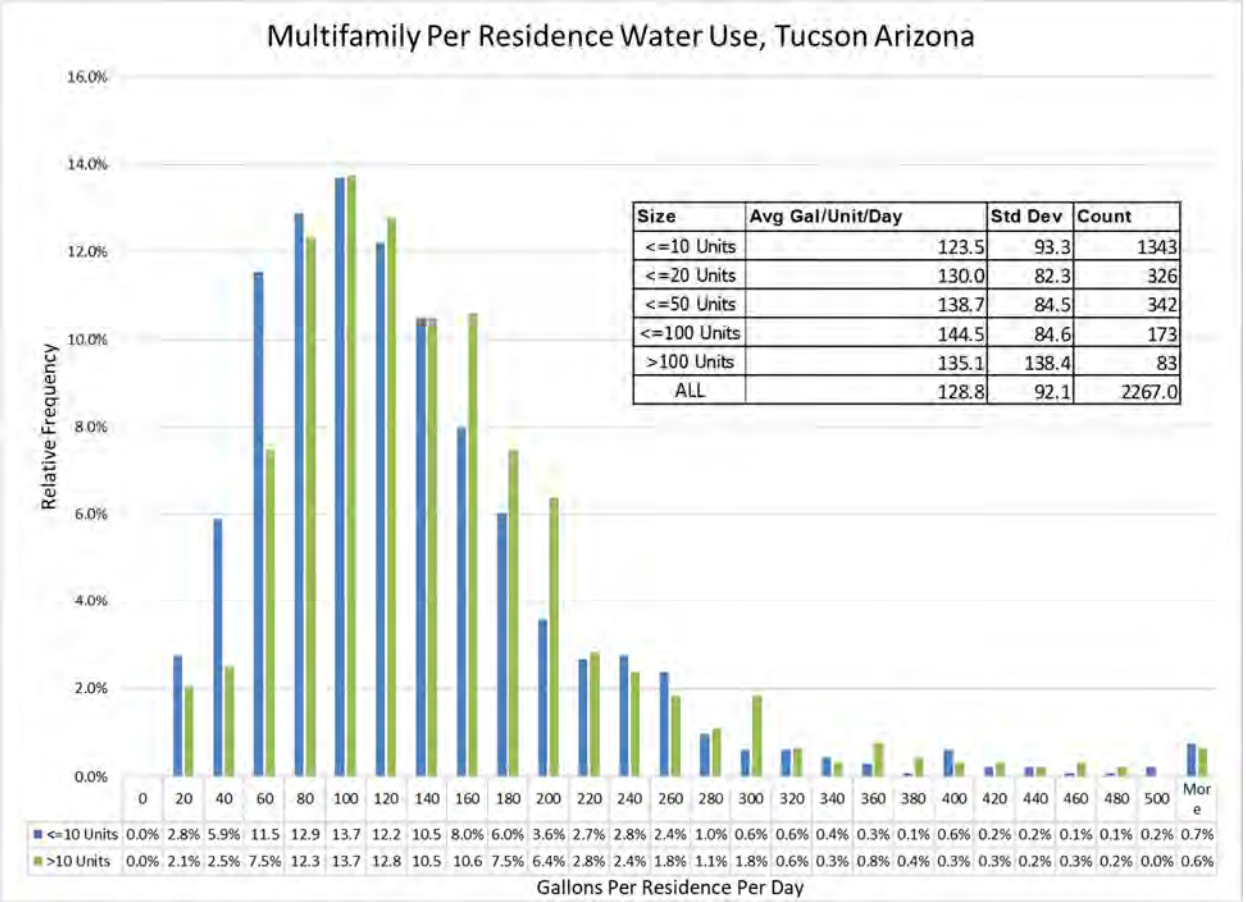

Figure 9 Multifamily Gallons per Residence per Day, Small and Large Buildings, 2018

2.2.2.2 Commercial, Industrial, and Institutional Trends

Water use in Tucson's CII sector declined since 2008 as shown in Figure 10, but the decline is less sharply defined than in the residential sectors. Minimum monthly use has not changed much since 2008 and maximum monthly use has reduced only slightly. One of the recommendations from this program analysis is to further extend and enhance commercial conservation programs based on their proportional consumption as shown in Figure 4. The fact that that residential sector has declined more steeply suggests additional potential may exist for commercial customers to increase efficiency and this sector is deserving of additional conservation program resources.

In contrast, water demand in Tucson's industrial and institutional sectors declined steeply since 2008 as shown in Figure 11. Total annual industrial sector use declined sharply from 2008 – 2015, bounced back up in 2016 and 2017 and down again in 2018. This trend also reflects the decrease in the number of industrial accounts, dropping by over 16% during this time period. Industrial users account for the smallest percent of usage of all customer classes. Both minimum monthly use and maximum monthly use followed the declining demand trend.

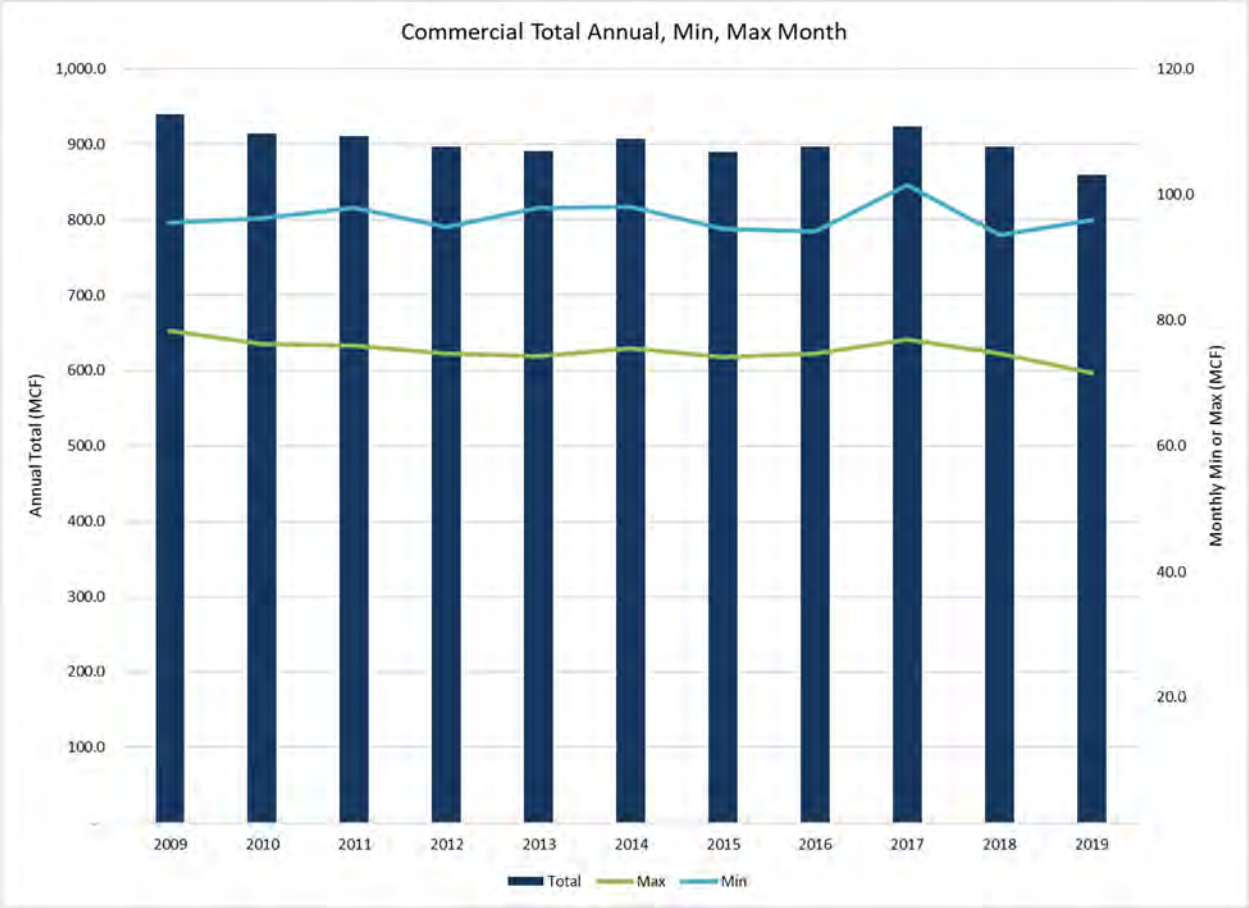

Figure 10 Commercial Annual and Minimum and Maximum Month Water Use, 2009 – 2019

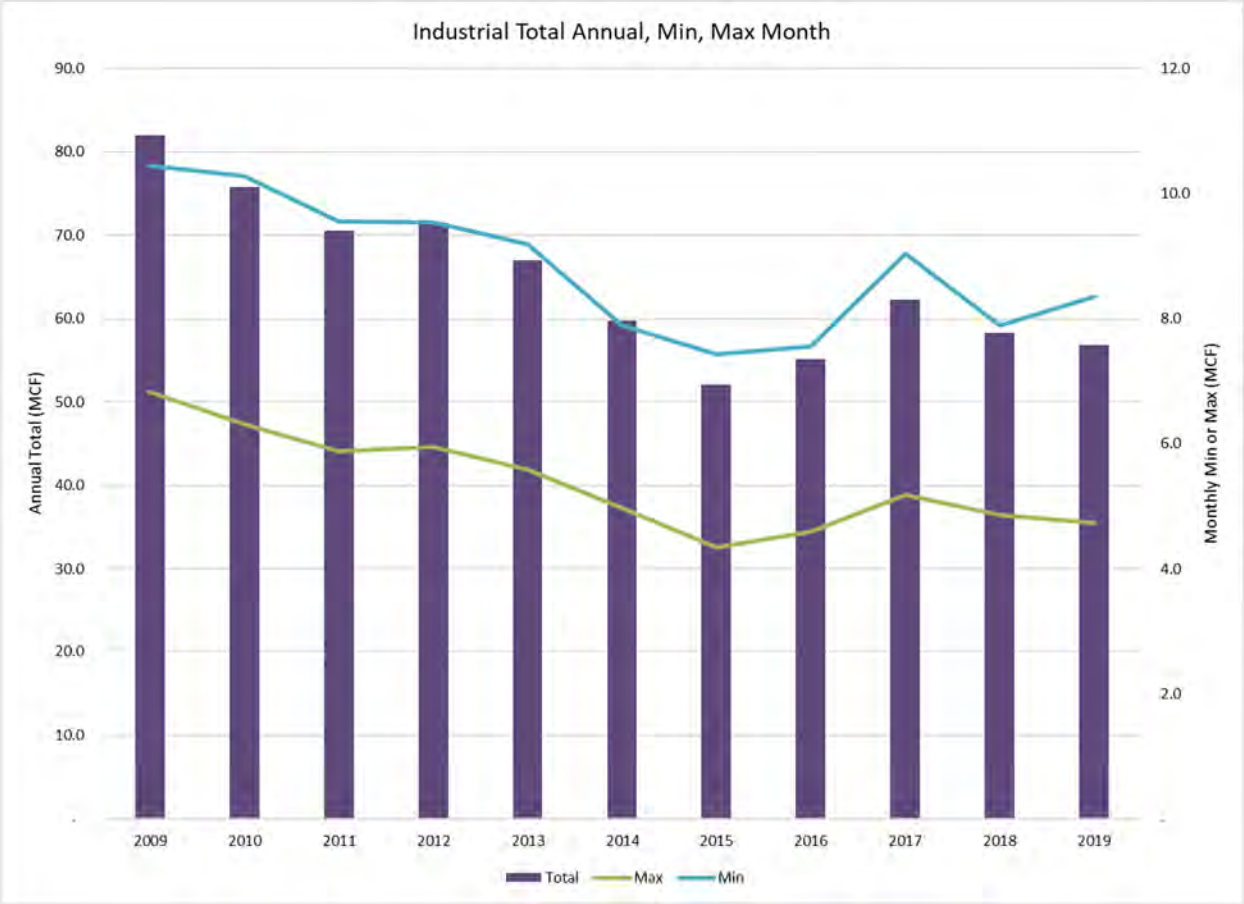

Figure 11 Industrial Annual and Minimum and Maximum Month Water Use, 2009 – 2019

3.0 Water Conservation 2030 – Ten-Year Savings Analysis

WaterDM prepared high, mid, and low range water savings estimates based on the financial incentives and rebates Tucson Water currently implements, as well as some they are evaluating and considering adding to the program. These estimates project water savings over the next 10 years, assuming annual fund revenue remains fairly constant. The mid-range estimate is based on Tucson Water's projected ten-year program implementation levels within current budget constraints. The low estimate assumes a 25% reduction in incentives and the high estimate assumes a 25% increase in incentives compared with the mid-range.

Using the mid-level savings estimate, Tucson's incentive programs alone are estimated to reduce Tucson water demand by 11,805 acre-feet over the next ten years. Summary results for each of the program implementation scenarios are shown in Table 5.

To develop the 10-year savings analysis, engineering estimates of water savings were calculated based on the goal number of incentives Tucson Water may offer each year and the estimated annual water savings achieved by each measure at the customer level. The calculated savings are combination of existing incentives that ongoing and expected to continue into the next decade and additional incentives that represent new areas of opportunity, based on emerging trends, technology and analysis findings. The useful

life of each product was also taken into consideration. Water savings accrue each year for the useful life of the specific program measure (e.g. toilet, clothes washer, etc.).

Annual average per unit annual water savings estimates were based on the best available research for each program measure.[5] In most instances the water savings estimates come from research conducted by the Alliance for Water Efficiency for their water tracking tool, or the Water Research Foundation, and in others the best available, locally relevant research was used to develop the savings estimates.

Water savings for each measure is assumed to continue and accrue for the useful life of the product. Table 3 presents the estimated useful life for each of the major incentive categories along with a source reference for the information. In general, the useful life of the measures Tucson Water implements extends beyond the 10-year time frame of this analysis.

Table 3 Useful life estimates for Tucson Water incentive programs and references

Incentive Program	Useful Life (years)	Reference for Useful Life
Single-Family HET	25	Alliance for Water Efficiency Tracking tool
Low-Income HET	25	Alliance for Water Efficiency Tracking tool
Multi-Family HET	25	Alliance for Water Efficiency Tracking tool
Commercial HET	25	Alliance for Water Efficiency Tracking tool
High-Efficiency Urinal	25	Alliance for Water Efficiency Tracking tool
Clothes Washer	15	Alliance for Water Efficiency Tracking tool
Gray Water	15	Not in AWE tracker, but set same as useful life of clothes washers since laundry water capture is the most common type of graywater system
Irrigation Upgrade	10	Alliance for Water Efficiency Tracking tool
TAP Commercial Upgrade	20	Alliance for Water Efficiency Tracking tool
Rainwater Harvesting	20	Batchelor, C., Fonseca, C. and Smits, S., 2011. *Life-cycle costs of rainwater harvesting systems.*

4.0 Conservation Program Recommendations

To develop the water savings estimate, the total anticipated water reductions from all incentivized measures that will be achieved over the next 10 years were aggregated. This provides an estimate of the water savings Tucson Water will over the next decade. This approach to estimating water savings is consistent with the approach that Tucson Water has used for many years and is similar to the method developed by the Alliance for Water Efficiency for their Water Conservation Tracking Tool.[6]

[5] The Alliance for Water Efficiency Water Conservation Tracking Tool, and the Water Research Foundation Residential, Multifamily, and CII end use studies formed the basis for the savings estimates.
[6] Water savings estimates should be reviewed and revised every five years to account for changes in fixtures and demand patterns.

4.1 10-Year Savings Estimates

A range of three water savings estimates were developed for the financial incentive and rebate program measures Tucson Water already implements and intends implement over the coming years. The range of savings estimates is shown in 4 (same as Table 1; reinserted here for reference). These engineering estimates of water savings were calculated based on quantities of incentives Tucson may offer each year, the expected useful life of each measure, and assumed annual water savings values based on research from the Alliance for Water Efficiency, the Water Research Foundation, and Tucson Water.

The mid-level water savings estimate was designed to model Tucson Water's current conservation incentive program implementation levels. The high savings estimate assumes a 25% increase in incentives compared with the mid-range and the low savings estimate assumes a 25% decrease in incentives. The specific savings contribution of each program component is shown in Table 5. The high and low estimates are presented in detail in Appendix B.

Table 4 Tucson Water New 10-Year Water Savings Estimates

Scenario	10-Year Water Savings Estimate (AF)	Avg. Savings/Yr. (AF)
High	16,931	1,693
Mid	11,661	1,166
Low	7,055	705

The low, mid and high scenarios in Table 4 are based are varying levels of rebate program activity, reflected as an annual number of incentives, and correlated to a range of costs to achieve estimated savings. These scenarios reflect conservation program design options described by staff and stakeholders gathered during input sessions in 2019. More specifically, the mid scenario reflects rebate expenditures based on the current allocation of program resources, with incentives accounting for about 30% of the total conservation budget annually. The high scenario reflects investment in additional future incentives, based on current demand trends and savings opportunities. Particularly, this technical memo identified savings potential in the commercial customer class, as well as outdoor savings in all customer classes, which may be addressed in part through incentives. The low scenario reflects a shift in resources from incentives to more investment in education, research and outreach to reinforce community-wide conservation actions. This scenario also reflects customized incentive packages for customers like Homeowners Associations and commercial businesses. Developing customized incentive packages is requires more staff resources and strong customer commitment. These constraints may reduce the number of these packages which is why this measure was included in the low estimate.

Substantial additional demand reductions beyond these estimates are expected due to Tucson Water's education and outreach efforts and through the natural replacement of older fixtures and appliances that occurs without incentive from Tucson Water. The long-term demand forecast developed for the One Water 2100 project should incorporate the totality of the impacts of the Tucson Water Conservation Program which go well beyond the more limited estimates presented in Table 5. Also included in Table 5 are

estimates of total savings including ongoing water savings from programs Tucson Water has implemented previously.[7]

[7] When forecasting future demand from the current baseline, only the future water savings estimate should be used. The total including ongoing savings from previous measures is useful for program evaluation, cost-effectiveness analysis, and understanding where water savings are being achieved.

Table 5 Mid-Range Water Savings Estimates for Financial Incentive and Rebate Program Measures

Tucson Water Conservation Program Incentive Measures	Mid-Range Items Per Year	Water Savings Per Item (gal/year)*	Mid-Range	
			10-Year Savings (MG)	10-Year Savings + Ongoing Previous (MG)
Existing Incentive Programs				
Single-Family High-Efficiency Toilet (HET)	1,500	7,483	741	2,478
Multi-Family HET	2,250	7,483	1,094	3,350
Commercial HET - (tank-type toilets)	150	8,030	78	403
Commercial HET - (flushometer-type toilets)	38	16,425	41	99
Low-Income HET	563	8,577	314	961
High-Efficiency Urinal	75	6,206	30	80
Gray Water	19	13,615	17	43
Irrigation Efficiency	0	229,950	0	76
Clothes Washer	1,125	7,043	515	1,081
Commercial Upgrade	56	40,000	146	234
Low-Income HET - Emergency Repairs	150	2,000	13	13
Rainwater harvesting rebate	225	5,535	81	81
Low Income Rainwater harvesting rebate	75	5,535	27	27
Existing Incentive Programs Total	**MG**		**3,097**	**8,926**
	Acre-Feet		**9,504**	**27,393**
Potential New Incentive Programs				
Turf removal rebates – (focus on public and non-residential, streetscapes & medians)	100	26,298	128	128
Customized landscape incentive package	100	13,149	64	64
Customized incentives for multifamily and HOAs	100	59,275	289	289
Multifamily Smart Controllers	250	1,250	15	15
Commercial Smart Controllers	250	1,250	15	15
Commercial Cooling Tower Program	20	120,000	119	119
Customer leak detection device rebate	500	2,969	72	72
Potential New Incentive Programs Total	**MG**		703	703
	Acre-Feet		2,157	2,157
Total Existing and Potential New Programs	**MG**		**3,800**	**9,629**
	Acre-Feet		**11,661**	**29,550**

Sources: Tucson Water, Alliance for Water Efficiency Water Conservation Tracking Tool, DeOreo, W. et. al. 2016. Residential End Uses of Water, Version 2. Water Research Foundation. Denver, CO.; Kiefer, J. et. al. 2018. Water Use in the Multi-Family Housing Sector. Water Research Foundation. Denver, CO.; Dziegielewski, B.et. al. 2000. Commercial and Institutional End Uses of Water. American Water Works Association and AWWA Research Foundation. ISBN 1-58321-035-0.; Chesnutt, T. et. al. 2019. Landscape Transformation: Assessment of Water Utility Program and Market Readiness Evaluation. Alliance for Water Efficiency. Chicago, IL; Tucson Water Conservation Program 2020 .

Water demand expert, Peter Mayer, P.E., Principal of WaterDM, prepared a set of recommendations for Tucson Water to consider based on his review of local and national water demand trends and Tucson's current water conservation program offerings. These recommendations are intended to increase the overall effectiveness of the Tucson Water Conservation Program to ensure continued, sustained, equitable demand reductions across all sectors of water customers.

1. **Adjust rebate levels and increase efficiency of fixtures and appliances for which rebates are offered to increase cost-effectiveness.**

Tucson Water only incentivizes the purchase of high-efficiency products that offer measurable improvement over other available options. To ensure this continues, fixture efficiency and performance must be considered because the volumetric differences between some products have become smaller. For example, the efficiency level of the toilets eligible for rebates can be reduced from 1.28 to 1.1 gallons/flush based on Maximum Performance Testing (MaP) scores, and similar adjustments could be made in the future if clothes washer efficiency increases. Tucson Water conservation staff should continue to manage both the efficiency level of incentivized products and the dollar amount of the incentive offered over the next decade to make best use of available funding and to ensure maximum water savings.

2. **Increased emphasis on commercial customers.**

Water demand in the commercial sector did not decline significantly over the past 10 years as it has in other sectors. Over the next 10 years Tucson Water could renew focus on commercial customers. This could include increased marketing of the customized efficiency packages created to fit the requirement of the customer.

For large water users such as multifamily complexes, HOAs, commercial properties, schools, and other institutional customers, Tucson Water currently offers the combination of account analysis and a water audit to identify areas for improvement, coupled with a package of financial incentives to pay for implementing the recommended efficiency improvements. The customized efficiency packages can include incentives for both indoor and outdoor measures including fixture replacement and landscape changes. It is recommended that Tucson Water increase the emphasis of this effort for commercial properties which will likely require extended outreach to high-demand commercial customers.

3. **Expand focus on desert-adapted landscapes.**

Tucson's urban landscape has undergone multiple transformations over the last half-century. As Tucson's population grew, water-intensive, non-native species and large amounts of turf gained popularity, but necessary water demand management led to widespread adoption of xeric plants over the last several decades. Today, sustainable practices like water harvesting are visible throughout the community. Given future climate projections and the policy focus of increasing shade canopy to reduce the urban heat island impact and mitigate community hotspots, there is a present opportunity for the next era of urban landscape transformation. A focus on landscape water-efficiency and resiliency, including increased tree canopy, and the continued transformation of high-water demand landscapes must be a cornerstone of the Tucson Water Conservation Program. It is recommended that Tucson Water expand efforts to incentivize customers to remove high-water use landscape areas and replace them with appropriate, desert-adapted landscapes, including trees, that requires less water.

This effort would be aided by the further strategic development of landscape water budgets which enable the conservation team to identify customers who are using water inefficiently outdoors. Many Tucson Water customers are already highly efficient in their outdoor use but identifying those who are not provides a way to target landscape transformation incentives to those customers with real opportunity to reduce use.

4. **Improve Tucson Water's ability to understand customer water use and ability to target conservation programs with customer-specific water budgets.**

Tucson Water's recently updated Drought Preparedness and Response Plan clearly ties Tucson's drought stages to water levels in Lake Mead and Tucson Water's Central Arizona Project (CAP) allocation. It also introduces the concept of customer-specific "water use guidelines" which will be used to help customers and Tucson Water understand who is using water reasonably and efficiently and who is not. Water use guidelines are synonym for the more technical term "water budgets", which is the quantity of water that is required for an efficient level of use.

Tucson Water has begun to develop landscape water budgets as a tool for targeting water efficiency, managing demand across the service area and extending outreach to the commercial sector. Tucson Water plans to expand development of customer-specific water use guidelines, which can include both indoor and landscape water budgets, for use in the water conservation program and in the drought response planning process.

5. **Increase customer-side leak detection.**

Large customer-side water leaks caused by toilets, irrigation systems, leaky services lines, fixtures left on, or other sources occur infrequently, but when they do happen, substantial volumes of water are wasted. New technology for monitoring water uses at the customer level, either through utility-scale advanced metering infrastructure (AMI) or using customer-level devices capable of detecting leaks is now widely available. The Tucson Water Conservation Program should continue to explore, deploy, and incentivize these technologies whenever appropriate. Reducing customer-side leakage should be an important water savings measure going forward.

6. **Support efforts to improve fixture efficiency in plumbing and building codes.**

Strong plumbing codes have proven one of the most effective ways to ensure water efficiency today and into the future. The efficiency of fixtures like toilets and faucets that can be installed in Tucson is established in the International Plumbing Code, 2012 Edition, which sets maximum uses for indoor fixtures.

Since 2012, the voluntary EPA WaterSense program has increased the efficiency of toilets, showerheads, faucets, and other water using fixtures and equipment. WaterSense sets voluntary efficiency standards that manufacturers may choose to meet and thus receive the WaterSense label designating the product for water efficiency and performance. Yet uncertainty about long-term funding for WaterSense make it problematic to include in codes.

To increase the efficiency of fixtures in all new buildings and remodels, Tucson could adopt an updated version of the International Plumbing Code or the Green Plumbing and Mechanical Code Supplement from IAPMO (www.iapmo.org), which includes specifications for high-efficiency fixtures. This would help ensure that only high-efficiency fixtures and appliances are installed in both new construction and renovation projects. Tucson Water conservation staff should work with stakeholders and the City's Planning and Development Services Department to advance this effort in the coming years.

5.0 Summary

Water conservation is an essential component of Tucson Water's long-term strategy to provide high-quality, reliable water service for the future. A water conservation program does not produce additional water resources above and beyond what is physically available. Instead, it preserves and extends currently available water supplies by increasing water-use efficiency and reducing per capita use. With this goal in mind, the Tucson Water Conservation Program's investments in the community and outreach to water users has demonstrably and steadily decreased per capita use and total water demand for more than 20 years.

The importance of water conservation to Tucson to the community and the long-term sustainability of the City motivated Tucson Water to take a closer look at the impact and future water savings of the Water Conservation Program in conjunction with the One Water 2100 Master Plan.

5.1 Water Conservation Program Recommendations

WaterDM, prepared a set of recommendations for Tucson Water to consider based on a review of local and national water demand trends and Tucson's current water conservation program offerings. These recommendations are intended to increase the overall effectiveness of the Tucson Water Conservation Program to ensure continued, sustained, equitable demand reductions across all sectors of water customers.

WaterDM's six recommendations are:

1. Adjust rebate levels and increase efficiency of fixtures and appliances for which rebates are offered to increase cost-effectiveness.
2. Increased savings opportunities for commercial customers.
3. Expand focus on outdoor water use, with emphasis on resilient, desert-adapted landscapes.
4. Improve Tucson Water's ability to understand customer water use and ability to target conservation programs with customer-specific water budgets.
5. Increase customer-side leak detection to reduce water waste and loss.
6. Support efforts to improve fixture efficiency in plumbing and building codes and consider additional policies to ensure community water savings.

5.2 Estimated 10-Year Water Savings

Over the next ten years, Tucson Water intends to extend and strengthen its water conservation program with the goal of saving an additional 11,805 acre-feet of water directly through the implementation of a wide range of indoor and outdoor measures and substantially more through pricing, codes and standards, and education programs.

A range of three water savings estimates were developed for the financial incentive and rebate program measures Tucson Water intends implement over the coming years. Using the mid-level savings estimate, Tucson's incentive programs alone are estimated to reduce Tucson water demand by 11,805 acre-feet over the next ten years. The engineering estimates of water savings were calculated based on the quantities of incentives Tucson may offer and annual water savings values based on research conducted by Tucson Water and WaterDM.

Additional demand reductions beyond these estimates are expected through Tucson Water's education and outreach efforts and through the natural replacement of older fixtures and appliances that occurs without incentive from Tucson Water. The long-term demand forecast developed for the One Water 2100 project developed by Jacobs incorporates the totality of the impacts of the Tucson Water Conservation Program and passive savings that will continue to accrue from previous incentives.

6.0 References

American Water Works Association. 2013. G480 Water Conservation Program Operation and Management Standard. AWWA. Denver, CO.

DeOreo, W.B., P. Mayer, J. Kiefer, and B. Dziegielewski. 2016. Residential End Uses of Water, Version 2. Water Research Foundation. Denver, CO.

Kiefer, J.C. and L.R. Krenz. 2018 Water Use in the Multifamily Housing Sector. Water Research Foundation. Denver, Colorado.

Mayer, P., W. DeOreo, T. Chesnutt, D. Pekelney, L. Summers. 2008. Water Budgets and Rate Structures: Innovative Management Tools. Water Research Foundation. Denver, Colorado.

Mayer, P.W., W.B. DeOreo, et. al. 1999. Residential End Uses of Water. American Water Works Association Research Foundation, Denver, Colorado.

Mayer, P.W. 2017. Water Conservation Keeps Rates Low in Tucson, Arizona. Alliance for Water Efficiency. Chicago, IL.

Rupprecht, C., M.M. Hamilton, and P.W. Mayer. 2020. Tucson Examines the Rate Impacts of Increased Water Efficiency and Finds Customer Savings. Journal of the American Water Works Association. January 2020, pp. 33-39. https://awwa.onlinelibrary.wiley.com/doi/10.1002/awwa.1429

7.0 Appendix A

7.1 AWWA G480 Water Conservation Standard Checklist

The American Water Works Association G480 Water Conservation Standard is a voluntary G-series standard that sets out minimum requirements for effective water conservation programs. Peter Mayer of WaterDM sat on the committee that developed the G40 standard in 2013 and 2020. WaterDM has prepared a check-list to help water utilities determine if they are fully compliant with the G480's 2020 voluntary requirements. Tucson Water meets or exceeds most of the G480 requirements and is almost fully compliant with this industry performance standard.

Water Conservation Program Operation and Management ANSI/AWWA G48-20		Tucson Water
		Yes/No/NA
4.1	Regulatory Requirements	Yes
4.1.1	Meets or exceeds state and local regulatory requirements	Yes
4.2	Top-Level Organization Functions	Yes
4.2.1	Staff for conservation initiatives (point of contact)	Yes
4.2.2	Water conservation & efficiency planning	Yes
4.2.3	Water efficiency in integrated resources planning	Yes
4.2.4	Water shortage or drought plan	Yes
4.2.5	Public information and education program	Yes
4.2.6	Water waste ordinance	Yes
4.3	Internal Utility Actions and Requirements	Yes
4.3.1	Metering of all sources and service connections	Yes
4.3.1.1	Universal metering (in progress at least)	Yes
4.3.1.2	Source water metering	Yes
4.3.2.1	Nonpromotional rate structure with financial incentive to reduce use	Yes
4.3.2.2	Volumetric components in sewer rate structure	Yes
4.3.3	Billing Practices	Yes
4.3.3.1	Monthly or bi-monthly billing	Yes
4.3.3.2	Bills clearly report consumption	Yes

4.3.3.3	Estimated readings a maximum of twice per year	Yes
4.3.4	Landscape efficiency program	Yes
4.3.4.1	Programs to improve design, installation, and maintenance practices	Yes
4.3.4.2	Irrigation scheduling based on plant needs and time of day	Yes
4.3.4.3	Landscape water budgets	Yes
4.3.4.4	Landscape transformations	Yes
4.3.5	Water loss control program	Yes
4.3.5.1	Utility water audit	Yes
4.3.5.2	Water audit validation	No
4.3.5.3	Public availability of water loss audit	No
4.4	External Policy Requirements	Yes
4.4.1	Water efficiency in building codes and standards	Yes
4.4.2	Integration of water efficiency and land use planning	Yes
4.5	Wholesale agency requirements	NA

8.0 Appendix B

8.1 Conservation Program Low and High Range Estimates

Table 6 High-Range Water Savings Estimates for Financial Incentive and Rebate Program Measures

Tucson Water Conservation Program Incentive Measures	High-Range Items Per Year	Water Savings Per Item (gal/year)*	High-Range	
			New 10-Year Savings (MG)	New + Ongoing 10-Year Savings (MG)
Existing Incentive Programs				
Single-Family High-Efficiency Toilet (HET)	2,000	7,483	988	2,725
Multi-Family HET	3,000	7,483	1,459	3,715
Commercial HET - (tank-type toilets)	200	8,030	377	429
Commercial HET - (flushometer-type toilets)	50	16,425	85	112
Low-Income HET	750	8,578	857	1,066
High-Efficiency Urinal	100	6,206	70	90
Gray Water	25	13,615	37	48
Irrigation Efficiency	0	229,950	0	76
Clothes Washer	1,500	7,043	909	1,253
Commercial Upgrade	75	40,000	185	283
Low-Income HET - Emergency Repairs	200	2,000	9	18
Rainwater harvesting rebate	300	5,535	54	108
Low Income Rainwater harvesting rebate	100	5,535	18	36
Existing Incentive Programs Total	MG		5,048	9,958
	Acre-Feet		15,493	30,561
Potential New Incentive Programs				
Turf removal rebates – (focus on public and non-residential, streetscapes & medians)	100	26,298	85	85
Customized landscape incentive package	100	13,149	43	43
Customized incentives for multifamily and HOAs	100	59,275	193	193

Multifamily Smart Controllers	250	1,250	10	10
Commercial Smart Controllers	250	1,250	10	10
Commercial Cooling Tower Program	20	120,000	79	79
Customer leak detection device rebate	500	2,969	48	48
Potential New Incentive Programs Total	MG		469	469
	Acre-Feet		1,438	1,438
Total Existing and Potential New Programs	MG		5,517	10,427
	Acre-Feet		16,931	31,999

Sources: Tucson Water, Alliance for Water Efficiency Water Conservation Tracking Tool, DeOreo, W. et. al. 2016. Residential End Uses of Water, Version 2. Water Research Foundation. Denver, CO.; Kiefer, J. et. al. 2018. Water Use in the Multi-Family Housing Sector. Water Research Foundation. Denver, CO.; Dziegielewski, B.et. al. 2000. Commercial and Institutional End Uses of Water. American Water Works Association and AWWA Research Foundation. ISBN 1-58321-035-0.; Chesnutt, T. et. al. 2019. Landscape Transformation: Assessment of Water Utility Program and Market Readiness Evaluation. Alliance for Water Efficiency. Chicago, IL.

Table 7 Low-Range Water Savings Estimates for Financial Incentive and Rebate Program Measures

Tucson Water Conservation Program Incentive Measures	Low-Range Items Per Year	Water Savings Per Item (gal/year)*	Low-Range	
			New 10-Year Savings (MG)	New + Ongoing 10-Year Savings (gal)
Existing Incentive Programs				
Single-Family High-Efficiency Toilet (HET)	1,000	7,483	494	2,231
Multi-Family HET	1,500	7,483	730	2,985
Commercial HET - (tank-type toilets)	100	8,030	52	377
Commercial HET - (flushometer-type toilets)	25	16,425	27	85
Low-Income HET	375	8,578	209	857
High-Efficiency Urinal	50	6,206	20	70
Gray Water	13	13,615	11	37
Irrigation Efficiency	-	229,950	0	0
Clothes Washer	750	7,043	343	909
Commercial Upgrade	38	40,000	98	185
Low-Income HET - Emergency Repairs	100	2,000	9	9
Rainwater harvesting rebate	150	5,535	54	54
Low Income Rainwater harvesting rebate	50	5,535	18	18
Existing Incentive Programs Total			2,065	7,818
			6,336	23,992
Potential New Incentive Programs				
Turf removal rebates – (focus on public and non-residential, streetscapes & medians)	50	26,298	43	43
Customized landscape incentive package	50	13,149	21	21
Customized incentives for multifamily and HOAs	50	59,275	96	96
Multifamily Smart Controllers	125	1,250	5	5

Commercial Smart Controllers	125	1,250	5	5
Commercial Cooling Tower Program	10	120,000	40	40
Customer leak detection device rebate	250	2,969	24	24
Potential New Incentive Programs Total	MG		234	234
	Acre-Feet		719	719
Total Existing and Potential New Programs	MG		2,299	8,052
	Acre-Feet		7,055	24,711

Sources: Tucson Water, Alliance for Water Efficiency Water Conservation Tracking Tool, DeOreo, W. et. al. 2016. Residential End Uses of Water, Version 2. Water Research Foundation. Denver, CO.; Kiefer, J. et. al. 2018. Water Use in the Multi-Family Housing Sector. Water Research Foundation. Denver, CO.; Dziegielewski, B.et. al. 2000. Commercial and Institutional End Uses of Water. American Water Works Association and AWWA Research Foundation. ISBN 1-58321-035-0.; Chesnutt, T. et. al. 2019. Landscape Transformation: Assessment of Water Utility Program and Market Readiness Evaluation. Alliance for Water Efficiency. Chicago, IL.